Karlsruher Institut für Technologie

Module Handbook
M.Sc. Biomedical Engineering Master 2025 (Master of Science)

SPO 2025

Winter semester 2025/26

Date: 05/06/2025

KIT DEPARTMENT OF ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY

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14.103. Integrated Systems and Circuits - T-ETIT-100972 451
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14.108. Introduction to Nanotechnology - T-MACH-111814 456
14.109. Introduction to the Finite Element Method - T-MACH-105320 457
14.110. Introduction to the Scientific Method (Seminar, Englisch) - T-ETIT-111317 458
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14.113. Lab Computer-Aided Methods for Measurement and Control - T-MACH-105341 461
14.114. Lab Course on Nanoelectronics - T-ETIT-100757 462
14.115. Lab Course on Noise Thermometry - T-ETIT-112714 463
14.116. Lab course on superconducting materials - T-ETIT-111242 464
14.117. Lab Course Printed Flexible Electronics - T-ETIT-113075 465
14.118. Lab Course Robotic Winding Technology for Superconducting Wires - T-ETIT-114158 466
14.119. Laboratory FPGA Based Circuit Design - T-ETIT-100759 467
14.120. Laboratory in Software Engineering - T-ETIT-100681 468
14.121. Laboratory Information Systems in Power Engineering - T-ETIT-114183 469
14.122. Laboratory Lighting Technology - T-ETIT-104726 470
14.123. Laboratory Mechatronic Measurement Systems - T-ETIT-106854 471
14.124. Laboratory Modern Software Tools in Power Engineering - T-ETIT-110898 472
14.125. Laboratory Nanotechnology - T-ETIT-100765 473
14.126. Laboratory Optoelectronics - T-ETIT-100764 474
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14.189. Plasma Sources - T-ETIT-100768 ... 537
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14.191. Polymers in MEMS B: Physics, Microstructuring and Applications - T-MACH-102191 ... 539
14.192. Polymers in MEMS C: Biopolymers and Bioplastics - T-MACH-102200 ... 540
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14.197. Practical Course: Machine Learning and Intelligent Systems - T-INFO-112104 ... 545
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14.228. Self Assignment-HOC-SPZ-Forum-ungraded - T-ETIT-111690 576
14.229. Self Assignment-HOC-SPZ-FORUM-ungraded - T-ETIT-111533 577
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14.248. Signal Processing in Communications - T-ETIT-100747 596
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14.252. SIL Entrepreneurship Project - T-WIWI-110166 600
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14.255. Software Engineering - T-ETIT-108347 603
14.256. Sol-Gel Processes - T-CIWVT-108822 604
14.257. Source Coding Techniques - T-ETIT-110673 605
14.258. Strategy Derivation for Engineers - T-ETIT-111369 606
14.259. Superconducting Magnet Technology - T-ETIT-113440 607
14.260. Superconducting Materials - T-ETIT-111096 608
14.261. Superconducting Nanowire Detectors - T-ETIT-111236 609
14.262. Superconductivity for Engineers - T-ETIT-111239 610
14.263. Surface Science, without Exercises - T-PHYS-113099 611
14.264. Sustainable Product Engineering - T-MACH-114033 612
14.265. System Integration and Communication Structures in Industry 4.0 and IoT - T-ETIT-112212 613
14.266. System Integration in Micro- and Nanotechnology - T-MACH-105555 614
14.267. System Integration in Micro- and Nanotechnology 2 - T-MACH-110272 615
14.268. System-on-Chip Laboratory - T-ETIT-100798 616
14.269. Systems and Software Engineering - T-ETIT-100675 617
14.270. Systems Engineering for Automotive Electronics - T-ETIT-100677 618
14.271. Team Project: Sensors and Electronics - T-ETIT-111007 619
14.272. Technical Acoustic - T-ETIT-104579 620

14.273. Technical Optics - T-ETIT-100804 621
14.274. Technologies in Radiotherapy - T-ETIT-114338 622
14.275. Test of Embedded Systems in Industrial Contexts - T-ETIT-100811 623
14.276. Thermal-Fluid-Dynamics - T-MACH-106372 624
14.277. Tutorial Introduction to the Finite Element Method - T-MACH-110330 625
14.278. Tutorial Mathematical Methods in Continuum Mechanics - T-MACH-110376 626
14.279. Ubiquitous Computing - T-INFO-114188 627
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1 Preamble

1.1 Overview of the degree program

The Master's degree program in Biomedical Engineering at the Karlsruhe Institute of Technology (KIT) is divided into the four subjects:

- Profiling Modules (42 CR)
- Elective Modules (42 CR)
- Interdisciplinary Qualification (6 CR)
- Master’s Thesis (30 CR)

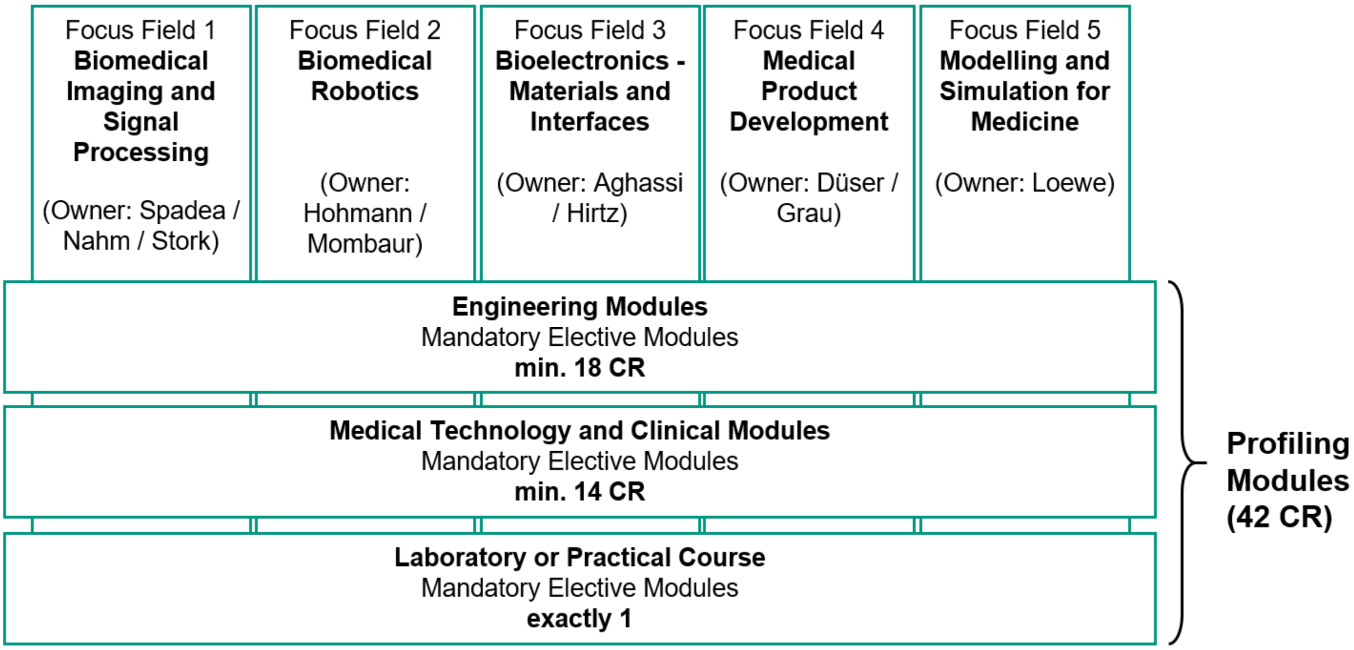
Profiling Modules

The “Profiling Modules” are subdivided into:

- Engineering Modules (min. 18 CR)
- Medical Technology and Clinical Modules (min. 14 CR)
- One Laboratory or Practical Course

Furthermore, there are five “Focus Fields” that provide the students an orientation and recommendation for possible study courses and thus a guideline of reasonable module combinations. The “Focus Fields” are:

- Biomedical Imaging and Signal Processing
- Biomedical Robotics
- Bioelectronics - Materials and Interfaces
- Medical Product Development
- Modelling and Simulation for Medicine



2 Introduction to the Module Handbook

2.1 General

The legal basis for the degree program and the conduct of examinations are the valid study and examination regulations (soon at the website of the Master program service).

The degree program is divided into subjects. Each subject in turn is divided into modules. Each module consists of one or more interrelated courses, which are concluded by a competence certificate. The scope of each module is indicated by credit points (CR), which are recorded in the curriculum after successful completion of the module.

The study and examination regulations define the subjects (and their scope) that are assigned to the compulsory modules and/or the elective modules in the degree program.

The **compulsory modules** include the part of the program that constitutes the program-specific subject profile.

The **elective modules** serve to sharpen or expand the profile and allow interdisciplinary combinations or application-oriented supplements.

Interdisciplinary qualifications are modules with a predominantly non-technical content; these must be passed with evaluated proof of credit points. The modules have to be selected from the range of courses offered by the House of Competence (HOC), the Centre for Cultural and General Studies (ZAK), and the Language Center (SPZ), as well as from courses offered by the KIT-Department of Electrical Engineering and Information Technology or other KIT departments.

Achievements can be booked into the module "Interdisciplinary Qualifications" by the students themselves. Students can access the module via the menu item "Exam Registration and Unregistration", which can also be used to access the study schedule. Here you will find a new tab "ÜQ/SQ-Leistungen", which displays the list of your unassigned achievements.

Subsequently, these have to be assigned to the courses ('Teilleistungen') with the title 'Self Assignment-HOC-SPZ-ZAK ...' according to the grading scale, graded or ungraded. Title and credits of the achievement are then adopted automatically.

The **Module Handbook** describes the modules that are part of the degree program. It contains:

- the composition of the modules
- the size of the modules (in CR)
- the average workload (in hours)
- the interdependencies of the modules
- the competence goals of the modules
- the type of competence certificate
- the calculation of the module grade

The Module Handbook thus provides the necessary orientation in the course of studies. Detailed information about the various lectures, exercises and seminars can be found in the course catalog.

You will find all information concerning the legal framework of your studies in the respective study and examination regulations of your degree program (soon at the website of the Master program service).

2.2 Notes on modules and courses

Level indication for the modules

Level 1 = 1st + 2nd semester Bachelor
Level 2 = 3rd + 4th semester Bachelor
Level 3 = 5th + 6th semester Bachelor
Level 4 = Master

Workload and credit points

Each credit point corresponds to an average workload of approx. 30 h. This effort is necessary for the students to achieve an average performance.

Versions of modules and courses

This specification provides information about the currently valid version of the module or the course. A new version is generated, for example, if an adjustment of the CR was carried out in the module or course. You will automatically receive the valid version in your curriculum. If you have already started a module, you can complete the module in the version you have started (grandfathering).

Course type

Describes the type of competence certificate according to the study and examination regulations § 4. Competence certificates are subdivided into course works or examinations.

Examinations are graded

1. written examinations,
2. oral examinations, or
3. examinations of another type

Course works are ungraded written, oral, or practical achievements that students usually complete during the course.

Events (lectures, exercises, tutorials, seminars)

In the chapter "Courses" the corresponding events of the current and the previous semester are shown in tabular form. For modules that are not offered every semester, you will thus receive complete information on the associated courses.

2.3 Registration and admission to module examinations

In order to take module examinations, students must register for the examination online in the student portal.

In exceptional cases, registration may be made in written form at the *Studierendenservice* (Student Services) or at another facility authorized by the *Studierendenservice*. Registration deadlines for the competence certificates may be set by the examiners.

Where elective options exist, students make a binding declaration of module choice when registering for the examination. Upon application of the student to the examination board, the choice or assignment may be changed subsequently.

Each module and competence certificate may be assessed only once in the same degree program.

An examination will be passed, if the grade is at least "sufficient" (4.0). A module will be passed if all required courses are passed.

3 Competence Goals

Through a research-oriented and practice-related orientation of the four-semester master's program, graduates of the KIT Biomedical Engineering program are prepared for the current challenges in the fields of research, development and translation of new technologies for the prevention, diagnosis and treatment of diseases. At the same time, graduates acquire the scientific qualification for a further scientific career, e.g. a doctorate.

Graduates of the BME master's program at KIT have all the competencies needed to translate medical and health care problems into engineering tasks and to develop solutions responsibly under technical, regulatory, economic and social conditions.

The professional competence profile of the program addresses the digitization and informationalization of health care and is based on three pillars: engineering expertise, medical application expertise and methodological competence for the development and placing on the market of medical devices and systems.

The competency profile includes the ability to collaborate in an interdisciplinary environment of physicians, engineers, computer scientists and natural scientists. The competencies also include the ability to communicate clearly and effectively and the understanding of the ethical and legal aspects of biomedical research and practice.

4 Master‘s thesis registration

4.1 Procedure for admission/registration of the Master’s thesis

Consultation with an examiner of the KIT-Department of Electrical Engineering and Information Technology regarding the topic.

For the preparation of an external Master's thesis, the examiner must sign a confirmation of supervision, which the students receive from the Master's examination board after submission of the approved individual study plan and fulfillment of the requirements.

After the examiner has installed the thesis in the CAMPUS system, the student will receive an automatic e-mail requesting him/her to register for the thesis in CAMPUS. After that the student registers for the thesis in CAMPUS.

The examiner enters the date of assignment and makes the "Examination Master Thesis" visible to the student ("Publication").

The examination board checks whether the prerequisites (see above) have been met. The approved individual study plan must be available at this step at the latest. A later change of the individual study plan is not possible. If all prerequisites are met, the student will receive an e-mail that the thesis has been approved. Work on the thesis before this approval is not permitted.

The student prepares the Master’s thesis and gives the presentation within the processing time. The time of submission will be recorded.

The examiner evaluates the work and enters and releases the grade in the CAMPUS system. The examination board makes the grade visible to the student ("publication"). The student receives an e-mail that the grade of the thesis has been entered in the system.

5 Recognition of external study and examination achievements

5.1 Basic regulations

The basic rules for the recognition of external achievements (credits and grades) can be found in the study and examination regulations:

- Bachelor ETIT SPO 2015 of 31.05.2015, §19
- Bachelor ETIT SPO 2018 of 28.09.2018, §19
- Bachelor ETIT SPO 2023 of 27.04.2023, §19
- Bachelor Medizintechnik SPO of 12.07.2022, §19
- Bachelor Medizintechnik Änderungssatzung of 28.04.2023
- Master ETIT SPO 2015 of 31.05.2015, §18
- Master ETIT SPO 2018 of 28.09.2018, §18
- Master Biomedical Engineering of 21.05.2025, §18

According to these regulations, the achievements required in the curriculum can also be achieved through recognition of external credits and grades.

External achievements may be acquired as follows:
1. within the higher education system (worldwide)
2. outside the higher education system (at institutions with standardized quality assurance systems; recognition may be denied if more than 50 percent of the curriculum are to be substituted)

Recognition is granted upon application by the student. With regard to the acquired competencies, it must be ensured that there is no significant difference to the achievements or degrees that are to be replaced. The application must be submitted within the first semester after enrollment at KIT.

The examination board is responsible for recognition and crediting and involves the responsible program consultant in the decision. Recognized credits and grades that were not achieved at KIT are shown as "recognized" in the transcript of records.

5.2 Grading

If the external grading system is comparable, the grade of the achievements to be recognized is adopted. If the grading system is not comparable, the grade is converted.

5.3 Procedure

1. **Present the application form and the required documents*** **to a subject examiner****.
   Important: Recognitions must be applied for at the examination board within the first semester after enrolment
2. In case of equivalence of the acquired competence goals, this is **confirmed with a stamp and signature by the subject examiner**.
3. **Hand in the completed and signed application together with the corresponding transcript of records to the office of the examination board.**

Note on examinations abroad
It is advisable to discuss planned external examinations with a program consultant with regard to later recognition.

*For the recognition it is required to present documents showing the examination achievements (Certificates, Transcript of Records, excerpts from the module handbook, lecture scripts or similar). In the case of documents that are not available in German or English, an officially certified translation may be requested.

**If you would like to have an achievement recognized instead of a KIT module, please contact the module coordinator (responsible for the module at KIT) for the subject examination. For recognition of examinations in the Elective Modules/ Interdisciplinary Skills/Area of Specialization, please contact one of the program consultants of the KIT-Department of Electrical Engineering and Information Technology.

If you have any further questions, please do not hesitate to contact the Program Service Bachelor and Master for ETIT, MIT, MEDT:

bachelor-info@etit.kit.edu, https://www.etit.kit.edu/english/studiengangservice_bachelor_etit_und_mit.php

master-info@etit.kit.edu,
https://www.etit.kit.edu/english/studiengangservice_master_etit_und_mit.php

F Focus Fields

Conception

For specialization, the Master's degree program in Biomedical Engineering offers module recommendations in different Focus Fields, which cover the competencies and application fields of the entire program. The Focus Fields are described in detail on the following pages.

Structure of the fields of spezialisation

According to §19(2) SPO, the Master's degree program in Biomedical Engineering at the Karlsruhe Institute of Technology (KIT) is divided into the four subjects:

- Profiling Modules (42 CR)
- Elective Modules (42 CR)
- Interdisciplinary Qualifications (6 CR)
- Master’s Thesis (30 CR)

Profiling Modules

The Profiling Modules are subdivided into:

- Engineering Modules (min. 18 CR)
- Medical Technology and Clinical Modules (min. 14 CR)
- One Laboratory or Practical Course

Focus Fields

Furthermore, there are five Focus Fields that provide the students an orientation and recommendation for possible study courses of the Profiling Modules and thus a guideline of module combinations. The recommended modules can be found in the respective curriculum (see following pages).

The Focus Fields are:

Index	Title
1	Biomedical Imaging and Signal Processing
2	Biomedical Robotics
3	Bioelectronics – Materials and Interfaces
4	Medical Product Development
5	Modelling and Simulation for Medicine

Practical/laboratory courses or workshops

Exactly one practical/laboratory course or workshop must be selected within the Profiling Modules. An additional one can be chosen within the Elective Modules. Modules that are primarily of lecture character are not included in this regulation.

Contact persons

The Program Service Master of the KIT Department of the Electrical Engineering and Information Technology are available to help with questions regarding the formal organization of the studies. The professors responsible for the Focus Fields are open for questions regarding the content of the Focus Fields and the composition of the individual curriculum.

F Focus Field 1: Biomedical Imaging and Signal Processing

Responsible: Prof. Dr.-Ing. Francesca Spadea (IBT)
Prof. Dr. rer. Nat. Werner Nahm (IBT)
Prof. Dr. rer. Nat. Wilhelm Stork (ITIV)

Description – Fields of application – Content and background

The focus field 'Biomedical Imaging and Signal Processing' in the Master's program focuses on advanced techniques and technologies in medical imaging and signal analysis. Students will gain expertise in Biomedical Optics, including light-tissue interaction and the development of optical systems for diagnosis and therapy.

The curriculum covers advanced medical imaging technologies, emphasizing the principles and methods of image processing for surgical guidance and biomarker extraction. Additionally, the program delves into advanced medical measurement technologies, exploring methods for acquiring and processing biosignals through both analog and digital signal processing techniques to extract relevant information.

he coursework integrates theoretical knowledge with practical applications, preparing students to develop innovative solutions for medical diagnostics and treatment. Emphasis is placed on interdisciplinary collaboration, combining insights from engineering, physics, and medicine.

Graduates will be prepared to work in research, development, and clinical environments, contributing to advancements in the healthcare sector. The focus field also emphasizes the importance of adhering to ethical standards and regulatory requirements in biomedical engineering.

F Focus Field 1: Biomedical Imaging and Signal Processing

Recommended modules:

		WS		SS	
Engineering Modules (EM, min. 18 CR)		**SWS**	**LP**	**SWS**	**LP**
in English					
Advanced Artificial Intelligence	*M-INFO-107198*			4	**6**
Explainable Artificial Intelligence	*M-INFO-106302*			2	**3**
Laser Physics	*M-ETIT-100435*	2+1	**4**		
Machine Learning - Foundations and Algorithms	*M-INFO-105778*			3	**6**
Optical Engineering and Machine Vision	*M-ETIT-106974*	4	6		
Optoelectronic Components	*M-ETIT-100509*			2+1	4
in German					
Deep Learning für Computer Vision I: Grundlagen	*M-INFO-105753*			2	3
Deep Learning für Computer Vision II: Fortgeschrittene Themen	*M-INFO-105755*	2	3		
Integrierte Intelligente Sensoren	*M-ETIT-100457*			2	3
Mikrosystemtechnik	*M-ETIT-100454*	2	3		
Medical Technology and Clinical Modules (MTCM, min. 14 CR)					
in English					
Advanced Molecular Cell Biology	*M-CHEMBIO-101904*	3	**5**		
Basic Molecular Cell Biology	*M-CHEMBIO-101903*			2	3
Computational Imaging	*M-INFO-106190*	3	5		
Imaging Techniques in Light Microscopy	*M-CHEMBIO-101905*	2	3		
Medical Image Processing for Guidance and Navigation	*M-ETIT-106672*	6	**9**		
Optical Systems in Medicine and Life Science	*M-ETIT-103252*			2	3
Optics and Vision in Biology	*M-CHEMBIO-101906*	3	4		
Scientific Group Project in Medical Ultrasound Imaging	*M-ETIT-106775*	2	3		
Technologies in Radiotherapy	*M-ETIT-107292*	4	6		
Modules provided by Städtisches Klinikum Karlsruhe	-	tbd	tbd	tbd	tbd
in German					
Gehirn und Zentrales Nervensystem	*M-INFO-100725*	2	3	or 2	3
Laboratory/Practical Courses (one to be chosen)					
Medical Measurement Technology Lab	*M-ETIT-106779*	2	**3**	4	**6**
Signal Processing Lab	*M-ETIT-106633*			4	6
Sum (EM+MTCM+Lab)			**21**		**21**

Summary			**LP**
Engineering Modules			**19**
Medical Technology and Clinical Modules			**14**
Laboratory/Practical Courses			**9**
Elective Modules *(see last page of chapter)*			42
Interdisciplinary Qualifications	*M-ETIT-105803*		6
Master’s Thesis			30
Sum			**120**

Gray backgrounds indicate modules/courses given in English. German titles indicate modules/courses given only in German. Bold and underlined credits are used to illustrate an exemplary curriculum.

F Focus Field 2: Biomedical Robotics

Responsible: Prof. Dr.-Ing. Sören Hohmann (IRS)
Prof. Dr. Katja Mombaur (IAR)

Description – Fields of application – Content and background

The focus field 'Biomedical Robotics' trains students to design robotic systems for medical applications. This focus field blends artificial intelligence, machine learning, and systems engineering with hands-on experience to prepare students for careers in medical robotics.

The curriculum covers advanced AI, machine learning, and deep learning for computer vision. Practical courses like the Practical Course: Human-Centred Robotics offer real-world experience. Specialized topics include assistive robotics, exoskeletons, and human-centred robotics, with joint seminars involving clinical partners.

Graduates can pursue careers in medical robotics, automation engineering, and AI for medical technology. They are equipped to work in medical technology companies, hospitals, and research institutions, driving innovation in medical robotics.

This focus field is perfect for those interested in using robotics to advance healthcare, providing a comprehensive foundation to succeed in the rapidly evolving field of medical robotics.

F Focus Field 2: Biomedical Robotics

Recommended modules:

		WS		SS	
Engineering Modules (EM, min. 18 CR)		**SWS**	**LP**	**SWS**	**LP**
in English					
Advanced Artificial Intelligence	*M-INFO-106299*			4	**6**
Computational Imaging	*M-INFO-106190*	3	5		
Explainable Artificial Intelligence	*M-INFO-106302*			2	3
Humanoid Robots – Locomotion and Whole-Body Control	*M-INFO-106649*	4	6	or 4	6
Machine Learning - Foundations and Algorithms	*M-INFO-105778*			4	6
Measurement Technology *(last time WiSe 25/26)*	*M-ETIT-105982*	2+1	**5**		
Signal Processing Methods	*M-ETIT-106899*	2+2	6		
Numerical Methods	*M-MATH-105831*			2+1	5
Numerical Methods with Programming Practice	*M-MATH-106972*			2+2	6
Optimization of Dynamic Systems	*M-ETIT-100531*	3	6		
Reinforcement Learning	*M-INFO-105623*	4	6		
Robotics II - Humanoid Robotics	*M-INFO-107123*			2	4
Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society	*M-INFO-106651*			2	3
Simulation and Optimization in Robotics and Biomechanics	*M-INFO-106504*	4	6		
Systems and Software Engineering	*M-ETIT-100537*	2+1	**6**		
Wearable Robotic Technologies	*M-INFO-107113*			2	**4**
Cyber-Physical Modeling	*M-ETIT-106953*			3+1	6
Multivariable Control Systems	*coming soon*	4	6		
in German					
Deep Learning for Computer Vision I: Grundlagen	*M-INFO-105753*			2	3
Deep Learning for Computer Vision II: Fortgeschrittene Themen	*M-INFO-105755*	2	3		
Informationsfusion	*M-ETIT-103264*	2+1	4		
Software Engineering	*M-ETIT-100450*			2	3

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F Focus Field 2: Biomedical Robotics

Recommended modules:

		WS		SS	
Medical Technology and Clinical Modules (MTCM, min. 14 CR)		**SWS**	**LP**	**SWS**	**LP**
in English					
Medical Image Processing for Guidance and Navigation	*M-ETIT-106672*	6	**9**		
Optical Systems in Medicine and Life Science	*M-ETIT-103252*			2	**3**
Seminar: Assistive robotics and exoskeletons in medical applications	*M-INFO-106400*	2	**3**		
Digital Twins for Human-Centred Robotics (*starting SoSe 26*)	-			4	6
Joint seminar with clinical partners	*tbd*	2	3	or 2	3
Modules provided by Städtisches Klinikum Karlsruhe	*tbd*	tbd	tbd	tbd	tbd
in German					
Gehirn und Zentrales Nervensystem	*M-INFO-100725*	2	3	or 2	3
Praktisches Maschine Learning	*M-ETIT-106673*			2+2	6
Ultraschall-Bildgebung	*M-ETIT-100560*			2	3
Laboratory/Practical Courses (one to be chosen)					
Medical Measurement Technology Lab	*M-ETIT-106779*	2	3	4	6
Practical Course: Human-Centred Robotics	*M-INFO-106646*	4	6	or 4	**6**
Practical Course: Movement and Technology	*M-INFO-106648*			4	6
Signal Processing Lab	*M-ETIT-106633*			4	6
in German					
Praktikum Software Engineering	*M-ETIT-100460*			4	6
Praktisches Maschine Learning	*M-ETIT-106673*			2+2	6
Sum (EM+MTCM+Lab)			**23**		**19**

Summary			**LP**
Engineering Modules			**21**
Medical Technology and Clinical Modules			**15**
Laboratory/Practical Courses			**6**
Elective Modules *(see last page of chapter)*			42
Interdisciplinary Qualifications	*M-ETIT-105803*		6
Master's Thesis			30
Sum			**120**

Gray backgrounds indicate modules/courses given in English. German titles indicate modules/courses given only in German. Bold and underlined credits are used to illustrate an exemplary curriculum.

F Focus Field 3: Bioelectronics – Materials and Interfaces

Responsible: Prof. Dr. Jasmin Aghassi-Hagmann (INT)
PD Dr. Dr. Michael Hirtz (INT)

Description – Fields of application – Content and background

The focus field 'Bioelectronics - Materials and Interfaces' offers a broad education in the development of advanced materials and their integration with and interfacing to biological systems. This focus field combines nano-/microtechnology, materials science, and biomedical engineering to prepare students for successful and innovative careers at the convergence of electronics and biology.

Through hands-on lab courses and theoretical studies, students learn about nanoelectronics, materials characterization, and microscale fluid mechanics for microfluidic systems. They also explore advanced topics such as optical systems for medical applications, scanning probe lithography for manufacturing biomedical devices, and get accustomed to connected measurement and control systems.

Graduates are equipped for careers in bioelectronics research, medical device engineering, and biomedical technology development. The program provides a solid foundation for understanding and creating devices that interface with biological systems e.g. in sensing, diagnostic, or even therapeutic applications. This opens pathways to roles in healthcare, industry, and academic research.

With a balanced curriculum and strong industry ties, this focus field is ideal for those interested in driving innovation in the future of bioelectronics and biomedical technology.

F Focus Field 3: Bioelectronics – Materials and Interfaces

Recommended modules:

		WS		SS	
Engineering Modules (EM, min. 18 CR)		**SWS**	**LP**	**SWS**	**LP**
in English					
Basics of Nanotechnology I	*M-PHYS-102097*	2	**<u>4</u>**		
Basics of Nanotechnology II	*M-PHYS-102100*			2	**<u>4</u>**
Materials Characterization	*M-MACH-103714*	4+2	**<u>6</u>**		
Micro Magnetic Resonance	*T-MACH-105782*	2	4		
Microscale Fluid Mechanics	*M-MACH-106539*	2	**<u>4</u>**		
Modern VLSI Technologies	*M-ETIT-106921*			2+2	6
Nano- and Quantum Electronics	*M-ETIT-105604*			3+1	6
Properties (Microstructure-Property-Relationships)	*M-MACH-103713*	4+2	6		
Surface Science	*M-PHYS-106483*			4	8
in German					
Rheologie von Polymeren	*M-CIWVT-104329*			2	4
Sol-Gel-Prozesse	*M-CIWVT-104489*	2	4		
Medical Technology and Clinical Modules (MTCM, min. 14 CR)					
in English					
Medical Image Processing for Guidance and Navigation	*M-ETIT-106672*	6	**<u>9</u>**		
Modeling Physiological Systems	*M-ETIT-106782*			3	**<u>6</u>**
Optical Systems in Medicine and Life Science	*M-ETIT-103252*			2	**<u>3</u>**
Scanning Probe Lithography for Biomedical Applications (*starting SoSe 26*)	-			2	3
Modules provided by Städtisches Klinikum Karlsruhe	*tbd*	tbd	tbd	tbd	tbd
Ubiquitous Computing	*M-INFO-107161*	2+1	5		
in German					
BioMEMS - Mikrosystemtechnik für Life-Sciences und Medizin I	*M-MACH-100489*	2	4		
BioMEMS - Mikrosystemtechnik für Life-Sciences und Medizin II	*M-MACH-100490*			2	4
BioMEMS - Mikrosystemtechnik für Life-Sciences und Medizin III	*M-MACH-100491*			2	4
BioMEMS - Mikrosystemtechnik für Life-Sciences und Medizin IV	*M-MACH-105483*	2	4		
BioMEMS - Mikrofluidische Chipsysteme V	*M-MACH-105484*	2	4		
Laboratory/Practical Courses (one to be chosen)					
Lab Course on Nanoelectronics	*M-ETIT-100468*	4	6	or 4	**<u>6</u>**
Laboratory Nanotechnology	*M-ETIT-100478*	4	6	or 4	6
Medical Measurement Technology Lab	*M-ETIT-106779*	2	3	or 4	6
Sum (EM+MTCM+Lab)			**<u>23</u>**		**<u>19</u>**

Summary			**LP**
Engineering Modules			**<u>18</u>**
Medical Technology and Clinical Modules			**<u>18</u>**
Laboratory/Practical Courses			**<u>6</u>**
Elective Modules *(see last page of chapter)*			42
Interdisciplinary Qualifications	*M-ETIT-105803*		6
Master's Thesis			30
Sum			**120**

Gray backgrounds indicate modules/courses given in English. German titles indicate modules/courses given only in German. Bold and underlined credits are used to illustrate an exemplary curriculum.

F Focus Field 4: Medical Product Development

Responsible: Prof. Dr.-Ing. Tobias Düser (IPEK)
M. Ed. Raphael Grau (IPEK)

Description – Fields of application – Content and background

In a world where health care solutions are becoming increasingly important, innovative medical products need to be established. Not only are they enabling more accurate diagnoses and more effective treatments, but they are also revolutionizing the way we deal with health problems and directly impact patients' lives.

The focus field 'Medical Product Development' covers aspects of the product development process in this highly regulated industry. Legislation and standards are framing the development process in order to ensure patient and user safety, including validation and verification procedures. Lectures about systems, methods and processes that support the creation of innovative health products which can be mechanical, cyber-physical and complex mechatronic, as well as digital solutions are part of this focus field.

You will gain knowledge about general product development concepts, validation aspects of medical devices and CAE applications as well as sustainable engineering aspects. Specialized courses such as organ support systems, clinical anatomy, and principles of medicine for engineers provide the medical context needed for product development in this field.

This program is ideal for individuals seeking to make a significant impact on healthcare by developing medical products that improve patient outcomes. If you're interested in combining engineering and medicine to create innovative medical solutions, this focus field offers the training and skills to succeed.

F Focus Field 4: Medical Product Development

Recommended modules:

		WS		SS	
Engineering Modules (EM, min. 18 CR)		**SWS**	**LP**	**SWS**	**LP**
in English					
Digital Twin Engineering	*M-ETIT-106040*	2	4		
Drive System Engineering - B: Stationary Machinery	*M-MACH-107190*	2	**4**		
HRI and Social Robotics	*M-INFO-106650*			4	**6**
Humanoid Robots – Locomotion and Whole-Body Control	*M-INFO-106649*			4	6
Measurement Technology *(last time WiSe 25/26)*	*M-ETIT-105982*	2+1	5		
Robotics II - Humanoid Robotics	*M-INFO-107123*			2	4
Seminar: Assistive robotics and exoskeletons in medical applications	*M-INFO-106400*	2	**3**		
Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society	*M-INFO-106651*			2	3
Seminar: Human-Robot Interaction	*M-INFO-106498*	2	**3**		
Wearable Robotic Technologies	*M-INFO-107113*			2	4
Advanced Systems Engineering (*starting SoSe 26*)	-			2	5
Digital Twins for Human-Centred Robotics (*starting SoSe 26*)	-			4	6
Cyber-Physical Modeling	*M-ETIT-106953*			3+1	**6**
in German					
Gerätekonstruktion	*M-MACH-102705*			4+4	12
Software Engineering	*M-ETIT-100450*			2	3

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F Focus Field 4: Medical Product Development

Recommended modules:

		WS		SS	
Medical Technology and Clinical Modules (MTCM, min. 14 CR)		**SWS**	**LP**	**SWS**	**LP**
in English					
Emergency Medicine and Pathophysiology	*coming soon*	2	**<u>4</u>**		
Human Factors Engineering	*coming soon*	2	**<u>4</u>**		
Modeling Physiological Systems	*M-ETIT-106782*			3	**<u>6</u>**
Medical Systems Engineering (*starting SoSe26*)	-			tbd	tbd
Regulatory Affairs and Quality Management in Medical Device product development	*M-ETIT-106920*			2	3
Modules provided by Städtisches Klinikum Karlsruhe	-	tbd	tbd	tbd	tbd
in German					
Ersatz menschlicher Organe durch technische Systeme	*M-MACH-102702*			2	4
Grundlagen der Medizin für Ingenieure	*M-MACH-102720*	2	4		
Laboratory/Practical Courses (one to be chosen)					
Practical Course: Human-Centred Robotics	*M-INFO-106646*	4	6	or 4	**<u>6</u>**
Practical Course: Movement and Technology	*M-INFO-106648*			4	6
in German					
CAE-Workshop	*M-MACH-102684*	3	4	or 3	4
Praktikum Software Engineering	*M-ETIT-100460*			4	6
Zuverlässigkeits- und Test-Engineering	*M-MACH-106050*	4	5		
Sum (EM+MTCM+Lab)			**<u>18</u>**		**<u>24</u>**

Summary			**LP**
Engineering Modules			**<u>22</u>**
Medical Technology and Clinical Modules			**<u>14</u>**
Laboratory/Practical Courses			**<u>6</u>**
Elective Modules *(see last page of chapter)*			42
Interdisciplinary Qualifications	*M-ETIT-105803*		6
Master's Thesis			30
Sum			**120**

Gray backgrounds indicate modules/courses given in English. German titles indicate modules/courses given only in German. Bold and underlined credits are used to illustrate an exemplary curriculum.

F Focus Field 5: Modelling and Simulation for Medicine

Responsible: PD Dr.-Ing. Axel Loewe

Description – Fields of application – Content and background

The focus field 'Modelling and Simulation for Medicine' revolves around applying computational techniques to address medical challenges. This focus field combines signal processing, numerical methods, and systems engineering to create models that simulate physiological processes and optimize medical technologies.

Students explore measurement technology, signal processing methods, and practical machine learning, gaining the skills needed to process medical data effectively. The program also covers AI for medical technology, providing insights into how artificial intelligence can enhance medical simulations.

Hands-on laboratory courses in biomedical engineering and medical image processing offer students practical experience, allowing them to apply theoretical concepts to real-world medical scenarios. This blend of theory and practice helps students understand and simulate complex physiological systems

Graduates are prepared for careers in medical simulation, healthcare technology, and systems engineering. Opportunities exist in research institutions, healthcare companies, and hospitals, where they can contribute to the development of innovative medical technologies.

This focus field is designed for those who wish to leverage computational tools to improve healthcare outcomes. The curriculum's comprehensive approach equips graduates with the expertise to create advanced models and simulations, making a significant impact in the medical field.

F Focus Field 5: Modelling and Simulation for Medicine

Recommended modules:

		WS		SS	
Engineering Modules (EM, min. 18 CR)		**SWS**	**LP**	**SWS**	**LP**
in English					
Measurement Technology *(last time WS 25/26)*	*M-ETIT-105982*	2+1	**<u>5</u>**		
Signal Processing Methods	*M-ETIT-106899*	2+2	6		
Numerical Methods	*M-MATH-105831*			2+1	**<u>5</u>**
Numerical Methods with Programming Practice	*M-MATH-106972*			2+2	6
Operations Research in Health Care Management	*M-WIWI-106853*	2+1	**<u>5</u>**	or 2+1	5
Optimization of Dynamic Systems	*M-ETIT-100531*	3	6		
Cyber-Physical Modeling	*M-ETIT-106953*			3+1	**<u>6</u>**
Systems and Software Engineering	*M-ETIT-100537*	2+1	6		
in German					
Grundlagen Finite Elemente	*M-BGU-100052*	2+2	6		
Numerische Methoden für partielle Differentialgleichungen	*M-ETIT-102311*			2+1	4
Medical Technology and Clinical Modules (MTCM, min. 14 CR)					
in English					
Medical Image Processing for Guidance and Navigation	*M-ETIT-106672*	6	**<u>9</u>**		
Modeling Physiological Systems	*M-ETIT-106782*			3	**<u>6</u>**
Modules provided by Städtisches Klinikum Karlsruhe	-	tbd	tbd	tbd	tbd
Ubiquitous Computing	*M-INFO-107161*	2+1	5		
in German					
Gehirn und Zentrales Nervensystem	*M-INFO-100725*	2	3	or 2	3
Praktisches Maschine Learning	*M-ETIT-106673*			2+2	6
Laboratory/Practical Courses (one to be chosen)					
In English					
Medical Measurement Technology Lab	*M-ETIT-106779*	2	3	4	**<u>6</u>**
in German					
Praktisches Maschine Learning	*M-ETIT-106673*			2+2	6
Sum (EM+MTCM+Lab)			**<u>19</u>**		**<u>23</u>**

Summary			**LP**
Engineering Modules			**<u>21</u>**
Medical Technology and Clinical Modules			**<u>15</u>**
Laboratory/Practical Courses			**<u>6</u>**
Elective Modules *(see last page of chapter)*			42
Interdisciplinary Qualifications	*M-ETIT-105803*		6
Master's Thesis			30
Sum			**120**

Gray backgrounds indicate modules/courses given in English. German titles indicate modules/courses given only in German. Bold and underlined credits are used to illustrate an exemplary curriculum.

E Elective Modules

Elective modules can be chosen as announced in chapter “Study Program Structure – Elective Modules”. Further modules may be chosen individually. For this purpose, please contact the BME Program Service via ***master-info@etit.kit.edu*** or [***https://www.etit.kit.edu/english/studiengangservice_master_etit_und_mit.php***](https://www.etit.kit.edu/english/studiengangservice_master_etit_und_mit.php).

Exemplary study plan: Master Biomedical Engineering

	Module	SWS	CR	Subject
1. Sem. (winter term)	Medical Image Processing for Guidance and Navigation	6	9	MTC
	Medical Measurement Technology Lab	2	3	Lab
	Computational Imaging	3	5	Elec
	Signal Processing Methods	4	6	Elec
	Optics and Vision in Biology	3	4	Elec
	Principles of Medicine for Engineers	2	4	Elec
		Sum CR	**31**	
2. Sem. (summer term)	Advanced Artificial Intelligence	4	6	Eng
	Explainable Artificial Intelligence	2	3	Eng
	Machine Learning - Foundations and Algorithms	3	6	Eng
	Medical Measurement Technology Lab	4	6	Lab
	Optoelectronic Components	3	4	Elec
	Modeling Physiological Systems	4	6	Elec
		Sum CR	**31**	
3. Sem. (winter term)	Laser Physics	3	4	Eng
	Advanced Molecular Cell Biology	4	5	MTC
	Optical Systems in Medicine and Life Science	2	3	Elec
	Optimization of Dynamic Systems	3	5	Elec
	Systems and Software Engineering	3	5	Elec
	Interdisciplinary Qualifications	4	6	IQ
		Sum CR	**28**	
4. Sem. (summer term)	Master's Thesis		30	Ma
		Sum CR	**30**	
		In total	**180**	

Subjects of the Master BME	Abbreviation	Extent
Profiling Modules		42 CR
Engineering Modules	Eng	min. 18 CR
Medical Technology and Clinical Modules	MTC	min. 14 CR
Laboratory/Practical Course	Lab	Number: 1
Elective Modules	Elec	42 CR
Interdisciplinary Qualifications	IQ	6 CR
Master's Thesis	Ma	30 CR

8 General Information

8.1 Study program details

KIT-Department	KIT Department of Electrical Engineering and Information Technology
Academic Degree	Master of Science (M.Sc.)
Examination Regulations Version	2025
Regular terms	4 terms
Maximum terms	8 terms
Credits	120
Language	
Grade calculation	Weighted average by credits

9 Study Program Structure

Mandatory	
Master's Thesis	30 CP
Elective Modules	42 CP
Profiling Modules	42 CP
Interdisciplinary Qualifications	6 CP
Voluntary	
Additional Examinations *This field will not influence the calculated grade of its parent.*	

9.1 Master's Thesis

Credits
30

Mandatory			
Modules in English			
M-ETIT-107356	Master's Thesis	WS+SS	30 CP

9.2 Elective Modules

Credits
42

Election notes
All modules are listed with English titles, regardless of the course language.

Electives (Election: at most 42 credits)			
Modules in English			
M-ETIT-103802	Adaptive Optics	WS	3 CP
M-INFO-107198	Advanced Artificial Intelligence	SS	6 CP
M-ETIT-106815	Advanced Communications Engineering	WS	6 CP
M-CHEMBIO-101904	Advanced Molecular Cell Biology	WS	5 CP
M-ETIT-106956	Antennas and Beamforming	WS	4 CP
M-CHEMBIO-101903	Basic Molecular Cell Biology	SS	2 CP
M-PHYS-102097	Basics of Nanotechnology I	WS	4 CP
M-PHYS-102100	Basics of Nanotechnology II	SS	4 CP
M-ETIT-107005	Batteries, Fuel Cells, and Electrolysis	WS	6 CP
M-MACH-106903	Biologically Inspired Robots	SS	3 CP
M-ETIT-101834	Business Innovation in Optics and Photonics	WS	4 CP
M-ETIT-105616	Channel Coding: Algebraic Methods for Communications and Storage	SS	3 CP
M-ETIT-105617	Channel Coding: Graph-Based Codes	WS	6 CP
M-ETIT-100539	Communication Systems and Protocols	SS	5 CP
M-ETIT-106689	Components of Power Systems	SS	3 CP
M-INFO-106190	Computational Imaging	WS	5 CP
M-ETIT-106953	Cyber-Physical Modeling	SS	6 CP
M-ETIT-106690	Digital Real Time Simulations for Energy Technologies	SS	3 CP
M-ETIT-103450	Digital Signal Processing in Optical Communications – with Practical Exercises	SS	6 CP
M-ETIT-106040	Digital Twin Engineering	WS	4 CP
M-MACH-105341	Digitalization from Production to the Customer in the Optical Industry	WS	4 CP
M-MACH-107190	Drive System Engineering B: Stationary Machinery	WS	4 CP
M-ETIT-105883	Electrocatalysis	SS	5 CP
M-ETIT-100386	Electromagnetics and Numerical Calculation of Fields	WS	4 CP
M-INFO-106302	Explainable Artificial Intelligence	SS	3 CP
M-ETIT-101919	Fabrication and Characterisation of Optoelectronic Devices	SS	3 CP
M-ETIT-100566	Field Propagation and Coherence	WS	4 CP
M-ETIT-100449	Hardware Modeling and Simulation	WS	4 CP
M-ETIT-106963	Hardware Synthesis and Optimization	SS	6 CP
M-INFO-106649	Humanoid Robots - Locomotion and Whole-Body Control	SS	6 CP
M-CHEMBIO-101905	Imaging Techniques in Light Microscopy	WS	3 CP
M-ETIT-106789	IT/OT-Security Seminar	WS	4 CP
M-ETIT-100434	Laser Metrology	SS	3 CP
M-ETIT-100435	Laser Physics	WS	4 CP
M-ETIT-100512	Light and Display Engineering	WS	4 CP
M-ETIT-100577	Lighting Design - Theory and Applications	WS	3 CP
M-INFO-105778	Machine Learning - Foundations and Algorithms	SS	6 CP
M-ETIT-104988	Machine Learning and Optimization in Communications	SS	4 CP
M-MACH-101923	Machine Vision	WS	8 CP
M-ETIT-105982	Measurement Technology	WS	5 CP
M-ETIT-106672	Medical Image Processing for Guidance and Navigation	WS	9 CP
M-MACH-106539	Microscale Fluid Mechanics	WS	4 CP
M-ETIT-105893	Mixed-Signal IC Design	SS	3 CP
M-ETIT-105971	Mobile Communications	WS	4 CP
M-ETIT-106244	Mobile Communications II	SS	3 CP
M-ETIT-106782	Modeling Physiological Systems	SS	6 CP
M-ETIT-100427	Modern Radio Systems Engineering	WS+SS	6 CP
M-ETIT-106921	Modern VLSI Technologies	SS	6 CP
M-ETIT-105604	Nano- and Quantum Electronics	SS	6 CP
M-ETIT-105881	Navigation and Localization Techniques	SS	3 CP

M-ETIT-100430	Nonlinear Optics	SS	6 CP
M-MATH-105831	Numerical Methods	SS	5 CP
M-MATH-106972	Numerical Methods with Programming Practice	SS	6 CP
M-WIWI-106853	Operations Research in Health Care Management	WS+SS	5 CP
M-ETIT-106974	Optical Engineering and Machine Vision	WS	6 CP
M-ETIT-103270	Optical Networks and Systems	WS	4 CP
M-ETIT-103252	Optical Systems in Medicine and Life Science	SS	3 CP
M-ETIT-100436	Optical Transmitters and Receivers	WS	6 CP
M-CHEMBIO-101906	Optics and Vision in Biology	WS	4 CP
M-ETIT-100531	Optimization of Dynamic Systems	WS	5 CP
M-ETIT-100509	Optoelectronic Components	SS	4 CP
M-ETIT-105914	Photonic Integrated Circuit Design and Applications	SS	6 CP
M-ETIT-105608	Physics, Technology and Applications of Thin Films	WS	4 CP
M-MACH-107035	Polymers in MEMS B: Physics, Microstructuring and Applications	WS	4 CP
M-ETIT-104567	Power Electronics	SS	6 CP
M-ETIT-106780	Practical Tools for Control Engineers	WS	4 CP
M-ETIT-105606	Quantum Detectors and Sensors	WS	6 CP
M-ETIT-106954	Quantum Engineering	SS	6 CP
M-ETIT-100420	Radar Systems Engineering	WS	6 CP
M-ETIT-105123	Radio Frequency Integrated Circuits and Systems	SS	6 CP
M-ETIT-106955	Radio-Frequency Electronics	WS	6 CP
M-ETIT-106920	Regulatory Affairs and Quality Management in Medical Device Product Development	SS	3 CP
M-INFO-105623	Reinforcement Learning	WS	6 CP
M-INFO-107123	Robotics II - Humanoid Robotics	SS	3 CP
M-ETIT-106775	Scientific Group Project in Medical Ultrasound Imaging	WS	3 CP
M-ETIT-106674	Seminar Advanced Concepts for Flexible and Soft Optoelectronic Devices and Sensors	SS	3 CP
M-ETIT-105615	Seminar on Applied Superconductivity	SS	3 CP
M-ETIT-106899	Signal Processing Methods	WS	6 CP
M-ETIT-106675	Signal Processing with Nonlinear Fourier Transforms and Koopman Operators	SS	6 CP
M-INFO-106504	Simulation and Optimization in Robotics and Biomechanics	WS	6 CP
M-ETIT-101971	Single-Photon Detectors	WS	4 CP
M-ETIT-106684	Superconducting Magnet Technology	SS	4 CP
M-ETIT-105521	Superconducting Materials	WS+SS	6 CP
M-ETIT-105609	Superconducting Nanowire Detectors	SS	4 CP
M-ETIT-105611	Superconductivity for Engineers	WS	5 CP
M-PHYS-106483	Surface Science, without Exercises	Irreg.	8 CP
M-ETIT-100537	Systems and Software Engineering	WS	5 CP
M-ETIT-100462	Systems Engineering for Automotive Electronics	SS	4 CP
M-ETIT-107292	Technologies in Radiotherapy	WS	6 CP
M-INFO-107161	Ubiquitous Computing	WS	5 CP
M-INFO-107113	Wearable Robotic Technologies	SS	4 CP
M-ETIT-107147	Workshop Finite Element Method in Electromagnetics	SS	3 CP
M-INFO-106498	Seminar: Human-Robot Interaction	WS	3 CP
M-INFO-106650	HRI and Social Robotics	SS	6 CP
M-INFO-106651	Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society	SS	3 CP
Modules in German			
M-ETIT-100466	Analog Circuit Design	WS	4 CP
M-MACH-102705	Appliance and Power Tool Design	SS	12 CP
M-ETIT-100444	Applied Information Theory	WS	6 CP
M-INFO-105338	Authentication and Encryption	SS	4 CP

M-INFO-100826	Automated Visual Inspection and Image Processing	WS	6 CP
M-ETIT-100400	Basics of Converter Control	SS	3 CP
M-BGU-100052	Basics of Finite Elements	WS	6 CP
M-MACH-105302	Basics of Technical Logistics II	WS	6 CP
M-MACH-107181	Biomechanics: Design in Nature and Inspired by Nature	WS	4 CP
M-MACH-100489	BioMEMS - Microsystems Technologies for Life Sciences and Medicine I	WS	4 CP
M-MACH-100490	BioMEMS - Microsystems Technologies for Life Sciences and Medicine II	SS	4 CP
M-MACH-100491	BioMEMS - Microsystems Technologies for Life Sciences and Medicine III	SS	4 CP
M-MACH-105296	Computational Intelligence	WS	4 CP
M-ETIT-100374	Control of Linear Multivariable Systems	WS	6 CP
M-ETIT-105915	Control of Power-Electronic Systems	SS	6 CP
M-MACH-105307	Data Analytics for Engineers	SS	5 CP
M-INFO-106505	Data Science	WS	8 CP
M-ETIT-100515	Design of Electrical Machines	WS	5 CP
M-ETIT-100541	Detectores for Applications in Space and Astronomy	WS	3 CP
M-ETIT-105415	Digital Beam-Forming for Imaging Radar	WS	4 CP
M-ETIT-100473	Digital Circuit Design	SS	4 CP
M-ETIT-100361	Distributed Discrete Event Systems	SS	4 CP
M-ETIT-101847	Dosimetry of Ionising Radiation	WS	3 CP
M-ETIT-100511	Electronic Circuits for Light Sources and Laser	SS	3 CP
M-ETIT-100410	Electronics and EMC	SS	3 CP
M-ETIT-100483	Fundamentals on Plasma Technology	SS	3 CP
M-ETIT-100453	Hardware/Software Co-Design	WS	4 CP
M-ETIT-100521	High-Power Microwave Technology	WS	3 CP
M-INFO-100725	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	WS+SS	3 CP
M-INFO-100824	Human-Machine-Interaction in Anthropomatics: Basics	WS	3 CP
M-ETIT-100399	Industrial Circuitry	WS	3 CP
M-ETIT-103264	Information Fusion	WS	4 CP
M-ETIT-100367	Information Technology in Industrial Automation Systems	SS	3 CP
M-ETIT-100457	Integrated Intelligent Sensors	SS	3 CP
M-ETIT-100474	Integrated Systems and Circuits	SS	4 CP
M-MACH-105419	Intellectual Property Rights and Strategies in Industrial Companies	WS+SS	4 CP
M-MACH-106525	Introduction to Bionics	SS	4 CP
M-MACH-102691	Introduction to Microsystem Technology I	WS	4 CP
M-MACH-102706	Introduction to Microsystem Technology II	SS	4 CP
M-MACH-107207	Introduction to Nanotechnology	SS	4 CP
M-MACH-106209	Introduction to the Finite Element Method	SS	4 CP
M-ETIT-100485	Lighting Engineering	WS	4 CP
M-WIWI-105003	Machine Learning 1	WS	5 CP
M-WIWI-105006	Machine Learning 2	SS	5 CP
M-MACH-106210	Mathematical Methods in Continuum Mechanics	WS	6 CP
M-ETIT-100454	Microsystem Technology	WS	3 CP
M-ETIT-105701	Microwave Module Design	WS	3 CP
M-ETIT-101968	Miniaturized Passive Microwave Circuits	WS	4 CP
M-ETIT-100508	Modelling and Simulation of Electrochemical Systems	SS	3 CP
M-ETIT-100371	Nonlinear Control Systems	SS	3 CP
M-MACH-105292	Novel Actuators and Sensors	WS	4 CP
M-MACH-107036	Numerical Fluid Mechanics	SS	4 CP
M-ETIT-102311	Numerical Methods for Partial Differential Equations	SS	4 CP
M-ETIT-102310	Optimal Control and Estimation	SS	3 CP
M-ETIT-100484	Optoelectronic Measurement Engineering	SS	3 CP

M-MACH-102702	Organ Support Systems	SS	4 CP
M-ETIT-102200	Packaging and Interconnects for Power Electronic Systems	WS	3 CP
M-INFO-100825	Pattern Recognition	SS	6 CP
M-ETIT-100519	Photometry and Radiometry	WS	3 CP
M-MACH-107064	Physical Basics of Laser Technology	WS	5 CP
M-ETIT-100481	Plasma Sources	WS	4 CP
M-ETIT-100394	Practical Aspects of Electrical Drives	WS	4 CP
M-WIWI-106852	Practical Seminar: Health Care Management (with Case Studies)	WS+SS	5 CP
M-MACH-105479	Practical Training in Basics of Microsystem Technology	WS+SS	4 CP
M-MACH-102720	Principles of Medicine for Engineers	WS	4 CP
M-ETIT-105594	Process Analysis: Modeling, Data Mining, Machine Learning	SS	3 CP
M-MACH-106195	Product Lifecycle Management	WS	4 CP
M-ETIT-104475	Project Management in the Development of Products for Safety-Critical Applications	WS	4 CP
M-MACH-105332	Quality Management	WS	4 CP
M-ETIT-105889	Quantum Machine Learning	WS	3 CP
M-ETIT-103241	Radio Receivers	WS	3 CP
M-CIWVT-104329	Rheology of Polymers	SS	4 CP
M-ETIT-105629	Seminar Electrocatalysis	WS+SS	3 CP
M-ETIT-100455	Seminar Embedded Systems	WS+SS	4 CP
M-ETIT-100396	Seminar New Components and Systems of Power Electronics	WS+SS	4 CP
M-ETIT-100441	Seminar Selected Topics in Communication	WS+SS	4 CP
M-ETIT-100380	Seminar Sensors	WS+SS	3 CP
M-ETIT-100378	Sensors	SS	3 CP
M-ETIT-100443	Signal Processing in Communications	SS	6 CP
M-ETIT-100450	Software Engineering	SS	3 CP
M-CIWVT-104489	Sol-Gel Processes	WS	4 CP
M-ETIT-105273	Source Coding Techniques	WS	3 CP
M-MACH-107189	Sustainable Product Engineering: Sustainable Product Design - Long-term Business Success with Sustainably Developed Products	SS	4 CP
M-ETIT-106026	System Integration and Communication Structures in Industry 4.0 and IoT	WS	3 CP
M-MACH-105315	System Integration in Micro- and Nanotechnology	SS	4 CP
M-MACH-105316	System Integration in Micro- and Nanotechnology 2	WS	4 CP
M-ETIT-105465	Team Project: Sensors and Electronics	WS+SS	3 CP
M-ETIT-101835	Technical Acoustic	WS	3 CP
M-ETIT-100538	Technical Optics	WS	5 CP
M-ETIT-100546	Test of Embedded Systems in Industrial Contexts	WS	4 CP
M-MACH-107112	Thermal-Fluid-Dynamics	WS	4 CP
M-ETIT-100560	Ultrasound Imaging	SS	3 CP
M-ETIT-104493	Verified Numerical Methods	WS	4 CP
Modules in German/English			
M-MACH-106461	Biomedical Engineering for Engineers - Fundamentals of Project Management in Medical Engineering	WS	4 CP
M-MACH-105484	BioMEMS - Microfludic Chipsystems V	WS	4 CP
M-MACH-105483	BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV	WS	4 CP
M-MACH-105485	Current Topics on BioMEMS	WS+SS	4 CP
M-INFO-105753	Deep Learning for Computer Vision I: Basics	SS	3 CP
M-INFO-105755	Deep Learning for Computer Vision II: Advanced Topics	WS	3 CP
M-MACH-105478	Fabrication Processes in Microsystem Technology	WS+SS	4 CP
M-INFO-100729	Human Computer Interaction	SS	6 CP
M-MACH-103714	Materials Characterization	WS+SS	6 CP
M-ETIT-106456	Mobile Communications Workshop	WS+SS	4 CP
M-ETIT-100475	Plastic Electronics / Polymerelectronics	WS	3 CP
M-MACH-107085	Polymers in MEMS C: Biopolymers and Bioplastics	SS	4 CP

M-MACH-102718	Product Development – Methods of Product Engineering	SS	6 CP
M-MACH-103713	Properties	WS+SS	6 CP
M-INFO-106400	Seminar: Assistive robotics and exoskeletons in medical applications	WS	3 CP
M-INFO-105884	Seminar: Digital Accessibility and Assistive Technologies	WS	3 CP
Laboratory/Practical Course (Election: between 0 and 1 items)			
Modules in English			
M-ETIT-102266	Digital Hardware Design Laboratory	SS	6 CP
M-ETIT-106464	Lab Course Printed Flexible Electronics	WS+SS	6 CP
M-ETIT-105402	Laboratory Modern Software Tools in Power Engineering	SS	6 CP
M-ETIT-106779	Medical Measurement Technology Lab	WS	9 CP
M-ETIT-106973	Microwave Engineering Lab	WS+SS	6 CP
M-ETIT-105464	MMIC Design Laboratory	WS+SS	6 CP
M-ETIT-100464	Optical Design Lab	SS	6 CP
M-ETIT-104485	Photonics and Communications Lab	SS	6 CP
M-INFO-106648	Practical Course: Movement and Technology	SS	6 CP
M-ETIT-106633	Signal Processing Lab	SS	6 CP
M-ETIT-105073	Student Innovation Lab	WS+SS	15 CP
Modules in German			
M-MACH-102684	CAE-Workshop	WS+SS	4 CP
M-ETIT-102264	Digital Hardware Design Laboratory	SS	6 CP
M-MACH-105291	Lab Computer-Aided Methods for Measurement and Control	WS	4 CP
M-ETIT-100470	Laboratory FPGA Based Circuit Design	WS+SS	6 CP
M-ETIT-100460	Laboratory in Software Engineering	SS	6 CP
M-INFO-105495	Practical Course: Biologically Inspired Robots	WS	6 CP
M-INFO-105958	Practical Course: Machine Learning and Intelligent Systems	WS+SS	8 CP
M-ETIT-106673	Practical Machine Learning	SS	6 CP
M-MACH-105479	Practical Training in Basics of Microsystem Technology	WS+SS	4 CP
M-MACH-106050	Reliability and Test Engineering	WS	5 CP
M-ETIT-100451	System-on-Chip Laboratory	WS	6 CP
Modules in German/English			
M-ETIT-100381	Batteries and Fuel Cells Laboratory	WS	6 CP
M-ETIT-107136	Communications Engineering Laboratory	WS+SS	6 CP
M-ETIT-107138	Electric Drives and Power Electronics Lab	SS	6 CP
M-ETIT-107137	Electrical Energy Systems Lab	WS	6 CP
M-INFO-105792	Humanoid Robotics Laboratory	WS	6 CP
M-ETIT-100468	Lab Course on Nanoelectronics	WS+SS	6 CP
M-ETIT-106263	Lab Course on Noise Thermometry	WS+SS	6 CP
M-ETIT-105614	Lab course on superconducting materials	WS+SS	6 CP
M-ETIT-107135	Lab Course Robotic Winding Technology for Superconducting Wires	WS	6 CP
M-ETIT-107159	Laboratory Information Systems in Power Engineering	SS	6 CP
M-ETIT-102356	Laboratory Lighting Technology	WS+SS	6 CP
M-ETIT-103448	Laboratory Mechatronic Measurement Systems	WS	6 CP
M-ETIT-100478	Laboratory Nanotechnology	WS+SS	6 CP
M-ETIT-100477	Laboratory Optoelectronics	WS+SS	6 CP
M-INFO-106646	Practical Course: Human-Centred Robotics	WS+SS	6 CP

9.3 Profiling Modules

Credits
42

Election notes
All modules are listed with English titles, regardless of the course language.

Engineering Modules (Election: at least 18 credits)			
Modules in English			
M-ETIT-107301	Modules in English Language:	see notes	0 CP
M-INFO-107198	Advanced Artificial Intelligence	SS	6 CP
M-PHYS-102097	Basics of Nanotechnology I	WS	4 CP
M-PHYS-102100	Basics of Nanotechnology II	SS	4 CP
M-INFO-106190	Computational Imaging	WS	5 CP
M-ETIT-106953	Cyber-Physical Modeling	SS	6 CP
M-ETIT-106040	Digital Twin Engineering	WS	4 CP
M-MACH-107190	Drive System Engineering B: Stationary Machinery	WS	4 CP
M-INFO-106302	Explainable Artificial Intelligence	SS	3 CP
M-INFO-106650	HRI and Social Robotics	SS	6 CP
M-INFO-106649	Humanoid Robots - Locomotion and Whole-Body Control	SS	6 CP
M-ETIT-100435	Laser Physics	WS	4 CP
M-INFO-105778	Machine Learning - Foundations and Algorithms	SS	6 CP
M-ETIT-105982	Measurement Technology	WS	5 CP
M-MACH-106539	Microscale Fluid Mechanics	WS	4 CP
M-ETIT-106921	Modern VLSI Technologies	SS	6 CP
M-ETIT-105604	Nano- and Quantum Electronics	SS	6 CP
M-MATH-105831	Numerical Methods	SS	5 CP
M-MATH-106972	Numerical Methods with Programming Practice	SS	6 CP
M-WIWI-106853	Operations Research in Health Care Management	WS+SS	5 CP
M-ETIT-106974	Optical Engineering and Machine Vision	WS	6 CP
M-ETIT-100531	Optimization of Dynamic Systems	WS	5 CP
M-ETIT-100509	Optoelectronic Components	SS	4 CP
M-INFO-105623	Reinforcement Learning	WS	6 CP
M-INFO-107123	Robotics II - Humanoid Robotics	SS	3 CP
M-INFO-106651	Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society	SS	3 CP
M-INFO-106498	Seminar: Human-Robot Interaction	WS	3 CP
M-ETIT-106899	Signal Processing Methods	WS	6 CP
M-INFO-106504	Simulation and Optimization in Robotics and Biomechanics	WS	6 CP
M-PHYS-106483	Surface Science, without Exercises	Irreg.	8 CP
M-ETIT-100537	Systems and Software Engineering	WS	5 CP
M-INFO-107113	Wearable Robotic Technologies	SS	4 CP
Modules in German			
M-ETIT-107300	Modules in German Language:	see notes	0 CP
M-MACH-102705	Appliance and Power Tool Design	SS	12 CP
M-BGU-100052	Basics of Finite Elements	WS	6 CP
M-ETIT-103264	Information Fusion	WS	4 CP
M-ETIT-100457	Integrated Intelligent Sensors	SS	3 CP
M-ETIT-100454	Microsystem Technology	WS	3 CP
M-ETIT-102311	Numerical Methods for Partial Differential Equations	SS	4 CP
M-CIWVT-104329	Rheology of Polymers	SS	4 CP
M-ETIT-100450	Software Engineering	SS	3 CP
M-CIWVT-104489	Sol-Gel Processes	WS	4 CP
Modules in German/English			
M-MACH-103714	Materials Characterization	WS+SS	6 CP
M-MACH-103713	Properties	WS+SS	6 CP
M-INFO-106400	Seminar: Assistive robotics and exoskeletons in medical applications	WS	3 CP
M-INFO-105753	Deep Learning for Computer Vision I: Basics	SS	3 CP
M-INFO-105755	Deep Learning for Computer Vision II: Advanced Topics	WS	3 CP

Medical Technology and Clinical Modules (Election: at least 14 credits)			
Modules in English			
M-ETIT-107301	Modules in English Language:	see notes	0 CP
M-CHEMBIO-101904	Advanced Molecular Cell Biology	WS	5 CP
M-CHEMBIO-101903	Basic Molecular Cell Biology	SS	2 CP
M-INFO-106190	Computational Imaging	WS	5 CP
M-CHEMBIO-101905	Imaging Techniques in Light Microscopy	WS	3 CP
M-ETIT-106672	Medical Image Processing for Guidance and Navigation	WS	9 CP
M-ETIT-106782	Modeling Physiological Systems	SS	6 CP
M-ETIT-103252	Optical Systems in Medicine and Life Science	SS	3 CP
M-CHEMBIO-101906	Optics and Vision in Biology	WS	4 CP
M-ETIT-106920	Regulatory Affairs and Quality Management in Medical Device Product Development	SS	3 CP
M-ETIT-106775	Scientific Group Project in Medical Ultrasound Imaging	WS	3 CP
M-ETIT-107292	Technologies in Radiotherapy	WS	6 CP
M-INFO-107161	Ubiquitous Computing	WS	5 CP
Modules in German			
M-ETIT-107300	Modules in German Language:	see notes	0 CP
M-MACH-100489	BioMEMS - Microsystems Technologies for Life Sciences and Medicine I	WS	4 CP
M-MACH-100490	BioMEMS - Microsystems Technologies for Life Sciences and Medicine II	SS	4 CP
M-MACH-100491	BioMEMS - Microsystems Technologies for Life Sciences and Medicine III	SS	4 CP
M-MACH-102702	Organ Support Systems	SS	4 CP
M-INFO-100725	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	WS+SS	3 CP
M-MACH-102720	Principles of Medicine for Engineers	WS	4 CP
M-ETIT-100560	Ultrasound Imaging	SS	3 CP
Modules in German/English			
M-INFO-106400	Seminar: Assistive robotics and exoskeletons in medical applications	WS	3 CP
M-MACH-105483	BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV	WS	4 CP
M-MACH-105484	BioMEMS - Microfludic Chipsystems V	WS	4 CP
Laboratory/Practical Course (Election: 1 item)			
Modules in English			
M-ETIT-107301	Modules in English Language:	see notes	0 CP
M-ETIT-106779	Medical Measurement Technology Lab	WS	9 CP
M-INFO-106648	Practical Course: Movement and Technology	SS	6 CP
M-ETIT-106633	Signal Processing Lab	SS	6 CP
Modules in German			
M-ETIT-107300	Modules in German Language:	see notes	0 CP
M-MACH-102684	CAE-Workshop	WS+SS	4 CP
M-ETIT-100460	Laboratory in Software Engineering	SS	6 CP
M-ETIT-106673	Practical Machine Learning	SS	6 CP
M-MACH-106050	Reliability and Test Engineering	WS	5 CP
Modules in German/English			
M-INFO-106646	Practical Course: Human-Centred Robotics	WS+SS	6 CP
M-ETIT-100468	Lab Course on Nanoelectronics	WS+SS	6 CP
M-ETIT-100478	Laboratory Nanotechnology	WS+SS	6 CP

9.4 Interdisciplinary Qualifications

Credits
6

Mandatory			
Modules in German/English			
M-ETIT-105803	Interdisciplinary Qualifications	WS+SS	6 CP

9.5 Additional Examinations

Additional Examinations (Election: at most 30 credits)			
Modules in German			
M-FORUM-106753	Supplementary Studies on Science, Technology and Society	WS+SS	16 CP

10 Contact persons and advice

Subject-specific advice:
Program consultants of the department

General advice:
Consultants of the Program Service Master
e-mail: master-info@etit.kit.edu (Advice e.g. on study scheduling, examination regulations, individual case problems, applications etc. as well as on organizational procedures at the KIT-Department of Electrical Engineering and Information Technology)
- „Altes Maschinenbaugebäude“ (Ehrenhof), Building 10.91, 3rd floor, room 223.1

11 Editors

KIT Department of Electrical Engineering and Information Technology
Karlsruhe Institute of Technology (KIT)
www.etit.kit.edu
Dean of Studies:
Prof. Dr. rer. nat. Werner Nahm
Module coordination (modulkoordination@etit.kit.edu):
Dr. rer. nat. Andreas Barth

Rubrik	Angaben
Modul:	**Modultitel:** **Emergency Medicine and Pathophysiology** • Englischer Titel (sollte das Modul einen dt. Titel haben): - • Sprache, in welcher das Modul gelehrt und die Prüfung abgehalten wird (meistens deutsch oder englisch): ☐ deutsch ☒ englisch • Wird das Modul im Bachelor oder Master angeboten? ☐ Bachelor ☒ Master • In welchem Semester wird das Modul erstmals angeboten? WiSe 25/26 • Findet die Veranstaltung im WiSe und/oder SoSe statt? ☒ WiSe ☐ SoSe ☐ jedes Semester • Wie wird das Modul bewertet? ☒ benotet ☐ unbenotet
Personen:	Ein*e Modulverantwortliche*r (i.d.R. Lehrstuhlinhaber*in) muss an der ETIT ein*e interne*r Dozent*in mit Prüfungsberechtigung sein. • **Modulverantwortliche*r: Raphael Grau** • **Prüfer*in: Raphael Grau** • **Dozent*in: Raphael Grau** • **Modulbearbeiter*in: Raphael Grau**
Studiengang und Bereichs-/Fachzuordnung:	Studiengang: ☐ Elektrotechnik und Informationstechnik ☐ Mechatronik und Informationstechnik ☒ Medizintechnik Bereich-/Fachzuordnung: ☐ Wahl-/Profilierungsbereich ☐ Pflichtbereich der Vertiefungsrichtung Anmerkungen (ggf. SPO, Vertiefungsrichtung, GVR/PVR, …) Angedacht an Ringvorlesung; VL aktuell in der Planung in Anhänggkeit von Gastdozierenden des Klinikums Karlsruhe (in Korrespondenz mit Prof. Nahm)
Moduldauer:	☒ 1 Semester ☐ 2 Semester
Lehrveranstaltungen:	**Ringvorlesung „Emergency Medicine and Pathophysiology“**
SWS:	Wöchentliche Präsenzzeit der Studierenden: 2
Leistungspunkte (LP):	Anzahl (siehe auch Arbeitsaufwand): 4

Abkürzungen: **LP:** Leistungspunkte**; SPO:** Studien- und Prüfungsordnung; **WiSe/SoSe**: Winter-/Sommersemester; **GVR/PVR**: Grundlagen-/Pflichtmodule der Vertiefungsrichtung

Rubrik	Angaben
Arbeitsaufwand:	**Unter den Arbeitsaufwand fallen:** **1. Präsenzzeit in Vorlesungen, Übungen: 15*2 h = 30 h** **2. Vor-/Nachbereitung derselbigen: 15*3 h = 45 h** **3. Klausurvorbereitung und Präsenz in selbiger: 45 h** **Summe: 120 h = 4 LP**
Qualifikationsziele:	- **Die Studierenden können den rechtlichen und wirtschaftlichen Rahmen des deutschen Gesundheitswesens und der präklinischen Versorgung erklären.** - **Die Studierenden können in englischer medizinischer Fachsprache kommunizieren.** - **Die Studierenden sind in der Lage sympomorientiert verschiedene Krankheitsbilder zu unterscheiden.** - **Die Studierenden können die grundlegende Funktionsweise notfallmedizinischer Verfahren und Medizinprodukte beschreiben.**
Inhalt:	**Diese Ringvorlesung bietet einen umfassenden Einblick in die Notfallmedizin und Pathophysiologie, wobei der Schwerpunkt auf der unmittelbaren Versorgung akuter medizinischer Notfälle liegt. Dabei wird die Pathophysiologie aus verschiedenen Fachdisziplinen beleuchtet, um ein tiefes Verständnis für die Mechanismen zu vermitteln, die den Krankheitsbildern zugrunde liegen.** **Ein wesentlicher Bestandteil der Vorlesung ist die Betrachtung der Pathophysiologie häufiger präklinischer Notfallbilder, wie z.B. Herzinfarkte, Schlaganfälle oder schwere Traumata. Wir untersuchen, wie diese komplexen Prozesse in akuten Situationen erkannt und mittels moderner Medizinprodukte effektiv behandelt werden können.** **Darüber hinaus wird die Struktur des Gesundheitssystems und der Notfallmedizin in Deutschland erläutert. Hierbei wird aufgezeigt, wie die verschiedenen Akteure – von Notärzten über Rettungsdienste bis hin zu Kliniken – zusammenarbeiten, um eine optimale Versorgung sicherzustellen.** **Die Ringvorlesung wird durch weitere Themen ergänzt, die sich nach den Schwerpunkten der dozierenden Ärzte und Notfallsanitäter richten und somit eine breite und praxisnahe Wissensvermittlung garantieren. Diese interdisziplinäre und praxisorientierte Herangehensweise bereitet die Teilnehmenden auf die Herausforderungen in der Notfallmedizin vor und fördert ein tiefgehendes Verständnis für die Pathophysiologie und ihre Anwendung in der klinischen Praxis.**
Voraussetzungen:	**keine**
Empfehlung:	**keine**
Anmerkungen:	**-**
Prüfung:	**Die Erfolgskontrolle erfolgt in Form einer schriftlichen Prüfung im Umfang von 90 Minuten.**
Prüfung Besonderheiten:	**-**
Modulnote:	**Die Modulnote ist die Note der schriftlichen/mündlichen Prüfung.**

Abkürzungen: **LP:** Leistungspunkte**; SPO:** Studien- und Prüfungsordnung; **WiSe/SoSe**: Winter-/Sommersemester;
GVR/PVR: Grundlagen-/Pflichtmodule der Vertiefungsrichtung

Rubrik	Angaben
Modul:	**Modultitel: Human-Factors-Engineering** • **Englischer Titel** (sollte das Modul einen dt. Titel haben): **-** • **Sprache**, in welcher das Modul gelehrt und die Prüfung abgehalten wird (meistens deutsch oder englisch): ☐ **deutsch** ☒ **englisch** • Wird das Modul im **Bachelor oder Master** angeboten? ☐ **Bachelor** ☒ **Master** • In welchem **Semester** wird das Modul **erstmals** angeboten? WiSe 25/26 • Findet die Veranstaltung im **WiSe und/oder SoSe** statt? ☒ **WiSe** ☐ **SoSe** ☐ **jedes Semester** • Wie wird das Modul **bewertet**? ☒ **benotet** ☐ **unbenotet**
Personen:	Ein*e Modulverantwortliche*r (i.d.R. Lehrstuhlinhaber*in) muss an der ETIT ein*e interne*r Dozent*in mit Prüfungsberechtigung sein. • **Modulverantwortliche*r: Prof. Dr.-Ing. Barbara Deml** • **Prüfer*in: Prof. Dr.-Ing. Barbara Deml** • **Dozent*in: Prof. Dr.-Ing. Barbara Deml** • **Modulbearbeiter*in: Prof. Dr.-Ing. Barbara Deml**
Studiengang und Bereichs-/Fachzuordnung:	Studiengang: ☐ **Elektrotechnik und Informationstechnik** ☐ **Mechatronik und Informationstechnik** ☒ **Medizintechnik** Bereich-/Fachzuordnung: ☒ **Wahl-/Profilierungsbereich** ☐ **Pflichtbereich der Vertiefungsrichtung** **Anmerkungen** (ggf. SPO, Vertiefungsrichtung, GVR/PVR, …) **-**
Moduldauer:	☒ **1 Semester** ☐ **2 Semester**
Lehrveranstaltungen:	Beispiel: *„Vorlesung Höhere Mathematik" und „Übung zur Höheren Mathematik", Seminare, Workshops, Tutorien (jeweils inkl. SWS)* **Human-Factors-Engineering (4 LP, 2 SWS)**
SWS:	Wöchentliche Präsenzzeit der Studierenden**: 2**
Leistungspunkte (LP):	Anzahl (siehe auch Arbeitsaufwand): **4**

Abkürzungen: **LP:** Leistungspunkte**; SPO:** Studien- und Prüfungsordnung; **WiSe/SoSe**: Winter-/Sommersemester; **GVR/PVR**: Grundlagen-/Pflichtmodule der Vertiefungsrichtung

Rubrik	Angaben
Arbeitsaufwand:	**1. Präsenzzeit in Vorlesungen, Übungen: 30h** **2. Vor-/Nachbereitung derselbigen: 30h** **3. Aufbereitung einer medizintechnischen Fallstudie: 30h** **4. Klausurvorbereitung und Präsenz in selbiger: 30h** **Summe: 120h = 4 LP**
Qualifikationsziele:	**Die Studierenden erwerben grundlegendes Wissen im Bereich der Ergonomie:** - **Sie können Arbeitsplätze und Produkte hinsichtlich kognitiver, physiologischer, anthropometrischer und sicherheitstechnischer Aspekte ergonomisch gestalten.** - **Ebenso kennen sie physikalische und psychophysische Grundlagen im Bereich der Arbeitsumweltgestaltung.** - **Darüber hinaus lernen die Teilnehmer wesentliche Methoden der verhaltenswissenschaftlichen Datenerhebung (z. B. Eyetracking, EKG, Dual-Task-Paradigma) kennen.** - **Die Studierenden sind schließlich fähig, Daten über die Interaktion zwischen Mensch und Maschine zu erheben, zu interpretieren und zu nutzen, um Systeme benutzerzentriert zu verbessern.**
Inhalt:	- **Diese Veranstaltung soll Studierenden die theoretischen und methodischen Grundlagen menschlicher Arbeitsplatzgestaltung und nutzerzentrierter Produktgestaltung vermitteln.** - **Darüber hinaus führt die Veranstaltung in die verhaltenswissenschaftliche Datenerhebung ein, wobei ein besonderer Fokus auf dem Usability-Testing liegt. Die Studierenden lernen auch wesentliche damit in Zusammenhang stehende Methoden der Datenauswertung kennen.**
Voraussetzungen:	**-**
Empfehlung:	**Aktuell noch keine konkreten Angaben möglich.**
Anmerkungen:	**Aktuell noch keine konkreten Angaben möglich.**
Prüfung:	**Die Erfolgskontrolle erfolgt in Form einer Aufbereitung der einschlägigen Fallstudie und einer schriftlichen Prüfung im Umfang von 60 Minuten**
Prüfung Besonderheiten:	**-**
Modulnote:	**Die Modulnote ist die Note der schriftlichen Prüfung.**

Abkürzungen: **LP:** Leistungspunkte**; SPO:** Studien- und Prüfungsordnung; **WiSe/SoSe**: Winter-/Sommersemester;
GVR/PVR: Grundlagen-/Pflichtmodule der Vertiefungsrichtung

13 Modules

M 13.1 Module: Adaptive Optics [M-ETIT-103802]

Responsible: Dr. Szymon Gladysz
Prof. Dr. Ulrich Lemmer

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	English	4	3

Mandatory			
T-ETIT-107644	Adaptive Optics	3 CP	Gladysz, Lemmer

Assessment
Type of Examination: Oral examination

Duration of Examination: approx. 30 Minutes

Modality of Exam: The oral exam will be scheduled during the semester break.

Prerequisites
None.

Competence Goal
The students will:

- get familiar with Fourier description of imaging through aberrated optical systems and random media,
- understand the description of aberrations through Zernike modes,
- learn how to analytically compute the effects of turbulence on various optical observables such as image/beam motion, temporal power spectra, Zernike modes, scintillation, etc.,
- understand the effect of noise on various quantities and metrics pertinent to the design of adaptive optical systems,
- understand the advantages and disadvantages of various schemes for wavefront sensing and correction,
- learn how to simulate and design simple adaptive optics systems.

Content
Adaptive optics is a technology of correcting the effect of atmospheric turbulence on images of space objects and on laser beams propagating through random and highly aberrated media such as turbulence, tissue, and the inside of the human eye, to name just a few applications. The course will familiarize the students with theoretical basics of light propagation through random media, principles of wavefront sensing and reconstruction, as well as wavefront correction with deformable mirrors. The students will also receive solid introduction to statistical optics, the Kolmogorov theory of turbulence, practical aspects of turbulence simulation and modelling of adaptive optics.

1. Theory of turbulence (covariances, structure functions, power spectra, inertial range, dimensional argument of Kolmogorov)
2. Fourier optics (point-spread function, modulation transfer function)
3. Statistical optics (characteristic function, probability density function)
4. Sources and description of aberrations (Zernike polynomials, orthogonality, Marechal criterion)
5. Adaptive optics systems (open- and closed-loop systems, error budgets, tip-tilt correction)
6. Wavefront sensing (Shack-Hartmann wavefront sensor, wavefront reconstruction, wavefront-sensorless AO)
7. Wavefront correction (tip-tilt mirrors, deformable mirrors, piezoelectric effect, microelectromechanical systems, electrostatic actuation)
8. Simulation of adaptive optical systems (analytic vs. end-to-end modelling)
9. Propagation of laser beams through atmospheric turbulence (Gaussian beams, Rytov theory, scintillation index, beam wander)
10. Modelling of free-space optical communication systems (aperture averaging, mean signal-to-noise ratio, false-alarm rate and fade probability, bit error-rate)

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
total 90 h, hereof 30 h contact hours and 60 h homework and self-studies

Recommendations
Basic knowledge of statistics.

Literature
Robert K. Tyson, Principles of Adaptive Optics, CRC Press

Michael C. Roggemann, Byron M. Welsh, Imaging through Turbulence, CRC Press

M 13.2 Module: Advanced Artificial Intelligence [M-INFO-107198]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114220	Advanced Artificial Intelligence	6 CP	Niehues

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- The students know the relevant elements of a technical cognitive system.
- The students understand the algorithms and methods of AI to model cognitive systems.
- The students are able to understand the different sub-components to develop and analyze a system .
- The students can transfer this knowledge to new applications, as well as analyze and compare different methods.

Content
Due to the successes in research, AI systems are increasingly integrated into our everyday lives. These are, for example, systems that can understand and generate language or analyze images and videos. In addition, AI systems are essential in robotics in order to be able to develop the next generation of intelligent robots .

Based on the knowledge of the lecture “Introduction to AI”, the students learn to understand, develop and evaluate these systems.
In order to bring this knowledge closer to the students, the lecture is divided into 4 parts. First, the lecture investigates method of perception using different modalities. The second part deals with advanced methods of learning that go beyond supervised learning. Then methods are discussed that are required for the representation of knowledge in AI systems. Finally, methods that enable AI systems to generate content are presented.

Workload
Lecture with 3 SWS + 1 SWS exercise , 6 CP.
6 LP corresponds to approx. 180 hours, of which
approx. 45 hours lecture attendance
approx. 15 hours exercise visit
approx. 90 hours post-processing and processing of the exercise sheets
approx. 30 hours exam preparation

13.3 Module: Advanced Communications Engineering [M-ETIT-106815]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113676	Advanced Communications Engineering	6 CP	Jäkel

Assessment
The assessment takes place in the form of a written examination lasting 120 min,

Prerequisites
none

Competence Goal
The students are able to analyze and assess properties of communication systems and consider aspects of implementation. They can use mathematical methods in the context of communication systems for understanding involved derivations in the research literature; deriving and autonomously elaborating theoretical results, and checking their viability by simulations.

Content
The module is introducing and deriving results covering, but not being limited to, properties of linear modulation, channel description and diversity schemes, and processing of receiver signals, all based on detailed theoretical concepts. Topics already covered in previous modules are deduced thoroughly and mathematical derivations and reasoning are provided.

Module Grade Calculation
The module grade is the grade of the written exam.

Additional Information
Starting winter term 25/26

Workload

1.
    1. Attendance to the lecture: 20 * 1,5 h = 30 h
    2. Preparation and review: 20 * 3 h = 60 h
    3. Attendance to the tutorial: 6 * 1,5 h = 9 h
    4. Preparation and review: 6 * 3,5 h = 21 h
    5. Preparation for the exam: 60 h

    In total: 180 h = 6 LP

Recommendations
Basics knowledge of communication systems, as, e.g., provided in KIT's Bachelor courses “Grundlagen der Datenübertragung” and “Nachrichtensysteme”, is supposed. Furthermore, working knowledge in the areas of system theory and probability theory is assumed.

Teaching and Learning Methods
Lecture: 3 SWS, Exercise: 1 SWS

M 13.4 Module: Advanced Molecular Cell Biology (Sp-AMCB) [M-CHEMBIO-101904]

Responsible: Prof. Dr. Martin Bastmeyer
Dr. Franco Weth

Organisation: KIT Department of Chemistry and Biosciences

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	English	4	3

Mandatory			
T-CHEMBIO-105196	Advanced Molecular Cell Biology	5 CP	Weth

Assessment
The exam will be oral or written depending on the number of course participants. The exact modality of the exam will be announced at the beginning of the semester. The exam is scheduled for the break after the WS. A resit exam will be offered when needed.

Prerequisites
none

Competence Goal
The students
• are able to extract the central ideas from an advanced textbook or review article and introduce their fellow student to the topic,
• have acquire an advanced knowledge of the cell division cycle and exemplify applications of FRET for its analysis,
• understand DNA replication, recombination and repair and the basis of fluorescence based deep sequencing,
• are familiar with nuclear organization and epigenetic regulation and FISH as a means of analysing chromosomes,
• understand protein folding and degradation and discuss optical tweezers as a tool for the investigation of the folding problem,
• can address posttranslational modifications and cutting edge technologies based on fluorophore click-chemistry to observe them,
• comprehend cell suicide (apoptosis) and techniques of laser ablation to induce cell death
• are familiar with the different forms of cell/cell and cell/matrix contacts and with TIRF microscopy as a means of studying them,
• conceive the mechanisms of cell migration and their observation by live cell imaging,
• are familiar with principal mechanisms of embryonic development and understand fluorescent microarray technology for profiling the accompanying gene expression changes,
• understand the concepts of tissues, stem cells and cancer and of the quantification of gene expression by fluorescent nanostring and real-time fluorescence spectroscopy (qPCR),
• understand excitability and synaptic transmission in neurons and their observation with voltage and calcium sensitive flourophores,
• are acquainted with the concepts of immunity and the application of antibodies in fluorescent immunoassays.

Content
Progress in no other field of science is so intimately linked to the continuing development and welfare of humanity as the achievements of the life sciences. Modern biomedical research, however, is inconceivable without cutting-edge Optics & Photonics technologies ranging from high-throughput sequencing to super-resolution microscopy. Most students of Optics & Photonics are therefore likely to get in contact with life scientists during their careers. In this course, they will prepare themselves for fruitful future collaborations, which rely on shared concepts and terminologies. To this end, students will familiarize themselves with the basic principles and ideas of Molecular Cell Biology, which is at the heart of modern Biosciences.

I. Introduction to the cell
II. Concepts from Organic Chemistry pertinent to the Life Sciences
III. Concepts from Physical Chemistry pertinent to the Life Sciences
IV. Nucleic acids and proteins
V. Gene expression
VI. Methods
VII. Genomic variability and evolution
VIII. Cell membranes
IX. Energy metabolism
X. Cell signalling
XI. Cell compartments
XII. Cytoskeleton and cell division

Workload
Total 150h, hereof 40h contact hours (30h class, 10h problem class), and 110h homework and self-studies

Recommendations
Passed exam of the Adjustment Course in “Basic Molecular Cell Biology”.

Teaching and Learning Methods
Advanced textbook or review articles will be announced on a weekly basis. They have to be read by all participants. The contents will be discussed in the class sessions. Each class session is chaired by one participant and all participants have to contribute a sub-chapter / figure per session. For the problems class, exercise sheets will be handed out and participants have to be prepared to present their solutions.

Literature
Molecular Biology of the Cell, Alberts, B., et al., Taylor & Francis, 6th ed., 2014
Molecular Cell Biology, Lodish, H., et al., Macmillan, 2013

M 13.5 Module: Analog Circuit Design [M-ETIT-100466]

Responsible: Prof. Dr. Ivan Peric
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100973	Analog Circuit Design	4 CP	Peric

Additional Information
Will be changed to English in winter term 25/26.

M 13.6 Module: Antennas and Beamforming [M-ETIT-106956]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113920	Antennas and Beamforming	4 CP	Zwick

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal
After successfully participating in this course, students have in-depth knowledge of antennas, antenna systems and beamforming methods. This includes functionality, calculation methods as well as aspects of practical implementation. They are able to understand how typical electromagnetic radiators work and to develop and dimension them with specified properties. Students understand the principle and function of beamforming and the differences between digital, analog and hybrid beamforming. They know the theory, procedures and algorithms for beamforming. They can understand how beamforming is used for radio communication and radar.

Content
The lecture begins with a brief review of the basic knowledge of antennas and antenna arrays from the Bachelor's course. This is followed by a detailed discussion of all major antenna types (functionality, specifics). Furthermore, antenna measurement methods are presented. In the second part, the basic knowledge of noise, radio transmission and radar ambiguities is briefly refreshed, followed by a detailed presentation of the various beamforming algorithms, each with reference to radio communication and radar systems. Aspects such as digital and hybrid beamforming, as well as MIMO and equivalent virtual antenna configuration are explained.

The lecture will be accompanied by exercises. These are discussed in a room exercise and the corresponding solutions are presented in detail.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
The workload includes:

- Attendance study time lecture: 30 h
- Attendance study time exercise: 15 h
- Self-study time including exam preparation: 75 h

A total of 120 h

Recommendations
Knowledge of the basics of radio frequency technology and some basic knowledge on communication and radar systems is recommended.

M 13.7 Module: Appliance and Power Tool Design [M-MACH-102705]

Responsible: Prof. Dr.-Ing. Sven Matthiesen
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
12 CP	graded	Each summer term	1 term	German	4	5

Mandatory			
T-MACH-105229	Appliance and Power Tool Design	4 CP	Matthiesen
T-MACH-110767	Appliance and Power Tool Design Project Work *This item will not influence the grade calculation of this parent.*	8 CP	Matthiesen

Assessment
Approx. 30 min oral examination.

The project work on device technology is examined together with the lecture on device design.

Prerequisites
Due to organizational reasons, the number of participants is limited. At the beginning of august, a registration form will be available at the IPEK website. In the case of too many applicants, a selection process will be taking place. An early application is advantageous.

Competence Goal
The students are able to ...

- analyze complex and contradictory problems regarding the overall system user –machine and hence to create new solutions with focus on customer use.
- list, to identify and to explain strategies and approaches for the design of technical machines, to transfer them on new problems and to evaluate the working results concerning quality, costs and customer use.
- name the impact of specific boundary conditions, e.g. high quantities of mechatronic systems considering the customer, on the resulting design, to interpret the consequences and to evaluate the effects in unknown situations.
- name aspects of a successful product engineering in a team of worldwide acting companies regarding the field customer, company and market.
- evaluate their relevance for self-chosen examples and to transfer them on unknown problems.

Content
Operation system, system of objects and system of objectives of mechatronic appliances and power tool designs.

Mode of operation as enabler of design, components of mechatronic systems, application oriented design, guidelines for appliance and power tool design.

Part of the lecture is a project work, in which theory will be reprocessed and presented in a practical way. In such exercises the students also will present their results developed in project teams.

The interaction of analysis and sysnthesis will be acquired in student teams at the example of different appliances and power tools.

Module Grade Calculation
The module grade consists only of the grade for the lecture Appliance and Power Tool Design.

Additional Information
Participation in the course on device design requires simultaneous participation in the project work on device technology. For organisational reasons the number of participants is limited. A registration form will be provided on the IPEK homepage at the beginning of August. If the number of applicants is too large, a selection procedure will take place. This is based on the following selection criteria:

- Students within the course of studies will be decided on the basis of their progress (not only with semesters), which will be determined in a personal interview. The personal selection interviews take place in addition, in order to make the students aware of the special project-oriented format and the time required in correlation with the ECTS points of the course before the final registration for the course.
- With the same study progress after waiting period
- With same waiting time by lot.
- The same procedure is used for students from other courses.

Workload

Lecture Appliance and Power Tool Design: 60 h

Appliance and Power Tool Design Project Work: 180 h

Recommendations

None

Teaching and Learning Methods

Lecture, exercise, project work

13.8 Module: Applied Information Theory [M-ETIT-100444]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100748	Applied Information Theory	6 CP	Jäkel

Assessment
The success control takes place in the form of an oral examination lasting 25 minutes. Before the examination, there is a preparation phase of 15 minutes in which preparatory tasks are solved.

Prerequisites
none

M 13.9 Module: Authentication and Encryption [M-INFO-105338]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-INFO-110824	Authentication and Encryption	4 CP	Müller-Quade

M 13.10 Module: Automated Visual Inspection and Image Processing (24169) [M-INFO-100826]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-INFO-101363	Automated Visual Inspection and Image Processing	6 CP	Beyerer

M 13.11 Module: Basic Molecular Cell Biology (AdjC-BMCB) [M-CHEMBIO-101903]

Responsible: Prof. Dr. Martin Bastmeyer
Dr. Franco Weth

Organisation: KIT Department of Chemistry and Biosciences

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
2 CP	pass/fail	Each summer term	1 term	English	4	2

Mandatory			
T-CHEMBIO-105199	Basic Molecular Cell Biology	2 CP	Weth

Assessment
The written exam over 120 Minutes is scheduled for the beginning of the break after the SS.

Prerequisites
none

Competence Goal
The students

- comprehend the fact that all life on earth is based on cells,
- understand the basic build-up of eukaryotic cells,
- know the central concepts of Organic and Physical Chemistry, on which life is based,
- know the structures and major functions of the four classes of biological macromolecules,
- comprehend the idea that a cell is a micro-factory based on nanomachines (proteins) that are instructed by informational macromolecules (DNA, RNA),
- conceive the idea that the variation of genomic information underlies evolution,
- know the methods of how cells acquire energy for life processes,
- are familiar with the roles of the cytoskeleton organelles and the cell membrane and
- are familiar with the basics of cellular responsitivity towards external cues,
- get a first glimpse on key technologies, which underlie experimental progress in the field

Content
I. Introduction to the cell
II. Concepts from Organic Chemistry pertinent to the Life Sciences
III. Concepts from Physical Chemistry pertinent to the Life Sciences
IV. Nucleic acids and proteins
V. Gene expression
VI. Methods
VII. Genomic variability and evolution
VIII. Cell membranes
IX. Energy metabolism
X. Cell signalling
XI. Cell compartments
XII. Cytoskeleton and cell division

Workload
Working hours in total are 60 hours for an average student. Thereof 30 h (= approx. 14 x 2h) attendance in lectures and 30 h self-study as preparation for the exam.

Teaching and Learning Methods
Progress in no other field of science is so intimately linked to the continuing development and welfare of humanity as the achievements of the life sciences. Modern biomedical research, however, is inconceivable without cutting-edge Optics & Photonics technologies ranging from high-throughput sequencing to super-resolution microscopy. Most students of Optics & Photonics are therefore likely to get in contact with life scientists during their careers. In this course, they will prepare themselves for fruitful future collaborations, which rely on shared concepts and terminologies. To this end, students will familiarize themselves with the basic principles and ideas of Molecular Cell Biology, which is at the heart of modern Biosciences.

Literature
Lecture presentations will be accessible in pdf-format.
Essential cell biology, Alberts, B., et al., Taylor & Francis, 4th ed., 2013
Principles of Cell Biology, Plopper, G., Jones & Bartlett Publ., 2011
Prerequisites

13.12 Module: Basics of Converter Control [M-ETIT-100400]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-100717	Basics of Converter Control	3 CP	Liske

Prerequisites
none

M 13.13 Module: Basics of Finite Elements (bauiM1S20-GRUNDFE) [M-BGU-100052]

Responsible: Prof. Dr.-Ing. Peter Betsch
Organisation: KIT Department of Civil Engineering, Geo and Environmental Sciences
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	4

Mandatory			
T-BGU-109908	Homework 'Basics of Finite Elements'	1 CP	Betsch
T-BGU-100047	Basics of Finite Elements	5 CP	Betsch

Assessment
- 'Teilleistung' T-BGU-109908 with not graded accomplishment according to § 4 Par. 3
- 'Teilleistung' T-BGU-100027 with oral examination according to § 4 Par. 2 No. 2

details about the learning controls see at the respective 'Teilleistung'

Prerequisites
none

Competence Goal
The students can describe the structure and the functionality of FE codes. They can formulate the basics of variational principles of FEM as well as the Lagrangian element family of different order of projection for one-dimensional, planar and spatial problems in the fields of linear strength of materials and heat transport. They know, that it is an approximate solution method for boundary value problems, and they are aware of its limits. They can get familiar quickly with commercial FE codes and can use them reasonably.

Content
The theoretical principles as well as the numerical implementation of Finite Element Methods are covered. The major terms are discussed such as weak form of the boundary value problem, test function, projection function, continuity requirements, domain discretization, Galerkin approximation, stiffness matrix, assembly,iso-parametric concept, numerical integration and accuracy of finite element approximation.

Module Grade Calculation
grade of the module is grade of the exam

Additional Information
none

Workload
contact hours (1 HpW = 1 h x 15 weeks):

- lecture, exercise: 60 h

independent study:

- preparation and follow-up lectures, exercises: 45 h
- processing exercises sheets: 30 h
- examination preparation: 45 h

total: 180 h

Recommendations
none

Literature
[1] Cook, Malkus, Plesha: Concept and Applications of Finite Element Analysis, 1989.
[2] Hughes: The Finite Element Method, 1987.
[3] Zienkiewicz, Taylor: The Finite Element Method, Volume 1,2 & 3, 2000.
[4] Bathe: Finite-Elemente-Methoden, 2001.

13.14 Module: Basics of Nanotechnology I [M-PHYS-102097]

Responsible: apl. Prof. Dr. Gernot Goll
Organisation: KIT Department of Physics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	3	1

Mandatory			
T-PHYS-102529	Basics of Nanotechnology I	4 CP	Goll

Assessment
Oral Exam. In the MSc Physics, this module is examined together with further modules attended as part of the major in physics. The total duration of the oral exam is approx. 60 minutes.

Prerequisites
none

Competence Goal
Students deepen their knowledge in one area of nano-physics, master the relevant theoretical concepts and are familiar with basic techniques and measurement methods of nano-analytics and lithography.

Content
Introduction to central areas of nanotechnology;

Teaching of the conceptual, theoretical and, in particular, methodological fundamentals:

- Methods of imaging and characterization (nanoanalytics)
  Basic concepts of electron microscopy and associated analytical capabilities are covered in an introductory manner. Scanning probe techniques such as tunneling and force microscopy for the investigation and imaging of conductive and insulating sample surfaces, respectively, are discussed. Complementary spectroscopic capabilities of the scanning probe techniques will be explained.
- Methods of nanostructure fabrication (lithography and self-assembly)
  Along the individual process steps from coating and exposure to structure transfer by etching and vapor deposition, the methods used will be explained, their application limits discussed and current developments highlighted.

The lecture "Nanotechnology II" covers application areas and current research topics in the summer semester.

Workload
120 hours consisting of attendance time (30 hours), wrap-up of lecture incl. exam preparation. (90 hours)

Recommendations
Basic knowledge of solid state physics and quantum mechanics is expected.

Literature
For follow-up and consolidation of the lecture material, reference is made to various textbooks as well as original and review articles. A detailed list will be given in the lecture.

M 13.15 Module: Basics of Nanotechnology II [M-PHYS-102100]

Responsible: apl. Prof. Dr. Gernot Goll
Organisation: KIT Department of Physics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	3	1

Mandatory			
T-PHYS-102531	Basics of Nanotechnology II	4 CP	Goll

Assessment
Oral Exam. In the MSc Physics, this module is examined together with further modules attended as part of the major in physics. The total duration of the oral exam is approx. 60 minutes.

Prerequisites
none

Competence Goal
The student deepens his knowledge in the field of nanophysics, masters the relevant theoretical concepts and is familiar with the basic application areas of nanophysics. The student is able to interpret current data and figures from the scientific literature and to present the current state of research as well as important "open questions".

Content
Introduction to central areas of nanotechnology

Teaching of the conceptual, theoretical and especially methodological basics;

Applications and current developments in the fields of nanoelectronics, nanooptics, nanomechanics, nanotribology, biological nanostructures, self-organized nanostructures, among others.

In addition, the lecture "Fundamentals of Nanotechnology I" in the winter semester deals with methods of imaging, characterization and fabrication of nanostructures.

Workload
120 hours consisting of attendance time (30 hours), wrap-up of the lecture incl. exam preparation and working on the exercises (90 hours)

Recommendations
Basic knowledge of solid state physics and quantum mechanics is expected.

Literature
For follow-up and consolidation of the lecture material, reference is made to various textbooks as well as original and review articles. A detailed list will be given in the lecture.

M 13.16 Module: Basics of Technical Logistics II [M-MACH-105302]

Responsible: Prof. Dr.-Ing. Kai Furmans
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	3

Mandatory			
T-MACH-109920	Basics of Technical Logistics II	6 CP	Furmans

Assessment
The assessment consistsof an oral or a written exam according to Section 4 (2), 1 or 2 of the examination regulation.

Prerequisites
none

Competence Goal
The student is able to

- describe and design processes and process networks in intralogistics,
- model and analyse the material flow between processes,
- describe material flow elements and apply them in a systematic way,
- check material flow elements for their safety.

Content
The aim of this lecture is to give an overview of the three major topics of technical logistics:

- Processes in intralogistic systems
- Technology of technical logistics
- Organization and control of intralogistic processes

Using the example of an intralogistics system, the various topics are presented over the course of the lecture period, so that students are in the end able to understand and describe such an overall system in detail.

Workload
Attendance: 36 hours

Rework: 114 hours

Recommendations
Basics knowledge of technical logistics I is preconditioned

Teaching and Learning Methods
Lectures

M 13.17 Module: Batteries and Fuel Cells Laboratory [M-ETIT-100381]

Responsible: Dr.-Ing. Andre Weber
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-ETIT-100708	Batteries and Fuel Cells Laboratory	6 CP	Weber

Prerequisites
none

M 13.18 Module: Batteries, Fuel Cells, and Electrolysis [M-ETIT-107005]

Responsible: Prof. Dr.-Ing. Ulrike Krewer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113986	Batteries, Fuel Cells, and Electrolysis	6 CP	Krewer

Assessment
Success control takes place in the form of a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal
Students gain an understanding of batteries, fuel cells and electrolysis including their application, design, and behavior. They acquire in-depth knowledge of the transport and charge transfer processes in them, their impact on performance and design, and the characteristics of the most frequent types of batteries, fuel and electrolysis cells. They understand how to analyze and characterize them using measurement methods and modeling. A practical insight into current areas of application and research topics of electrochemical energy storage and conversion allows them to relate the course work to demands of the society and for R&D. They are able to communicate with specialists from related disciplines in the field of (application of) batteries, fuel cells and electrolysis and can actively contribute to the opinion-forming process in society with regard to energy technology issues.

Content
The course introduces batteries, fuel cells and electrolysis and their use for sustainable mobile and stationary energy supply and storage. The course is divided into five sections. The first part covers the role of batteries, fuel cells and electrolysis for renewable energy storage and electrification of the energy system and the present applications. This is followed by a fundamentals part, where the processes in electrochemical cells at open circuit and during operation and their relation to cell performance and behavior are discussed. It contains thermodynamics, kinetics, transport and performance measures. The third part deals with the working principle, design and operation of fuel cells and electrolysis and the particularities of the different cell types. This is followed by a similar part for batteries. Finally, dynamic and stationary methods for characterizing the cells are covered.

Group project

As part of the coursework, student groups work on the design of a battery, fuel cell or electrolyser for a given application during the semester. This includes literature research on cell type, materials and material data as well as the dimensioning and energetic evaluation of the cell. The results are documented in a short technical report.

Module Grade Calculation
The module grade is the grade of the written examination.

Workload

1. Lecture attendance time: 15 * 2 h = 30 h
2. Preparation and follow-up time for lecture: 15 * 5 h = 75 h
3. Exercise attendance time: 7 * 2 h = 14 h
4. Preparation and follow-up time for exercise: 7 * 4 h = 28 h
5. Group work including writing of a report: 33 h
6. Exam preparation and attendance: included in preparation and follow-up time.

Total: 180 h = 6 CP

13.19 Module: Biologically Inspired Robots [M-MACH-106903]

Responsible: Prof. Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-MACH-113856	Biologically Inspired Robots	3 CP	Rönnau

Assessment
See partial achievement

Prerequisites
None

Competence Goal
Students are familiar with various design principles of the "bionics" method in robotics and can analyze and evaluate models for kinematics, mechanics, control, perception and cognition.

Students understand the lightweight construction concepts and material properties of natural models. They are familiar with the concepts and methods of lightweight robotics and can describe the resulting effects on the energy efficiency of mobile robot systems.

Students can distinguish between different natural muscle types and how they function. They also know the corresponding artificial muscle systems and can derive the underlying muscle model.

Students know the most important human senses and the associated stimulus processing and information coding. They can derive technological sensors that perform the same function in robotics.

Students can differentiate the function of a central pattern generator (CPG) from a reflex. They can theoretically derive neuro-oscillators and explain how they control the movement of a robot. Furthermore, they can generate walking patterns for six-legged robots based on the "Cruse rules".

Students can distinguish between different types of locomotion and suitable stability criteria for walking movements. They know the most important walking patterns for multi-legged walking robots and can represent these in a gait diagram.

Students know the most important algorithms for machine learning methods and can explain their advantages and disadvantages in robotics.

Students know the subsumption system architecture and can evaluate the advantages of a reactive system architecture. They can combine "behaviors" for biologically inspired robots into behavior networks.

Students can apply Mendel's laws and explain the differences between meitosis and mitosis. They can also explain the basic genetic algorithm.

Students can identify the greatest challenges in the development of innovative, humanoid robot systems and are familiar with possible solutions and successful implementations.

Content
The lecture biologically inspired robots deals intensively with robots whose mechanical design, sensor concepts or control architecture were inspired by nature. In detail, we will look at solutions from nature (e.g. lightweight construction concepts using honeycomb structures, human muscles) and then at robot technologies that utilize these principles to solve similar tasks (lightweight 3D printed parts or artificial muscles in robotics).

After discussing these biologically inspired technologies, concrete robotic systems and applications from current research that successfully utilize these technologies will be presented. In particular, multi-legged walking robots, snake-like and humanoid robots are presented and their sensor and drive concepts are discussed.

The lecture focuses on the concepts of control and system architectures (e.g. behavior-based systems) of these robotic systems, with locomotion being the main focus. The lecture ends with an outlook on future developments and the development of commercial applications for these robots.

Workload
90 working hours, of which approx:

- 30h for attendance time in lectures
- 30h for preparation and follow-up time
- 30h for exam preparation and participation in the oral exam

M 13.20 Module: Biomechanics: Design in Nature and Inspired by Nature [M-MACH-107181]

Responsible: Prof. Dr. Claus Mattheck
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	pass/fail	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105651	Biomechanics: Design in Nature and Inspired by Nature	4 CP	Mattheck

Assessment
Colloquium, ungraded

Prerequisites
none

Competence Goal
The students know and understand mechanical optimization schemes which are realized in nature. The students can analyze the derived thinking tools and can apply them for simple technical cases.

Content
* mechanics and growth laws of trees
* failure criteria and safety factors
* computer simulation of adaptive growth
* notches and damage case studies
* optimization inspired by nature
* structural shape optimization without computers
* universal shapes of nature
* fibre reinforces materials
* failure of trees, hillsides, dikes, walls and pipes

Module Grade Calculation
ungraded

Workload
regular attendance: 30 hours
self-study: 90 hours

Teaching and Learning Methods
Seminar / Workshop

M 13.21 Module: Biomedical Engineering for Engineers - Fundamentals of Project Management in Medical Engineering [M-MACH-106461]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-MACH-112817	Biomedical Engineering for Engineers - Fundamentals of Project Management in Medical Engineering	4 CP	Ahrens, Guber, Rajabi

M 13.22 Module: BioMEMS - Microfludic Chipsystems V [M-MACH-105484]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-MACH-111069	BioMEMS - Microfludic Chipsystems V	4 CP	Guber, Rajabi

Assessment
Oral exam (20 min)

Prerequisites
none

Competence Goal
The students master the basics of microfluidics. They are able to develop, manufacture and test microfluidic systems in an application-oriented manner. They master applications such as Lab-on-chip, Organ-on-chip, Body-on-chip.

Content
Introduction in microtechnical production processes and biomaterials. Detailed application examples from the fields of lab-on-chip, organ-on-chip and body-on-chip.

Workload
Literature: 19 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Teaching and Learning Methods
Lecture

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

M 13.23 Module: BioMEMS - Microsystems Technologies for Life Sciences and Medicine I [M-MACH-100489]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-100966	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I	4 CP	Guber

Assessment
Written exam (75 min)

Prerequisites
none

Competence Goal
The lecture will first address relevant microtechnical manufacturing methods. Then, selected biomedical applications will be presented, as the increasing use of microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical products, instruments, and operation and analysis systems.

Content
Introduction into various microtechnical manufacturing methods: LIGA, Micro milling, Silicon Micromachining, Laser Microstructuring, µEDM, Metal-Etching
Biomaterials, Sterilisation.
Examples of use in the life science sector: basic micro fluidic strucutures: micro channels, micro filters, micromixers, micropumps, microvalves, Micro and nanotiter plates, Microanalysis systems (µTAS),
Lab-on-chip applications.

Workload
Literature: 20 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

13.24 Module: BioMEMS - Microsystems Technologies for Life Sciences and Medicine II [M-MACH-100490]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-100967	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II	4 CP	Guber

Assessment
Written exam (75 min)

Prerequisites
None

Competence Goal
The lecture will first shortly address some relevant microtechnical manufacturing methods. Then, selected biomedical applications will be presented, as the increasing use of microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical products, instruments, and operation and analysis systems.

Content
Examples of use in Life-Sciences and biomedicine: Microfluidic Systems:
LabCD, Protein Cristallisation
Microarrys
Tissue Engineering
Cell Chip Systems
Drug Delivery Systems
Micro reaction technology
Microfluidic Cells for FTIR-Spectroscopy
Microsystem Technology for Anesthesia, Intensive Care and Infusion
Analysis Systems of Person´s Breath
Neurobionics and Neuroprosthesis
Nano Surgery

Workload
Literature: 20 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II;
Springer-Verlag, 1994

M. Madou
Fundamentals of Microfabrication

13.25 Module: BioMEMS - Microsystems Technologies for Life Sciences and Medicine III [M-MACH-100491]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-100968	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III	4 CP	Guber

Assessment
Written exam (75 min)

Prerequisites
none

Competence Goal
The lecture will first shortly address some relevant microtechnical manufacturing methods. Then, selected biomedical applications will be presented, as the increasing use of microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical products, instruments, and operation and analysis systems.

Content
Examples of use in minimally invasive therapy
Minimally invasive surgery (MIS)
Endoscopic neurosurgery
Interventional cardiology
NOTES
OP-robots and Endosystems
License of Medical Products and Quality Management

Workload
Literature: 20 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II;
Springer-Verlag, 1994

M. Madou
Fundamentals of Microfabrication

13.26 Module: BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV [M-MACH-105483]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-MACH-106877	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV	4 CP	Ahrens, Guber

Assessment
Oral exam (20 min)

Prerequisites
none

Competence Goal
The students get to know selected areas of application in the life sciences. They will be able to design and develop novel products for different fields of application in the life sciences, as well as implement them in production technology.

Content
Examples from the life science sector: biosensor technology, microfluidic basic structures and systems, micro-assembly, medical implants, micro-process engineering, optofluidics, medical products law.

Workload
Literature: 19 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

M 13.27 Module: Business Innovation in Optics and Photonics [M-ETIT-101834]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-104572	Business Innovation in Optics and Photonics	4 CP	Nahm

Assessment
Type of Examination: examination of another type

Duration of Examination: 4 group presentations à 20 minutes (approx.)

Modality of Exam: The exam consists of four group presentations. 2nd day: Technology Presentation. 3rd day: Development plan presentation. 4th day: Business Canvas presentation. Final presentation at Zeiss visit: Business pitch

Prerequisites
Good knowledge in optics & photonics.

Competence Goal
The student has an understanding how innovative concepts for optical and photonics products are transferred into a successful business development. The student knows about and makes first hands on experiences on business development aspects in a technology start up environment. The students acquire specialized knowledge in technologies and applications in the field of smart mobile solutions for optical applications as well as an introduction into the field of patent rights.

The students can organize themselves in groups and distribute and execute tasks. Further they gain competences in the fields teamwork, organization and communication.

The studetns

- understand the implications of intellectual property
- are able to perform data base research
- know how to develop a business plan
- get an understanding of how to design a project
- are able to develop in small groups innovative business cases for a potential future product

Content
This course is instructed and presented by external innovation specialists of the R&D, business and management departments of the Carl Zeiss AG.

- Introduction: Examples of existing smart mobile device applications, Brainstorming for ideas
- Technology Introduction: Mobile device technology, Optic components, Display technology (LCD, OLED), Tracking and Sensor Technologies in smart mobile devices
- Group Work Technology
- Group Presentations Technology
- Business Case Development/ Business Plan: Market segmentation, Market research, Essentials of finance, How to write a business plan?
- Management of Intellectual Property (IP): Importance of IP Management, Patent research, Patent claims, Licencing, Patent infringement, Patent litigation
- Project Design: How to run an agile R&D Project?, Traget costing, Networked product development
- Agile project simulation
- Group Work
- Excursion to Carl Zeiss AG in Oberkochen (full day)
- Presentation of results of the group work to the new business experts committee of the Carl Zeiss AG

Module Grade Calculation
The final grade is the weighted average of the gradings for the four presentations. The three intermediate presentations are each weighted 1, the final presentation is weighted 3.

Workload
total 120 h, thereof 34 h contact hours and 86 h preparation, homework, self-studies and excursion

13.28 Module: CAE-Workshop [M-MACH-102684]

Responsible: Prof. Dr.-Ing. Tobias Düser
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German	4	3

Mandatory			
T-MACH-105212	CAE-Workshop	4 CP	Düser

Assessment
Written examination (with practical part on the computer), duration 60 min

Prerequisites
None

Competence Goal
The students are able to ...

- name the purposes and limits of numerical simulation and optimization of the virtual product development.
- solve simple realistic tasks in the field of finite element analysis and structure optimization with industrial common software.
- evaluate and to question the results of a simulation.
- identify and improve the mistakes of a simulation or optimization.

Content

- introduction to the finite element analysis (FEA)
- stess and modal analysis of finite element models using Abaqus/CAE as a preprocessor and Abaqus solver
- introduction to topology and shape optimization
- creation and calculation of various optimization models with the optimization package of Abaqus

Workload
regular attendance: 31.5 h

self-study: 88,5 h

independent work with different software tools (supported by tutors and assistants)

discussing and presenting results in small groups

Teaching and Learning Methods
Seminar

Literature
The workshop script will be allocated at Ilias.

M 13.29 Module: Channel Coding: Algebraic Methods for Communications and Storage [M-ETIT-105616]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-111244	Channel Coding: Algebraic Methods for Communications and Storage	3 CP	Schmalen

Assessment
The exam is held as an oral exam of approx. 20 min.

Competence Goal
The students are able to analyse and assess problems of algebraic channel coding. They can apply methods of algebraic coding theory in the context of communication systems for data transmission and data storage and are able to assess their implementation.Additionally, they will get knowledge to current research topics and research results.

Content
This course focuses on the formal and mathematical basics for the design of coding schemes in digital communication systems. These include schemes for data transmission, data storage and networking. The course starts by introducing he necessary fundamentals of algebra which are then used to derive codes for different applications. Besides codes that are important for data transmission appliations, e.g., BCH and Reed-Solomon-Codes, we also investigate codes for the efficient storage and reconstruction of data in distributed systems (locally repairable codes) and codes that increase the throughput in computer networks (network codes). Real applications are always given to discuss practical aspects and implementations of these coding schemes. Many of these applications are illustrated by example code in software (python/MATLAB).

Module Grade Calculation
Grade of the module corresponds to the grade of the oral exam.

Workload

1. *Attendance to the lecture: 15 * 2 h = 30 h*
2. *Preparation and review: 15 * 4 h = 60 h*
3. *Preparation for the exam: included in preparation and review*
4. *In total: 90 h = 3 LP*

Recommendations
Knowledge of basic engineering as well as basic knowledge of communications engineering.

Previous attendance of the lectures "Communication Engineering I" and "Probability Theory" is recommended.

M 13.30 Module: Channel Coding: Graph-Based Codes [M-ETIT-105617]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-111245	Channel Coding: Graph-Based Codes	6 CP	Schmalen

Assessment
The success control takes place in the form of an oral examination lasting 25 minutes. Before the examination, there is a preparation phase of 30 minutes in which preparatory tasks are solved.

Prerequisites
none

Competence Goal
Students will be able to understand and apply advanced and modern methods of channel coding. They get to know various tools of modern coding theory for the analysis and optimization of coding schemes, conceptual design approaches of error correction building blocks as well as applications in digital communications (for example, 5G). Additionally, they will get knowledge to current research topics and research results.

Content
The course expands on the topics dealt with in the lecture “Verfahren der Kanalcodierung”. The focus is on modern methods that have been brought into practice in the past few years and that achieve the capacity limits postulated by Shannon. For this purpose, known techniques have to be extended and new methods have to be learnt additionally. The lecture introduces the theoretical limits very quickly and follows with a discussion on the basic concepts of channel coding, including block codes. Based on this, modern error correction methods like LDPC codes, spatially coupled codes, and Polar codes are treated in depth. The lecture ends with a view on the application of channel coding in classical and distributed storage scenarios and in computer networks. Many of the applications are illustrated with example implementations in software (python/MATLAB).

Module Grade Calculation
The modul grade is the grade of the oral exam.

Workload
- Lecture attendance time: 15 * 3 h = 45 h
- Presence time Exercise: 15 * 1 h = 15 h
- Lecture preparation / revision: 15 * 3 h = 45 h
- Exercise: 15 * 1 h = 15 h
- Exam preparation and attendance: 60 h

Total workload: approx. 180 h = 6 LP

Recommendations
Previous attendance of the lectures "Communication Engineering I" and "Probability Theory" is recommended. Knowledge from the lecture "Applied Information Theory" can be helpful. Previous attendance of the lecture “Verfahren der Kanalcodierung” can be helpful, but is not necessary.

M 13.31 Module: Communication Systems and Protocols [M-ETIT-100539]

Responsible: Dr.-Ing. Jens Becker
Prof. Dr.-Ing. Jürgen Becker

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-101938	Communication Systems and Protocols	5 CP	Becker, Becker

Assessment
The examination consists of a written examination of 120 min.

Prerequisites
none

Competence Goal
The students are able to:

- know basic communication systems and to name them
- categorize different communication systems in regards to possible constraints
- name basic mechanisms of communication systems
- carry out these mechanisms
- choose valid mechanisms suitable under given constraints
- design a communication system adhering to constraints, specifications and be able to choose suitable methods, components, and subsystems
- know current communication systems and know about their properties, mechanisms and application.

Content
The lecture will present the physical and technical basics for the design and construction of communication systems. Procedures and technical implementations for communication between electronic devices are presented. This includes, among other things, modulation methods, line model, arbitration, synchronization mechanisms, error correction mechanisms, multiplexing, communication systems, bus systems and on-chip communication. On the basis of selected practical examples, the application of the lecture contents in real systems is demonstrated.

- Information: Definition, Representation, Communication
- Physics: Media, Signals, Mathmatical Descriptions, Line Coupling & Termination, AD Conversion & Sampling, Line Codes, Modulation
- Data Transmission: Definition & Requirements, Transmission Channels, MultiUse of Channels, Multiplexing, Multiple Senders (Arbitration), Multiple Receivers (Addressing), Classification, Interfaces
- Bus Systems: Definitions, Protocols, Transmission of Dataframes, Classification
- Error Protection: Fundamentals, Errors, Error Detection/Correction: Error Handling
- Topologies: physical, logical, examples
- Networks: networks vs. busses, structure, Network specific topologies, routing, OSI Model, TCP/IP, Ethernet
- Classification of Com.Systems
- Real World Systems: Automotive Busses, PC Busses, Field Busses, Networks

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
The workload includes:

1. Attendance in 15 lectures an 7 exercises: 33 h
2. Preparation / follow-up: 66 h (2 h per unit)
3. Preparation of and attendance in examination: 24 h + 2 h

A total of 125 h = 5 LP

M 13.32 Module: Communications Engineering Laboratory [M-ETIT-107136]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-114159	Communications Engineering Laboratory	6 CP	Jäkel

Assessment
The examination consists of the participation in the experiments and an oral examination. The overall impression is rated.

Prerequisites
none

Competence Goal
Students are able to apply methods of signal processing and communications engineering in the implementation of communication systems.

They are able to carry out communications engineering calculations and use the tools required for simulations methodically and appropriately. This enables students to classify the components involved in a communication system in terms of their performance and to understand their interaction in an overall system.

Content
The practical course consists of 11 experiments and covers the following topics:

Introduction to Python, DFT, the sampling theorem, filter design and multirate filters, stochastic signals, digital modulation methods, source coding, channel coding, GNU Radio and Software Defined Radio, OFDM, synchronization algorithms and optimization.

Module Grade Calculation
The module grade results of the participation in the experiments and an oral examination. Details will be given during the lecture.

Additional Information
Attendance is compulsory during all laboratory sessions, including the introductory session. Compulsory attendance is necessary both for carrying out the work in the team on site and for the practical teaching of techniques and skills that cannot be learned in pure self-study

Workload
- Attendance time practical course: 11 * 4 h = 44 h

- Lecture preparation and follow-up: 11 * 8 h = 88 h

- Exam preparation and attendance of exame: 48 h

Total: 180 h

Recommendations
Previous attendance of the lectures "Signals and Systems" and "Communications Engineering I".

13.33 Module: Components of Power Systems [M-ETIT-106689]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113445	Components of Power Systems	3 CP	Leibfried

Assessment
The examination takes place in form of an oral examination lasting approx. 20 minutes.

Prerequisites
none

Competence Goal
Students know the main components of electrical networks and how they interact. Students understand the structure of cable systems in AC and DC voltage technology. The procedure for insulation coordination and overvoltage protection in the high-voltage grid is introduced. They will be able to reproduce key relationships. Students are familiar with the future challenges and trends for selected components and transmission technologies of electrical grids.

Content

- Substations
  o Types of Substations
  o Basic Requirements ans Standardization
  o Air Insulated Switchgears
  o Gas Insulated Switchgears
- Principle of Inductive Equipments
  o Magnetic Field in an Iron Circuit
  o Basic Design of Transformers
- Transformers
  o Overview
  o Design and Components of Power Transformers and Reactors
- Overhead Transmission Lines
  o Development of overhead lines system voltages
  o Grid Development with OVH Transmission Lines
  o Parts of an Overhead Line
  o Comparison DC and AC OVH Transmission Lines
  o Effects of OHL on Environment
- Cables
  o Development of Cable Lines System Voltages
  o Grid Development with cable systems
  o Parts of Cables Systems
  o Comparison DC and AC Cables Systems
  o Offshore Cables Systems
  o Effects of Cables on Environment
- Insulation Arresters
  o Insulation Coordination
  o Surge Arresters
- Circuit Breaker and Disconnectors
  o Circuit Breakers
  o Disconnectors
- Power Cable Accessories and Power Line Monitoring
  o Accessories
  o Power Line Monitoring
- Application of Power Electronics in Power System
  o Development of Power Electronics
  o Fundamental Principles of PE
  o Application of PE in Power System
- Energy Innovation and Trends

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
The workload includes:

1. attendance in lectures: 30 h
2. preparation / follow-up and preparation of and attendance in examination: 60 h

A total of 90 h = 3 CR

13.34 Module: Computational Imaging [M-INFO-106190]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-INFO-112573	Computational Imaging	5 CP	Meyer

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Qualification goal: Students are able to model questions of machine vision optically and algorithmically and to process them using holistic optimization.

Learning objectives: Students know
- the essential components of machine vision, their optical modelling and suitable coding methods in the sense of computational imaging,
- methods for emitting, capturing and processing light fields for applications in photography and industrial image processing,
- the concept of light transport analysis, corresponding modelling, capturing and processing methods and
- approaches to holistic modelling and optimization of optical image capturing and processing systems.

Content
Digital image acquisition and processing have revolutionized various fields of applications, e.g., medical imaging or automated visual inspection. Yet, the design of most such systems is still based on the separate and individual optimization of the employed illumination, image acquisition and image processing components. By following a holistic approach for system design, modelling and optimization, computational imaging methods yield superior performance with respect to the state of the art. After introducing the students into relevant basics of optics and signal theory, the lecture will thoroughly cover various topics of computational imaging. Accompanying practical exercises will complement the theoretical part of the lecture. The course will enable students to adequately model artificial vision problems in the sense of computational imaging in order to obtain holistically optimal solutions.

Workload
Lecture with 2 SWS + 1 SWS exercise
5 ECTS corresponds to approx. 150 hours
approx. 30 hours lecture attendance,
approx. 15 hours exercise attendance,
approx. 90 hours post-processing and working on the exercises
approx. 30 hours Exam preparation

Literature
- Ayush Bhandari, Achuta Kadambi, Ramesh Raskar, Computational Imaging, MIT Press, 2022.
- Jürgen Beyerer, Fernando Puente León, Christian Frese, Machine Vision, Springer, 2015.
- Joseph. W. Goodman, Introduction to Fourier Optics. 4. Auflage W. H. Freeman, 2017.

13.35 Module: Computational Intelligence [M-MACH-105296]

Responsible: apl. Prof. Dr. Ralf Mikut
apl. Prof. Dr. Markus Reischl

Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105314	Computational Intelligence	4 CP	Meisenbacher, Mikut, Reischl

Assessment
see individual course

Prerequisites
None

Competence Goal
The students are able to apply the fundamental methods of computational intelligence (fuzzy logic, artificial neural networks, evolutionary algorithms) efficiently. They know the basic mathematical foundations and are able to transfer these methods to practical applications.

Content

- Terms and definitions Computational Intelligence, application fields and examples
- Fuzzy logic: fuzzy sets; fuzzification and membership functions; inference: T-norms and -conorms, operators, aggregation, activation, accumulation; defuzzification methods, structures for fuzzy control
- Artificial Neural Nets: biology of neurons, Multi-Layer-Perceptrons, Radial-Basis-Function nets, Kohonen maps, training strategies (Backpropagation, Levenberg-Marquardt)
- Evolutionary Algorithms: Basic algorithm, Genetic Algorithms and Evolution Strategies, Evolutionary Algorithm GLEAM, integration of local search strategies, memetic algorithms, application examples
- Deep Learning: History, Architectures, Training strategies, Interpretability and Explainable AI, Use Cases

Module Grade Calculation
The module grade is the grade of the written examination.

Workload
The work load is about 120 hours, corresponding to 4 credit points.

Teaching and Learning Methods
Lecture

13.36 Module: Control of Linear Multivariable Systems [M-ETIT-100374]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100666	Control of Linear Multivariable Systems	6 CP	Kluwe

Assessment
Success is checked as part of a written overall test (120 minutes) of the course.

Prerequisites
none

Competence Goal
- The students first acquired basic knowledge of the various forms of description of linear multivariable systems in the frequency and time domain with both time-continuous and time-discrete models.
- In particular, they are able to transform multi-size systems in the state space to different normal forms depending on the requirements.
- The students have an understanding of fundamental properties such as Stability, trajectory profiles, controllability and observability as well as pole / zero configuration are achieved and the systems can analyze them accordingly.
- You master the basic principles for controlling linear multi-variable systems both in the frequency domain (series decoupling) and in the time domain (pole specification with pre-filter)
- In concrete terms, the students are familiar with the design procedures modal control, decoupling control in the time domain and the complete modal synthesis.
- You are familiar with the problem of state quantity determination by state observers and the design of complete and reduced observers.
- Students are able to use advanced concepts such as output feedback and dynamic controllers if necessary.
- You can continue to counter the problems of high model orders in the state space by reducing the order based on the dominance analysis.

Content
The aim is to impart basic and advanced methods for the treatment of linear multi-size systems, the focus being on the state space. In this way, the students are introduced to a model that allows more modern and, in particular, non-linear processes. On the one hand, the module provides a comprehensive overview of the most important aspects in the variable description of the systems and the analysis of their characteristic properties. On the other hand, all facets of the synthesis of regulations for initial and permanent disorders and the observers often required for this are conveyed.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
The workload includes:

Attendance time in lecture / exercise (3 + 1 SWS: 60h = 2 CP)

Preparation / follow-up lecture / exercise (90h = 3 CP)

Preparation / attendance time written exam (30h = 1 CP)

Recommendations
For a deeper understanding, basic knowledge of system dynamics and control technology is absolutely necessary, as taught in the ETIT Bachelor module "System Dynamics and Control Technology" M-ETIT-102181.

13.37 Module: Control of Power-Electronic Systems [M-ETIT-105915]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-111897	Control of Power-Electronic Systems	6 CP	Liske

Prerequisites
none

M 13.38 Module: Current Topics on BioMEMS [M-MACH-105485]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-MACH-102176	Current Topics on BioMEMS	4 CP	Guber

Assessment
Active participation and own presentation (30 Min.).

Prerequisites
none

Competence Goal
The students are able to work on medical-technical or biological topics. They learn the medical and biological basics and are able to transfer them to engineering sciences and find novel technical solutions.

Content
Topics: Minimally invasive surgery, interventional cardiology, implants, biomaterials, sterilization techniques, microanalysis systems

Workload
Literature: 19 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Teaching and Learning Methods
Project Work

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

M 13.39 Module: Cyber-Physical Modeling [M-ETIT-106953]

Responsible: Prof. Dr.-Ing. Mike Barth
Prof. Dr.-Ing. Sören Hohmann

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113908	Cyber-Physical Modeling	6 CP	Barth, Hohmann

Assessment
The examination takes place in the form of a written examination lasting 90 min.

Prerequisites
none

Competence Goal

- The students are familiar with the concepts of Cyber-Physical System.
- Students understand the need for advanced methods and services in the field of automation.
- Students can validate different information models and ontologies for their applicability in CPS.
- Students will be able to model data, information and knowledge or extract them from existing systems.
- The students know suitable modeling tools and their application.
- The students understand the general model concept as well as the characteristics of physical and data-based modeling and can describe their differences.
- They can structure complex systems and systematically analyze dependencies of subsystems.
- They can explain the general procedure of physical and data-based modeling, apply it to technical systems, and analyze the results.
- They can apply causal and non-causal modeling approaches and distinguish between them.
- Students have gained an understanding of generalized, cross-domain, physical relationships and can develop models for electrical, mechanical, pneumatic and hydraulic systems.
- They can describe the relationship between generalized, cross-domain, physical models and basic procedures of physical-based control and explain their advantages / limitations based on basic knowledge of control engineering.
- The students can estimate and judge the effects of disturbances and real conditions on the identification results.

Content
This course aims at engineering students that focus on a system-based engineering curriculum, including architectures, modeling & simulation for Cyber Physical Systems. The module is designed to teach students the theoretical and practical aspects of Digital Twins and their interconnection with their physical counterpart. It encompasses fundamental topics along the complete process of modeling technical systems. For this purpose, it includes the conception and construction of digital twins including their model components. In terms of modeling and simulation of physical systems, two major areas will be covered: On the one hand, physical-based modeling techniques which derive formal model equations based on analyzing the physical first-principles of technical systems. This includes, inter alia, generalized equivalent circuits, bond graphs, port-Hamiltonian systems, variational analysis (Euler-Lagrange of the first kind). Selected topics of physical-based control methods will also be briefly introduced to integrate the complete physical control design in the wider control context and highlight its possible benefits. On the other hand, data-based identification techniques will be covered which are used to identify concrete model parameters for a given technical system from experimental data sets. When combining the identification with an initial, non-physical, structural set up of model equations, the complete process is often referred to as data-based modeling or black-box modeling. Both modeling areas base on available information about the physical system which is structured in Meta- and Information-Models. Examples that are covered in this lecture are Metamodels, e.g. AutomationML or the asset administration shell principles. Also, semantic web principles and ontologies will be part of the lecture content.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload

1. attendance in lectures an exercise: 3+1 SWS (60 h)
2. pre-/postprocessing of the lecture (90 h)
3. preparation of and attendance in the exam: (30 h)

   A total of 180 h = 6 CR

Recommendations

Interest in Modeling and Simulation of modern Cyber-Physical Systems in combination with concepts of digital twins, system architectures and Co-Simulation.

Sound understanding of engineering mechanics, electrical, mechatronic systems / physics / Software-Engineering should be fulfilled to successfully attend the lecture, exercise tasks / case studies, and exam.

M 13.40 Module: Data Analytics for Engineers [M-MACH-105307]

Responsible: apl. Prof. Dr. Ralf Mikut
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105694	Data Analytics for Engineers	5 CP	Meisenbacher, Mikut, Reischl

Assessment
A performance assessment is obligatory and can be oral, a written exam, or of another kind.

Prerequisites
None

Competence Goal
The students are able to apply the methods of data analysis efficiently. They know the basic mathematical data mining foundations for the analysis of single features and time series using classifiers, clustering and regression approaches. They are able to use various relevant methods as Bayes classifiers, Support Vector Machines, decision trees, fuzzy rulebases and they can adapt application scenarios (with data preprocessing and validation techniques) to real-world applications.

Content

- Introduction and motivation
- Terms and definitions (types of multidimensional features - time series and images, problem classes)
- Scenario: Problem formulation, feature extraction, evaluation, selection and transformation, distance measures, Bayes classifiers, Support-Vector-Machines, decision trees, clustering, regression, validation
- Biweekly computer exercises (Software practice with SciXMiner and Python): Data import, benchmark datasets, control of hand prostheses, energy prediction

Workload
The work load is about 150 hours, corresponding to 5 credit points.

Teaching and Learning Methods
Lecture

13.41 Module: Data Science [M-INFO-106505]

Responsible: Prof. Dr.-Ing. Klemens Böhm
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each winter term	2 terms	German	4	1

Mandatory			
T-INFO-113124	Data Science	8 CP	Böhm

Competence Goal
At the end of the course, participants should have a good understanding of the necessity of data science concepts and be able to explain them. They should be able to assess and compare a wide variety of approaches to managing and analyzing large data sets in terms of their effectiveness and applicability. Participants should understand which problems are currently open in the field of data science and have gained a broad and deep insight into the current state of research in this area.

Content
Data Science 1

Data science techniques are arousing great interest among users. The spectrum is broad and includes traditional sectors such as banking and insurance, newer players, in particular internet companies or operators of new information services and social media, and natural and engineering sciences. In all cases, there is a desire to maintain an overview of very large, sometimes distributed data sets, to extract interesting correlations from the data set with as little effort as possible and to be able to systematically compare expected system behavior with actual behavior. This lecture deals with the necessary steps for extracting knowledge from data, techniques for preparing the data and basic models for extracting knowledge, e.g. in the form of statistics, association rules, clusters or systematic predictions.

Data Science 2

The lecture "Data Science 2" focuses on the following topics: High-dimensional data and their peculiarities and methods for their analysis, data streams and corresponding approaches, data pre-processing in the form of data cleaning, for example.

Additional Information
This module replaces Data Science I and Data Science II and combines them.

Literature
Literature will be announced in the lecture. There are several well readable relevant books, for example:

- Data Mining: Concepts and Techniques (3rd edition):
  Jiawei Han, Micheline Kamber, Jian Pei, Morgan Kaufmann Publishers 2011
- Data Mining and Analysis, Fundamental Concepts and Algorithms: Mohammed J. Zaki, Wagner Meira JR., Campridge University Press 2014
- Introduction to Data Mining:
  Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Addison-Wesley 2006
- https://www.amazon.de/Data-Mining-Textbook-Charu-Aggarwal/dp/3319381164
- https://www.amazon.de/DATA-MINING-FRANK-CHRISTOPHER-WITTEN/dp/9351073890

13.42 Module: Deep Learning for Computer Vision I: Basics [M-INFO-105753]

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German/English	4	1

Mandatory			
T-INFO-111491	Deep Learning for Computer Vision I: Basics	3 CP	Stiefelhagen

Competence Goal
Students should be able to grasp the underlying concepts in the field of deep learning and its various applications.

- Understand the theoretical basis of deep learning
- Understand the Convolutional Neural Networks (CNN)
- Develop basis for the concepts and algorithms used in building and training the CNNs.
- Able to apply deep learning in different computer vision applications.

Content
In recent years tremendous progress has been made in analysing and understanding image and video content. The dominant approach in Computer Vision today are deep learning approaches, in particular the usage of Convolutional Neural Networks.

The lecture introduces the basics, as well as advanced aspects of deep learning methods and their application for a number of computer vision tasks. The following topics will be addressed in the lecture:

- Introduction to Deep Learning
- Convolutional Neural Networks (CNN): Background
- CNNs: basic architectures and learning algorithms
- Object Recognition with CNN
- Image Segmentation with CNN
- Recurrent Neural Networks
- Generating image descriptions (Image Captioning)
- Automatic question answering (Visual Question Answering)
- Generative Adversarial Networks (GAN) and their applications
- Deep Learning platforms and tools

Additional Information
The course is partially given in German and English.

M 13.43 Module: Deep Learning for Computer Vision II: Advanced Topics [M-INFO-105755]

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German/English	4	3

Mandatory			
T-INFO-111494	Deep Learning for Computer Vision II: Advanced Topics	3 CP	Stiefelhagen

M 13.44 Module: Design of Electrical Machines [M-ETIT-100515]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-ETIT-100785	Design of Electrical Machines	5 CP	Doppelbauer

Prerequisites
none

Recommendations
Modul: Elektrische Maschinen und Stromrichter

13.45 Module: Detectores for Applications in Space and Astronomy [M-ETIT-100541]

Responsible: Prof. Theo Scherer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100761	Detectors for Applications in Space and Astronomy	3 CP	Scherer

Prerequisites
none

13.46 Module: Digital Beam-Forming for Imaging Radar [M-ETIT-105415]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-110940	Digital Beam-Forming for Imaging Radar	4 CP	Zwick

Assessment
The examination consists of a written exam (approx. 120 min.) and weekly excercises. The overall impression is rated.

Prerequisites
The lecture builds upon Spaceborne Radar Remote Sensing (engl.). The basic principles will be repeated in the lecture. The following lectures are helpful for a comprehensive understanding: Radar System Engineering (engl.), Antennen und Mehrantennensysteme, , Modern Radio System Engineering (engl.).

Competence Goal
Students have a basic knowledge of antenna arrays, radar, multipath propagation and noise. They understand the principle and functionality of beam shaping and the differences between digital, analog and hybrid beam-forming. They know the theory, methods, and algorithms of beam-forming. They can understand how beam-forming is applied to radar. You can explain basic radar system concepts and summarize the various applications.

Content
The lecture is (inherently) interdisciplinary and ideally suited to teach students the combination if signal processing for imaging radar and digital beam-forming. The basic knowledge about antennas & antenna arrays, radar ambiguities and noise is explained in the lecture. This is followed by a details on various beam forming algorithms with reference to imaging radar systems and with application examples from spaceborne synthetic aperture radar (SAR). Aspects such as digital and hybrid beam forming, as well as MIMO and equivalent virtual antenna configuration are explained. Lecture notes (english) are offered to the participants to consolidated the study material.

The lecture is be accompanied by exercises on the lecture material. These are discussed in a room exercise and the associated solutions are presented in detail.

Module Grade Calculation
The module grade results of the assessment of the written exam and the weekly excercises. Details will be given during the lecture.

Workload
- Attendance time in lectures (1.5 h per 15 dates) and exercises (1.5 h per 7 dates) = 33 h
- Preparation / revision: 15 weeks each 3 h = 45 h
- Exam preparation and presence in the exam: 1 week à 40 h = 40 h
- Total effort approx. 120 hours = 4 LP

Recommendations
Basics of signal processing and radar techniques are useful.

M 13.47 Module: Digital Circuit Design [M-ETIT-100473]

Responsible: Prof. Dr. Ivan Peric
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100974	Digital Circuit Design	4 CP	Peric

Additional Information
Will be changed to English in summer term 25.

13.48 Module: Digital Hardware Design Laboratory [M-ETIT-102266]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-104571	Digital Hardware Design Laboratory	6 CP	Becker

Assessment
Control of success is carried out in an oral examination as well as during the laboratory exercises in form of laboratory reports and/or oral interrogations.

Prerequisites
none

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module M-ETIT-102264 - Digital Hardware Design Laboratory must not have been started.

Competence Goal
The students

- know the practical usage of FPGAs
- are able to efficiently use modern hardware development tools
- know how to describe hardware in VHDL
- can self dependently draft and implement VHDL-Components based on given specifications
- are able to practically apply common concepts and principles in hardware development (e.g. pipelining)

Content
Grouped in teams of two, the students are introduced to the design of complex hardware/software systems. The laboratory takes place in weekly 4 hour laboratory sessions. During the first few sessions, the students are introduced to the implementation of VHDL-components, the usage of modern synthesis and simulation tools as well as basic knowledge on FPGAs.

Based on those fundamentals, students develop the different components of an image processing system in the second part of the laboratory. This includes implementation and testing steps for the individual components as well as the integration to an overall system. Finally, the hardware system can be realized on FPGA-Hardware and tested with live camera images.

Module Grade Calculation
The module grade is composed of the result of the oral examination and the effected performance during the laboratory sessions (e.g. reports, oral interrogations, etc.).

Additional Information
The module ETIT-102264 („Praktikum Entwurf digitaler Systeme“) must not have been started or completed.

Workload
The amount of work is distributed as follows:

- time of presence during the laboratory sessions: 11 sessions with 4h = 44h
- Preparation and wrap-up: 6h per laboratory session = 66h
- Preparation for the examination: 40h

In total 150h (25h per credit point).

Recommendations
Previous knowledge in design and design automation for electronic systems (e.g. from the lectures HSO, No. 2311619 or HMS, No. 2311608) is recommended.

13.49 Module: Digital Hardware Design Laboratory [M-ETIT-102264]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-104570	Digital Hardware Design Laboratory	6 CP	Becker

Prerequisites
none

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module M-ETIT-102266 - Digital Hardware Design Laboratory must not have been started.

13.50 Module: Digital Real Time Simulations for Energy Technologies [M-ETIT-106690]

Responsible: Prof. Dr.-Ing. Giovanni De Carne
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113449	Digital Real Time Simulations for Energy Technologies	3 CP	De Carne

Assessment
The examination takes place in form of other types of examination. It consists of an assessment from an exercise on HiL and an oral overall examination (approx. 15 minutes) explaining the exercise results. The overall impression is evaluated.

Prerequisites
none

Competence Goal
To give bachelor’s and master’s degree students an overview of the need, concept, implementation and execution of Hardware in the Loop (HiL) testing. At the end of the course:

- The students will be able to understand the setup of HiL systems (Device Under Tests, Real Time simulator, I/O, power amps for PHiL, interfacing principles and techniques)
- The students will be able to devise HiL test cases, creating models with an understanding of the trade-off between simulation fidelity and computational resources.
- The students can interface Device Under Tests, running Real Time simulations and executing tests.
- The students are able to perform an independent HiL project and deliver HiL experimental results.

Content
Lesson 1: Introduction

- Overview of control system development process (V-cycle and variants).
- Real-time simulation concept – What does it mean simulating in real time?
- Basic concepts of Real Control Prototyping and Control-Hardware in the Loop.
- Basic concept of Power-HiL

Lesson 2: Introduction to real time simulation (1/2)

- Initial definitions for real time simulations: Wall-clock time, simulation time, hard real-time and soft real-time.
- Off-line simulation software solvers
- Numerical integration, DAE solvers, numerical stability. Complexities induced by switches.
- Distinctions between state-space based and nodal approach-based solvers for CPU
- Difference between CPU and FPGA modeling
- Numerical examples & practical implementation of solvers

Lesson 3: Modelling in real time: grid modelling

- Modeling for HiL, level of model detail vs computational performance
- problems with parallelization due to latencies in transferring data, I/O latency considerations.
- Introducing transmission line decoupling, stublines, ITM and other techniques
- Introducing the State-Space Nodal approach

Lesson 4: Modelling in real time: power electronics

- Modelling components for fast transients (e.g, switches), average models, full switching models
- Interface FPGA-based with CPU-based modelling
- Practical examples and applications

Lesson 5: Modelling in real time: multi-time-scale networks

- Modeling for HiL: different time-scales phasor/RMS, EMT, fast EMT on FPGA.
- Stability issues associated with multi-time-scale hybrid simulation (e.g. RMS/EMT or EMT on CPU and FPGA.
- Multi-time-scale simulation with phasor/EMT/FPGA

Lesson 6: Rapid Control Prototyping (RCP)

- Main Concept and benefits from RCP, Applications
- Generating a code from Simulink and implementation in the real time simulator
- FPGA-based RCP, Datalogging
- Demonstration in classroom

Lesson 7: Controller Hardware In the Loop

- Definition of HIL and testing opportunities
- Analog and digital I/O in real time simulators
- Designing an HiL test – identifying controller functionality to be tested, creating appropriate model and test sequences, identifying potential failures and testing in failure/off-design conditions, use of test automation

Lesson 8: Power Hardware In the Loop

- Introduction to PHIL
- PHIL equipment: power amplifiers. 2Q/4Q applications, specifying power amplifiers
- Interface algorithms between Real Time Simulation and the Device Under Test
- Stability vs. interface accuracy, current state of the art
- Impedance-based stability analysis

Module Grade Calculation
The module grade results of the assessment of an exercise and the oral exam. Details will be given during the lecture.

Workload
The workload includes (2 SWS):

attendance in lectures and exercises: 15*2 h = 30 h
preparation / follow-up: 15*4 h = 60 h
final project, preparation of and attendance in examination: 30 h
A total of 120 h = 4 CR

Recommendations

- Good knowledge of power electronics, linear control theory, and power systems is required.
- Good knowledge of Matlab/Simulink simulation environment is required.

M 13.51 Module: Digital Signal Processing in Optical Communications – with Practical Exercises [M-ETIT-103450]

Responsible: Prof. Dr.-Ing. Sebastian Randel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-106852	Digital Signal Processing in Optical Communications – with Practical Exercises	6 CP	Randel

Assessment
The exercise sheets and the oral questionnaire are used to rate other types of examinations. The overall impression is assessed. Duration about 20 minutes.

Prerequisites
Basic knowledge of optical communication systems. Proven, for example, by completing one of the modules "Optical Networks and Systems-ONS", "Optoelectronic Components -OC, or" Optical Transmitters and Receivers - OTR.

Competence Goal

- The students understand the functioning of modern optical communication systems, which combine electro-optical technologies with digital signal processing.
- You are able to independently implement and test algorithms from digital signal processing as well as suitable simulation and test environments in a suitable scripting language (e.g. Matlab or. Python).
- Furthermore, they can estimate the influence of interfering effects occurring in the glass fiber such as chromatic dispersion and polarization mode dispersion.
- You are also able to estimate the complexity and power consumption of the resulting logic circuits.

Content

- The module deals with algorithms from digital signal processing that are used in broadband optical communication systems. Practical exercises in which the students implement algorithms independently form an essential part of the module.
- In lectures there will be an introduction to the development of digital coherent transmitters and receivers. Building on this, essential function blocks such as the dispersion compensation, the adaptive equalization of polarization mode dispersion as well as carrier and clock recovery are discussed.
- In the exercises, these function blocks are to be implemented in software (Matlab, Octave).
- In addition, individual examples show how digital signal processing algorithms are described in hardware (Hardware Description Language - HDL) and how their complexity scales.

Module Grade Calculation
The exercise sheets and the oral questioning are used to rate other types of examinations. The overall impression is assessed.

Workload
Approximately 170h workload of the student. The workload includes:

30h - attendance in lectures

30h - exercises

70h - preparation / follow-up

40h - written exercises and exam

Recommendations
Knowledge of the basics of optical communication technology and digital signal processing is helpful.

M 13.52 Module: Digital Twin Engineering [M-ETIT-106040]

Responsible: Prof. Dr.-Ing. Mike Barth
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-112224	Digital Twin Engineering	4 CP	

Assessment
The examination takes place in form of other types of examination. It consists of a model library developed in the course of a semester-long project in the modeling language Modelica and a presentation of the library lasting 25 minutes. The quality of the model library is evaluated within the framework of the criteria: documentation, formal correctness, functionality, usability, HMI and modeling level of detail. The presentation is evaluated as an additional aspects. The overall impression is evaluated.

Prerequisites
none

Competence Goal

- The students will be able to analyze, structure and formally describe problems in the area of object-oriented physical system modeling.
- The students will be able to understand, apply and further develop the Modelica modeling language.
- The students are able to transfer bidirectionally acting systems into a model.
- The students are able to transfer physical equations into the modeling environment.
- The students are able to critically evaluate the different numerical integration methods for their applicability and to use them sensibly.
- The students are able to create system models and co-simulations using functional mockup units.
- The students will be able to implement a real system at the appropriate modeling depth for the task.
- The students will be able to abstract real system properties and, if necessary, decide whether they need to be modeled.
- The students know suitable simulation tools and their application.

Content

- This module is designed to provide students with the theoretical and practical aspects of object-theoretic equation-based modeling.
- This module also provides a definition of the digital twin and its aspects of the management shell.
    - In this context, a classification of simulation models in the I4.0 VWS takes place.
- Both system simulation in the Open Modelica Editor (OME) and co-simulation with Functional Mockup Units (FMU) will be covered.
- Students create a new model library of a mechatronic system in a semester-long project (teams of 3-4 students).
- The module provides an overview of modern system simulation methods based on bidirectional flow and potential modeling.
- Beyond theoretical and practical modeling, the module imparts the knowledge about practice-relevant modeling levels or depths.
- Furthermore, quality standards for simulation models with focus on the engineering of plants/systems are discussed.

Module Grade Calculation
The assessment of the developed model library and the presentation of the library will be included in the module grade. More details will be given at the beginning of the course.

Workload
The workload includes:

1. attendance in lectures an exercises: 10*1,5 h = 15 h
2. preparation / follow-up: 15*2 h = 30 h
3. Implementation of the model library: 60 h
4. preparation of and attendance in the final presentation: 15 h

A total of 120 h = 4 CR

M 13.53 Module: Digitalization from Production to the Customer in the Optical Industry [M-MACH-105341]

Responsible: Dr.-Ing. Marc Wawerla
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-110176	Digitalization from Production to the Customer in the Optical Industry	4 CP	Wawerla

Assessment
Alternative test achievement

Prerequisites
None

Competence Goal
The students …

- are capable to comment on the content covered by the lecture.
- are able to analyze and evaluate the suitability of digitalization technologies in the optical industry.
- are able to assess the applicability of methods such as disruptive innovation and agile project management.
- are able to appreciate the practical challenges to digitalization in industry.

Content
The module deals with Digitalization along the entire value chain end-to-end, with a focus on production and supply chain. Within this context, concepts, tools, methods, technologies and concrete applications in the industry are presented. Furthermore, the students get the opportunity to get first-hand insights into the digitalization journey of a German technology company.

Main topics of the module:

- Concepts and methods such as disruptive innovation and agile project management
- Overview on technologies at disposal
- Practical approaches in innovation
- Applications in industry
- Field trip to ZEISS

Additional Information
For organisational reasons, the number of participants for the course is limited. As a result, a selection process will take place. Further information for application can be found via: https://www.wbk.kit.edu/english/education.php.

Workload
regular attendance: 21 hours
self-study: 99 hours

Teaching and Learning Methods
Lecture

M 13.54 Module: Distributed Discrete Event Systems [M-ETIT-100361]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100960	Distributed Discrete Event Systems	4 CP	Heizmann

Prerequisites
none

M 13.55 Module: Dosimetry of Ionising Radiation [M-ETIT-101847]

Responsible: PD Dr. Bastian Breustedt
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-104505	Dosimetry of Ionising Radiation	3 CP	Breustedt

Assessment
Success control is carried out as part of an overall written examination (2 h).

Prerequisites
none

Content
Dosimetry of ionizing radiation The lecture defines the various dose terms used to characterize radiation exposure and the underlying dosimetric system. It describes the methods and techniques of dosimetry for ionizing radiation for various applications. The topics covered are:

Ionizing radiation and interactions with matter, biological radiation effects

Characterization of radiation fields

Dose terms and your applications

Methods and techniques for external exposure dosimetry (external dosimetry)

Methods and techniques for internal exposure dosimetry (internal dosimetry)

Dosimetry applications in medicine Dosimetric laboratories at KIT

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
The workload includes:

Attendance time in lectures (2 h 15 appointments each) = 30 h

Self-study (3 h 15 appointments each) = 45 h

Preparation / post-processing = 20 h

Total effort approx. 95 hours = 3 LP

M 13.56 Module: Drive System Engineering B: Stationary Machinery [M-MACH-107190]

Responsible: Sascha Ott
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-114000	Drive System Engineering B: Stationary Machinery	4 CP	Ott

Assessment
See individual course

Prerequisites
None

Competence Goal
Students acquire the basic skills required to develop future energy-efficient and safe drive system solutions for use in industrial environments. Holistic development methods and evaluations of drive systems are considered.

Content
The focus can be divided into the following chapters:

- Drive train system
- Operator system
- System environment
- System components
- Development process

Module Grade Calculation
The module grade corresponds to the grade from the individual course.

Additional Information
None

Workload
Attendance: 30h

Self-study: 90h

Recommendations
Attendance of the course Drive System Engineering A: Automotive Systems

Teaching and Learning Methods
Lecture

Literature
VDI-2241: "Schaltbare fremdbetätigte Reibkupplungen und -bremsen", VDI Verlag GmbH, Düsseldorf

Geilker, U.: "Industriekupplungen - Funktion, Auslegung, Anwendung", Die Bibliothek der Technik, Band 178, verlag moderne industrie, 1999

Base For
None

M 13.57 Module: Electric Drives and Power Electronics Lab [M-ETIT-107138]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German/English	4	1

Mandatory			
T-ETIT-114162	Electric Drives and Power Electronics Lab	6 CP	Doppelbauer

Assessment
Success control takes place in the form of other types of examination. It consists of one oral examination per experiment. The overall impression is assessed.

Prerequisites
none

Competence Goal
Students are able to connect power converters and electrical machines to the electrical grid and operate them correctly. They implement current control in a rotating coordinate system. They analyze and document the operating characteristics of direct current, induction and synchronous machines through measurements. You will know and operate measuring devices with which characteristic values, characteristic curves and time curves of electrical and mechanical variables are recorded and saved.

Content
The aim of the practical course is to use selected examples to guide students in applying and deepening the theoretical knowledge acquired in lectures in practice. In almost all experiments, the students deal with the combination of analog and digital electrical signal processing, control engineering methods, a power electronic actuator and an electrical machine to be driven. Specifically, the following 8 experiments are carried out:

- Experiment SoC:
  "Space vector transformation and current control with digital signal processing system (system on chip)"
- Experiment LH:
  "Power semiconductors - measurement of static and dynamic properties of an IGBT and a SiC MOSFET"
- Experiment PSM:
  "Permanently excited synchronous machine - speed control with subordinate current control in the constant flux and field weakening range"
- Experiment FAM:
  "Field-oriented control of the three-phase induction machine"
- Experiment DAB:
  "Getting to know topology, modulation methods and modeling"
- PV experiment:
  "Operation of solar modules at the point of maximum energy yield and integration of a lithium-ion storage system"
- MMC experiment:
  "Implementation of a cascaded MMC control system consisting of energy and current controllers"
- VASM experiment:
  "Measurement of the induction machine on the test bench to determine the machine parameters"

Module Grade Calculation
The assessments of the oral examinations are included in the module grade. Further details will be provided at the beginning of the course.

Workload
180h

- Attendance time in the internship with interview: 40 h
- Preparation time: 125 h
- Follow-up time: 15h

Recommendations

The courses

- Regelung elektrischer Antriebe und
- Leistungselektronik

should have been completed or at least heard in parallel to the practical course.

M 13.58 Module: Electrical Energy Systems Lab [M-ETIT-107137]

Responsible: Prof. Dr. Martin Doppelbauer
Prof. Dr.-Ing. Thomas Leibfried

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-ETIT-114160	Electrical Energy Systems Lab	6 CP	Badent, Doppelbauer, Leibfried

Assessment
Success control takes place in the form of other types of examinations consisting of questions on the content of the experiments with written and oral components. The overall impression is assessed.

Prerequisites
none

Competence Goal
Students can calculate and use induction machines, transformers, uncontrolled rectifier circuits, variable-speed drive systems and high-voltage generators. They can carry out partial discharge measurements.

Content
Building on the basic lectures on electrical machines, power electronics and electrical energy systems, students gain an insight into the fundamental systems of electrical power engineering.

Module Grade Calculation
The questions on the individual experiments are included in the module grade. Further details will be provided at the beginning of the course.

Additional Information
Joint event of IEH and ETI.

Workload
The workload is 180 hours and is made up as follows:

- Attendance time 40 h
- Self-study time 140 h

M 13.59 Module: Electrocatalysis [M-ETIT-105883]

Responsible: Prof. Dr. Ulrike Krewer
Dr. Philipp Röse

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each summer term	1 term	English	4	3

Mandatory			
T-ETIT-111831	Electrocatalysis	5 CP	Röse

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal
Students have a well-grounded knowledge of electrocatalytic energy technologies for the conversion and storage of electrical energy in chemicals (Power-to-X). They know the functional principle of state-of-the-art electrocatalysts in fuel cells and electrolysis and understand the underlying electrochemical and physical processes. Participation in the course enables the students to assess and understand the relationship between electrode structure and their selectivity, performance and stability.
Furthermore, the students learn the theoretical basics of experimental methods that are relevant for the investigation of model electrodes and technical cells.

Content
Lecture:

- **Basics, concepts and definitions within the Power-to-X context:** Catalysis and electrocatalysis; activity and selectivity; fundamentals of electrochemical processes, elementary steps involving adsorbed intermediates.

- The role of intermediates: Electron transfer without intermediates, multi-electron transfer with intermediates; differences in adsorption energies of intermediates and active surfaces

- **Theoretical treatment of electron transfer reactions:** Tunneling processes at electrodes; electron transfer reactions (Marcus theory); role of electrode material on rate of electrode reaction.

- Measurement methods for the investigation of electrocatalytic reactions: Determination of the effective surface; Determination of the activity of electrochemically active species; Determination of the selectivity; Operando measurement methods

- Technically important electrocatalytic reactions and processes: The oxygen reduction reaction (ORR) and evolution reaction (OER); the chlorine evolution reaction.

Module Grade Calculation
The module grade is the grade of the written examination.

Workload
attendance in lectures: 30 * 45 min. = 22,5 h

attendance in exercises: 15 * 45 min. = 11,25 h

preparation and follow up of the lectures and practice: 76.25 hours (approx. 1.75 hours per lecture or exercise)

preparation of examination and attendance in examination: 40 h

A total of 150 h = 5 CR

Recommendations
The participation of the module "Electrochemical Energy Technologies" is helpful.

M 13.60 Module: Electromagnetics and Numerical Calculation of Fields [M-ETIT-100386]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-100640	Electromagnetics and Numerical Calculation of Fields	4 CP	Zwick

Assessment
Success control is carried out in the form of a written test of 120 minutes.

Prerequisites
none

Competence Goal
Students with very different background in electromagnetic field theory will be brought to a high level of comprehension. They will understand the concept of electric & magnetic fields and of electric potential & vector potential and they will be able to solve simple problems of electric & magnetic fields using mathematics. They will understand the equations and solutions of wave creation and wave propagation. Finally the student will have learnt the basics of numerical field calculation and be able to use software packages of numerical field calculation in a comprehensive and critical way.

The student will

- be able to deal with all quantities of electromagnetic field theory (E, D, B, H, J, M, P, ...), in particular: how to calculate and how to measure them,
- derive various equations from the Maxwell equations to solve simple field problems (electrostatics, magnetostatics, steady currents, electromagnetics),
- be able to deal with the concept of field energy density and solve practical problems using it (coefficients of capacitance and coefficients of inductance),
- be able to derive and use the wave equation, in particular: to solve problems how to create a wave and calculate solutions of wave propagation through various media,
- be able to outline the concepts, the main application areas and the limitations of methods of numerical field calculation (FDM, FDTD, FIM, FEM, BEM, MoM, TLM)
- be able to use one exemplary software package of numerical field calculation and solve simple practical problems with it.

Content
This course first gives a comprehensive recap of Maxwell equations and important equations of electromagnetic field theory. In the second part the most important methods of numerical field calculation are introduced.

Maxwell’s equations, materials equations, boundary conditions, fields in ferroelectric and ferromagnetic materials

electric potentials, electric dipole, Coulomb integral, Laplace and Poisson’s equation, separation of variables in cartesian, cylindrical and spherical coordinates

Dirichlet Problem, Neumann Problem, Greens function, Field energy density and Poynting vector,

electrostatic field energy, coefficients of capacitance, vector potential, Coulomb gauge, Biot-Savart-law, magnetic field energy, coefficients of inductance magnetic flux and coefficients of mutual inductance, field problems in steady electric currents,

law of induction, displacement current

general wave equation for E and H, Helmholtz equation

skin effect, penetration depth, eddy currents

retarded potentials, Coulomb integral with retarded potentials

wave equation for potential and Vector potential and A, Lorentz gauge, plane waves

Hertzian dipole, near field solution, far field solution

transmission lines, fields in coaxial transmission lines

waveguides, TM-waves, TE-waves

finite difference method FDM

finite difference - time domain FDTD, Yee ´s algorithm

finite difference - frequency domain

finite integration method FIM

finite element method FEM

boundary element method BEM, Method of Moments (MOM), Transmission LIne Matrix Methal (TLM),

solving large systems of linear equations

basic rules for good numerical field calculation

The lecturer reserves the right to alter the contents of the course without prior notification.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
Each credit point corresponds to approximately 25-30 hours of work (of the student). This is based on the average student who achieves an average performance. The workload includes:

Attendance time in lectures (3 h 15 appointments each) = 45 h

Self-study (4 h 15 appointments each) = 60 h

Preparation / post-processing = 20 h

Total effort approx. 125 hours = 4 LP

Recommendations
Fundamentals of electromagnetic field theory.

Literature
Matthew Sadiku (2001), Numerical Techniques in Electromagnetics.
CRC Press, Boca Raton, 0-8493-1395-3
Allen Taflove and Susan Hagness (2000), Computational electrodynamics: the finite-difference time-domain method.
Artech House, Boston, 1-58053-076-1
Nathan Ida and Joao Bastos (1997), Electromagnetics and calculation of fields.
Springer Verlag, New York, 0-387-94877-5
Z. Haznadar and Z. Stih (2000), Electromagnetic Fields, Waves and Numerical Methods.
IOS Press, Ohmsha, 1 58603 064 7
M.V.K. Chari and S.J. Salon (2000), Numerical Methods in Electromagnetism, Academic Press, 0 12 615760 X

M 13.61 Module: Electronic Circuits for Light Sources and Laser [M-ETIT-100511]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100783	Electronic Circuits for Light Sources and Laser	3 CP	Kling

Prerequisites
none

13.62 Module: Electronics and EMC [M-ETIT-100410]

Responsible: Dr. Martin Sack
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100723	Electronics and EMC	3 CP	Sack

Prerequisites
none

M 13.63 Module: Explainable Artificial Intelligence [M-INFO-106302]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Organisation: KIT Department of Electrical Engineering and Information Technology
KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-112774	Explainable Artificial Intelligence	3 CP	Lioutikov

Assessment
See Partial Achievements (Teilleistung).

Prerequisites
See Partial Achievements (Teilleistung).

Competence Goal
• Students are able to understand problems and challenges of XAI
• Students can identify and differentiate different types and approaches of XAI
• Students can implement various XAI approaches
• Students understand current research questions and directions of XAI

Content
Recent advances in Machine Learning and Deep Learning in particular have lead to the imminent introduction of AI agents into a wide variety of applications. However, the apparent “black-box” nature of these approaches hinders their application in both critical systems and close human-robot interactions. The sub-field of eXplainable Artificial Intelligence (XAI) aims to address this shortcoming. This lecture will introduce and discuss various concepts and methods of XAI and consider them from perspective of Robot Learning and Human-Robot Interaction.
The lecture will start with a (brief) introduction into relevant deep learning approaches, before discussing interpretable scene, task and behavior representations. Afterward the lecture will consider itself with Data-Driven and Goal-Driven AI. Finally, first approaches that incorporate XAI and XAI-based human feedback directly into the learning process itself will be discussed. An exemplary list of topics is given below:

• Introduction to XAI
◦ Interpretable Machine Learning vs Explainable Machine Learning

• Primer / Introduction to relevant Deep Learning Concepts
◦ MLPs and CNNs
◦ Graph Neural Networks
◦ Transformers
◦ Diffusion Models
◦ Score Based Methods

• Interpretable Structures
◦ Scene Representations
◦ Task Representations
◦ Behavior Representations
• Data-Driven Explainable AI: XAI Methods for
◦ Shapley Values
◦ Saliency Maps
◦ Concept Activation Vectors
◦ Linguistic Neuron Annotation

• Goal-Driven Explainable AI: XAI Methods for
◦ Generative Explaining Models
◦ Behavior Verbalization
◦ Behavior Visualization

• Interactive Learning
◦ Integrating Human Feedback
◦ Explanatory Interactive Learning

Workload
Workload = 90h = 3 ECTS
- ca 30h lecture attendance
- ca 30h post-processing
- ca 30h exam preparation

Recommendations
• Experience in Machine Learning is recommended, e.g. through prior coursework.
◦ The Computer Science Department offers several great lectures e.g., "Maschinelles Lernen - Grundlagen und Algorithmen" and "Deep Learning "
• A good mathematical background will be beneficial
• Python / PyTorch experience could be beneficial when we discuss practical examples/implementations.

M 13.64 Module: Fabrication and Characterisation of Optoelectronic Devices [M-ETIT-101919]

Responsible: Prof. Dr. Bryce Sydney Richards
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-103613	Fabrication and Characterisation of Optoelectronic Devices	3 CP	Richards

Assessment
Type of Examination: written exam

Duration of Examination: 120 Minutes

Modality of Exam: One written exam offered at the end of each semester.

Prerequisites
None

Competence Goal
The students build knowledge on process technology for the fabrication of a range of optoelectronic devices, including LEDs, solar cells, laser diodes, photodiodes, etc. They learn to compare the advantages of different technological approaches, including their economic boundary conditions. This is a technologiccal-based course where students will use their prior fundamental knowledge to gain a firm grasp on the fabrication sequences and characterisation (optical, electrical, electronic, materials) steps that are required to realise the above devices.

While fulfilling the learning targets, the students

- possess the basic knowledge about the working principles of optoelectronic devices;
- comprehend the boundary conditions for the design of optoelectronic devices and have a good understanding of the challenges in microfabrication
- are familiar with different lithographic techniques, including e-beam lithography, optical lithography, multiple-photon lithography, X-ray lithography, etc.
- comprehend the different techniques that are available for thin-film deposition of dielectrics, metals and semiconductors
- understand what role micro-optics can play in such devices
- be able to determine the most promising characterisation techniques for evaluating material quality, electronic properties, as well as optical and electrical performance.
- Exposure to different dry- and wet-etching processes to help realise device structures
- have an understanding of the economic implications of the chosen technologies and their compatibility with highthroughput production

Content
I. Overview: Opto-electronic Devices

II. Thin-film growth and deposition

- epitaxial growth of III-V semiconductors, as well as Si and Ge
- chemical vapour deposition (CVD) based processes, including atomic layer deposition (ALD)
- physical vapour deposition (PVD) based processes, including evaporation (thermal and e-beam) and sputtering (DC and RF)

III. Lithographic techniques

- e-beam lithography, optical lithography, laser interference lithography, two-photon lithography, X-ray lithography

IV. Etching processes

- wet- and dry-etching processes for semiconductors, dielectrics and metals

V. Micro-optics

- micro-optic design in opto-electronic devices

VI. Characterissation:

- materials properties (electron microscopy, crystallinity, bonding energies, elemeental concentrations, layer thicknesses ...)
- electronic properties (dopant profiling, mobility, minority carrier lifetimes, resistivity, bandgap measurements, ...)
- optical (spectrophotometry, photoluminescence, ...)
- electrical (current-voltage measurements, quantum efficiency / spectral response, ...)

VII. Excursion (TBA)

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
Total 90h, hereof 30h contact hours (24h lecture,
6h problem class), and 60h homework and selfstudies

Literature
TBD

13.65 Module: Fabrication Processes in Microsystem Technology [M-MACH-105478]

Responsible: Dr. Klaus Bade
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-MACH-102166	Fabrication Processes in Microsystem Technology	4 CP	Bade

Assessment
Oral exam

Prerequisites
none

Competence Goal
Students of the course can

- outline and discuss a self-selected microtechnical process chain for a submitted microtechnical product or tool
- Explain process steps in detail
- Recognize connections between individual process steps
reflect relevant interdisciplinary knowledge from chemistry, engineering and physics
- Describe typical tools (masks, mould inserts) and their production

Content
The lecture offers a specialization in manufacturing technology for structure generation in microtechnology, preferably with large height or high aspect ratio. For this purpose, the lithographic process chain (UV-, X-ray, electron beam, 2-photon lithography) is presented intensively in the first half of the lecture. Starting with typical substrates and resists, resist processing, exposure and development are treated. Micro electroplating is discussed to build metallic microstructures. In the second half of the lecture, production methods for typical tools such as masks and mold inserts are a main focus. Furthermore, newer concepts for micro- and nanostructuring based on self-organisation are presented.

Throughout the lecture the description of the process steps by simple and deeper reaching models at the interface between engineering, chemistry and physics is used for a deeper understanding. The role of recurring ideas, such as the role of mass transfer or kinetic control in the individual process steps, will be taught and simple rules for process control and plant design will be derived. Attention is drawn to similarities and differences with microelectronic manufacturing processes. Special attention is paid to the interactions between different manufacturing steps in the complex process chain with regard to cause-and-effect. The technically important guarantee of homogeneity in the surface and freedom from defects of the process result is discussed by means of some manufacturing steps.

Translated with www.DeepL.com/Translator (free version)

Workload
Literature: 19 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Teaching and Learning Methods
Lecture

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

13.66 Module: Field Propagation and Coherence [M-ETIT-100566]

Responsible: Prof.Dr.Dr.h.c. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-100976	Field Propagation and Coherence	4 CP	Freude

Assessment
Type of Examination: oral exam

Duration of Examination: approx. 30 minutes

Modality of Exam: Oral examination, usually one examination day per month during the summer and winter terms. An extra questions-andanswers session will be held for preparation if students wish so.

Prerequisites
none

Competence Goal
Presenting in a unified approach the common background of various problems and questions arising in general optics and optical comunications

The students

- knwo the common properties of counting of modes, density of states and the sampling theorem
- comprehend the relationship between propagation in multimode waveguides, mode coupling, MMI and speckles
- can analyze propagation in homogeneous media with respect to system theory, antennas, and the resolution limit of optical instruments
- understand that coherence as a general concept comprises coherence in time, in space and in polarisation
- comprehend the implication of complete spatial incoherence, and what is the radiation efficiency of a source with a diameter smaller than a wavelength (the mathematical Hertzian dipole, for instance)
- can assess when can two incandescent bulbs form an interference pattern in time
- know under which conditions a heterodyne radio receiver, which is based on a non-stationary interference, actually works

Content
The following selection of topics will be presented:

- Light waves, modes and rays: Longitudinal and transverse modes, sampling theorem, counting and density of modes ("states")
- Propagation in multimode waveguides. Near-field and far-field. Impulse response and transfer function. Perurations and mode coupling. Multimode interference (MMI) coupler. Modal noise (speckle)
- Propagation in homogeneous media: Resolution limit. Non-paracial and paracial optics. Gaussian beam. ABCD matrix
- Coherence of optical fields: Coherence function and power spectrum. Polarisation, eigenstates and principal states. Measurement of coherence with interferometers (Mach-Zehnder, Michelson). Self-heterodyne and self-homodyne setups

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
total 120 h, hereof 45 h contact hours (30 h lecture, 15 h problem class), and 75 h homework and self-studies

Recommendations
Minimal background required: Calculus, differential equations and Fourier transform theory. Electrodynamics and field calculations or a similar course on electrodynamics or optics is recommended.

Literature

Detailed lecture notes as well as the presentation slides can be downloaded from the IPQ lecture pages. Additional reading:

Born, M.; Wolf, E.: Principles of optics, 6. Aufl. Oxford: Pergamon Press 1980

Ghatak, A.: Optics, 3. Ed. New Delhi: Tata McGraw Hill 2005

Hecht, E.: Optics, 2. Ed. Reading: Addison-Wesley 1974

Hecht, J.: Understanding fiber optics, 4. Ed. Upper Saddle River: Prentice Hall 2002

Iizuka, K.: Elements of photonics, Vol. I and II. New York: John Wiley & Sons 2002

Further textbooks in German (also in electronic form) can be named on request

13.67 Module: Fundamentals on Plasma Technology [M-ETIT-100483]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100770	Fundamentals on Plasma Technology	3 CP	Kling

Prerequisites
none

M 13.68 Module: Hardware Modeling and Simulation [M-ETIT-100449]

Responsible: Dr.-Ing. Jens Becker
Prof. Dr.-Ing. Jürgen Becker

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-100672	Hardware Modeling and Simulation	4 CP	Becker, Becker

Assessment
Achievement is examined in the form of a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal
After completing this module, students will be familiar with different hardware description languages and their applications in various abstraction levels. They will gain knowledge of the SPICE Hardware Description Language and become proficient in building and deriving the analog matrix for spice simulation. In the realm of digital design, they will develop a comprehensive understanding of the hardware description language VHDL, encompassing the VHDL Standard and its extensions, such as VHDL 2008, the 9-valued logic, and the VHDL-AMS standard. Furthermore, students will achieve a profound comprehension of simulator principles, particularly the delta cycle model. They will also grasp the fundamentals of fault simulations for testing fabricated circuits and learn to derive test vectors. Additionally, students will acquire an understanding of higher-level hardware construction languages like Chisel and SystemC.

Content
In order to address the complexity of modern chips during development, it is essential to utilize modern hardware description languages. This course offers insights into the various levels of abstraction in these languages. It starts by covering the fundamentals of analog description using SPICE and then progresses through VHDL, VHDL-AMS, and Verilog. Additionally, the course introduces more abstract languages like Chisel and SystemC.

Topics covered in the course are:

- Design Process
- Basics of Modeling and Simulation
- Low Level Modeling
- VHDL
  - VHDL-AMS
  - 9-valued logic
  - Delta cycle simulation
  - Fault simulation
- Verilog
- Chisel
- SystemC

Module Grade Calculation
The module grade results from the grade of the written examination.

Workload
The workload is covered by:

1. Participating in lectures and tutorials: 33h
2. Preparing and wrap up of the above named units: 66h
3. Exam preparation and presence: 21h

Sum: 120h = 4 LP

13.69 Module: Hardware Synthesis and Optimization [M-ETIT-106963]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113922	Hardware Synthesis and Optimization	6 CP	Becker

Assessment
The examination takes place within the framework of an oral overall examination (approx. 30 minutes)

Prerequisites
none

Competence Goal
Students know the basic steps required for the automated design of optimized digital circuits. They are able to classify them in the Y-chart and assess their complexity.

They will be able to name and explain the most important approaches for these design steps and evaluate them with regard to optimality and computational effort. This includes the ability to use algorithms for these approaches, e.g. selected graph algorithms, metaheuristics such as simulated annealing. The students are also able to determine their respective runtime complexities.

In addition, they can solve given problems from the field of design automation by selecting a suitable approach based on certain optimization criteria and applying it to the respective problem.

Content
The module focuses on teaching the formal and methodological foundations for the automated design of optimized electronic systems. The relevant scientific and methodological properties of the methods used are discussed and their implementation in industrial practice is also taught.

The following topics are covered:

- Graph Algorithms and Complexity
- High-Level Synthesis
- Algorithms for Scheduling, Allocation and Binding Problems
- Register-Transfer-Level Synthesis
- Retiming Algorithms
- Logic Optimization
- Technology Mapping for Standard Cells and FPGAs
- Physical Design
- Placement of Standard Cells with ILP and Simulated Annealing
- Global and Detailed Routing

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
The workload includes (4 SWS):

1. attendance in lectures and exercises: 50 h
2. preparation / follow-up: 50 h
3. preparation of and attendance in examination: 80 h

A total of 180 h = 6 CR

Recommendations
Basic knowledge in the field of digital circuits, e.g. as taught in the course “Digital Technology” (2311615) is helpful.

13.70 Module: Hardware/Software Co-Design [M-ETIT-100453]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100671	Hardware/Software Co-Design	4 CP	Harbaum

Assessment
Success control takes place in the form of an oral examination (approx. 20 minutes).

Prerequisites
none

Competence Goal
By attending the Hardware/Software Co-Design lecture, students learn the necessary multi-criteria methods and hardware/ software target architectures. Attending the lecture contributes to the understanding of these methods of hardware/software co-design and enables students to apply what they have learned to novel problems.

Students learn about the main target architectures and are able to name their advantages and disadvantages with regard to their applicability in hardware/software co-design. Students will become familiar with various methods for assessing design quality and will be able to apply these in the early phases of system design. Furthermore, students have an overview of partitioning methods for HW/SW systems, can classify them and know the respective advantages and disadvantages of the methods. Students will be able to select and apply a suitable method for typical HW/SW partitioning problems.

By attending the course, students will have a cross-component understanding of the topic of co-design. Furthermore, attending the course enables students to apply the methods presented to problems independently. Tools that are introduced in the course of the lecture can be used for this purpose.

Attending the lecture enables students to independently classify current scientific work, e.g. theses, and to work on them using the latest methods.

Content

- The lecture presents the theoretical principles of the interlinked design of hardware and software parts of a system. In addition, their practical application is demonstrated using various current software and hardware components.
- The accompanying exercises are intended to consolidate the knowledge acquired in the lectures. Selected topics are repeated and students learn how to apply the methods for modern system design using theoretical and practical examples.
- Hardware-software co-design is the simultaneous and interlinked design of hardware and software parts of a system. Most modern embedded systems (examples are cell phones, automotive and industrial control systems, game consoles, home cinema systems, network routers) consist of cooperating hardware and software components. Enabled by rapid advances in microelectronics, embedded systems are becoming increasingly complex with diverse application-specific criteria. The use of appropriate computer-aided design tools is not only necessary to handle the increasing complexity, but also to reduce design costs and design time. The lecture Hardware Software Co-Design deals with the necessary multi-criteria methods and hardware/software target architectures:
    - Target architectures for hardware/software systems
        - Processor design: pipelining, superscalarity, VLIW, SIMD, cache, MIMD
        - General-purpose processors (GPP), microcontrollers (μC), digital signal processors (DSP), graphics processors (GPU), application-specific instruction set processors (ASIP), field programmable gate arrays (FPGA), system-on-chip (SoC), bus systems, multicore and network-on-chip (NoC)
    - Assessment of the design quality
        - Hardware and software performance
    - Hardware/software partitioning methods
        - Iterative and constructive heuristics

Module Grade Calculation
The module grade is the grade of the oral examination.

Additional Information
Will be changed to 6 CR in winter term 25/26.

Workload
The workload includes:

1. attendance time in 14 lectures, 7 exercises: 31.5 hrs
2. preparation and follow-up of the same: 63 hours (3 hours per unit)
3. exam preparation and attendance: 20 hours preparation and 0.5 hours exam

Recommendations
Knowledge of the basics of digital technology and information technology is helpful.

13.71 Module: High-Power Microwave Technology [M-ETIT-100521]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100791	High-Power Microwave Technology	3 CP	Zwick

Assessment
The success control is carried out as part of an oral overall examination (approx. 20 minutes) of the selected courses, which in total meet the minimum requirement for LP.

Prerequisites
none

Competence Goal
The students have a comprehensive overview of high-performance microwave technology, in particular the generation of high and very high power levels down to the THz range using modern vacuum electron tubes. They are able to describe different types and components of tubes, their mode of operation and their areas of application. The lecture includes transmission technology and diagnostics at high and highest performance, various applications in UHF transmission, in satellite communication, in radar technology, for THz applications (spectroscopy), in material process technology and in particle accelerator and fusion experiments. The students can identify the areas of application for the different tube types and assess their suitability.

Content
The term high-performance microwave technology means the generation, transmission, application and diagnostics of microwaves at high and very high outputs. In the lecture, the microwave range covers a frequency range from under 1 GHz (30 cm wavelength) to 1 THz (0.3 mm wavelength). The power range spans a range from 1 W (THz range) to over 1 MW in the classic microwave range (1 GHz to 300 GHz). The lecture focuses on microwave tubes as they are the only power generators and amplifiers that span such a frequency and power range. The lecture thus fulfills the requirements of modern satellite communication, THz spectroscopy, radar technology, particle accelerators and fusion. The applications mentioned have a rapidly increasing need for ever more powerful high-performance microwave components.

The lecture is interdisciplinary. This introduces the dominant tube types and deals with the associated components. The preferred fields of application for the respective tube types are explained. Components for high-performance transmission and diagnostics are presented.

Module Grade Calculation
The module grade is the grade of the oral exam.

Additional Information
Will be changed to English in winter term 25/26.

Workload
The workload includes:

Attendance study time lecture / exercise: 30 h

Self-study time including exam preparation: 60 h

A total of 90 h = 3 LP

Recommendations
Knowledge of the basics of high frequency technology is helpful.

M 13.72 Module: HRI and Social Robotics [M-INFO-106650]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-113396	HRI and Social Robotics	4 CP	Bruno
T-INFO-113397	HRI and Social Robotics - Pass	2 CP	Bruno

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know the foundations of Human-Robot Interaction (HRI) and Social Robotics, including: design principles and methodologies, human factors influencing HRI (anthropomorphization), sensors, actuators and software architecture for social robotics, challenges and solutions for key abilities of social robots (spatial interaction, engagement detection, non-verbal interaction, verbal interaction, emotion generation and detection), research methods (study design principles, statistical tools for analyses) and have seen state-of-the-art research topics in the field including social learning, theory of mind, trust and ethical considerations in HRI.
Thanks to the exercise sessions and assignments, students gain first-hand knowledge and can independently apply techniques related to the above theory items, including for collecting stakeholders' feedback for a robot design, programming the robot's social behaviour along multiple modalities, extracting relevant user information from available sensors, designing and analysing HRI experiments.

Content
The lectures cover all foundational topics in HRI (design principles and methodologies, human factors influencing HRI, sensors, actuators and software architecture for social robotics), challenges and solutions for key abilities of social robots (spatial interaction, engagement detection, non-verbal interaction, verbal interaction, emotion generation and detection), research methods (study design principles, statistical tools for analyses) and state-of-the-art topics including social learning, theory of mind and ethical considerations in HRI.
In the exercise sessions and related assignments students can experience first-hand how the theoretical concepts seen in the lectures can be applied in practice and learn how to collect stakeholders' feedback for a robot design, program the robot's social behaviour along multiple modalities, extract relevant user information from available sensors, design and analyse HRI experiments. At the end of the course, the students have a solid understanding of HRI, its principles, challenges and solutions and can autonomously apply such knowledge in practical contexts.

Workload
Course workload:
1) Attendance of the course: 22.5h (15x90min slots)
2) Attendance of the exercise sessions: 22.5h (15x90min slots)
3) Self-study of course material and work on homework assignments: 60h (4h/week)
4) Preparation for the exam: 80h

Recommendations
Knowledge of the content of modules Robotics I - Introduction to Robotics is helpful.

13.73 Module: Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy (24139 / 24678) [M-INFO-100725]

Responsible: Prof. Dr.-Ing. Tamim Asfour

Organisation: KIT Department of Informatics

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each term	1 term	German	4	1

Mandatory			
T-INFO-101262	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	3 CP	Asfour, Spetzger

M 13.74 Module: Human Computer Interaction (24659) [M-INFO-100729]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German/English	4	1

Mandatory			
T-INFO-101266	Human-Machine-Interaction	6 CP	Beigl
T-INFO-106257	Human-Machine-Interaction Pass	0 CP	Beigl

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
After completing the course, students will be able to
reproduce basic knowledge about the field of human-machine interaction
name and apply basic techniques for analysing user interfaces
apply basic rules and techniques for designing user interfaces
analyse and evaluate existing user interfaces and their function

Content
Topics are:
1. human information processing (models, physiological and psychological principles, human senses, action processes),
2. design principles and design methods, input and output units for computers, embedded systems and mobile devices,
3. principles, guidelines and standards for the design of user interfaces
4. technical basics and examples for the design of user interfaces (text dialogues and forms, menu systems, graphical interfaces, interfaces in the WWW, audio dialogue systems, haptic interaction, gestures),
5. methods for modelling user interfaces (abstract description of interaction, embedding in requirements analysis and the software design process),
6. evaluation of systems for human-machine interaction (tools, evaluation methods, performance measurement, checklists).
7. practising the above basics using practical examples and developing independent, new and alternative user interfaces.

Workload
The total workload for this course unit is approx. 180 hours (6.0 credits).
Attendance time: Attendance of the lecture 15 x 90 min = 22 h 30 min
Attendance time: Attendance of the exercise 8 x 90 min = 12 h 00 min
Preparation / follow-up of the lecture 15 x 150 min = 37 h 30 min
Preparation / follow-up of the exercise 8x 360min =48h 00min
Go through slides/script 2x 2 x 12 h =24 h 00 min
Prepare exam = 36 h 00 min
SUM = 180h 00 min

M 13.75 Module: Human-Machine-Interaction in Anthropomatics: Basics (24100) [M-INFO-100824]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-INFO-101361	Human-Machine-Interaction in Anthropomatics: Basics	3 CP	Beyerer, van de Camp

M 13.76 Module: Humanoid Robotics Laboratory [M-INFO-105792]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German/English	4	2

Mandatory			
T-INFO-111590	Humanoid Robotics Laboratory	6 CP	Asfour

Competence Goal

- Students will be able to independently understand, structure, analyze, and solve a complex humanoid robotics problem using existing programming skills, alone or in a small team.
- Students can convey complex technical content in a presentation.

Content

In this practical course, a is worked on alone or in small teams with up to 3 students. Questions of humanoid robotics are dealt with, such as semantic scene interpretation, active perception, planning of grasping and manipulation tasks, action representation with motion primitives, and programming by demonstration.

The project work (alone or in groups) is performed largely independently but supported by scientific staff of the H2T. At the end of the practical course, the work has to be documented and presented in a scientific talk.

Additional Information

- Internship dates are always by arrangement with the supervising staff member.
- An extension work of the topic as a master thesis is possible in principle.
- The number of participants in this practical course is generally **limited** and varies with the number of available research projects at the institute.

Workload

Practical course with 4 SWS, 6 LP.
6 LP corresponds to ca. 180 hours, thereof
ca. 10h Attendance time in project discussion meetings
ca. 10h Preparation and follow-up of the above
ca. 150h Self-study to work on the topic
ca. 10h Preparation and giving of a scientific presentation

Recommendations

- Very good programming skills in at least one high-level programming language are strongly recommended.
- Attendance of the lectures Robotics 1, Robotics 2, Robotics 3, as well as the robotics practical course are recommended.
- Project-specific recommendations (knowledge of C++, Python, ...) will be announced in the individual project descriptions

M 13.77 Module: Humanoid Robots - Locomotion and Whole-Body Control [M-INFO-106649]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-INFO-113395	Humanoid Robots - Locomotion and Whole-Body Control	6 CP	Mombaur
T-INFO-114282	Humanoid Robots - Locomotion and Whole-Body Control -Pass	0 CP	Mombaur

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
By the end of the course, students will be able to:
- Develop kinematic and dynamic models of humanoid robots
- Understand basic principles of human whole-body movement
- Control gaits and other whole-body motions for humanoid robots and maintain balance
- Explain advanced methods for humanoid motion generation, optimization, and learning
- Give an overview of the state of the art in locomotion and whole-body control of humanoid robotics
- Complete a graduate level research project on humanoid robots including simulation and real-robot implementation

Content
This course introduces fundamentals and recent developments in the field of humanoid robotics with a focus on locomotion and whole-body motions. We will cover kinematic and dynamic modeling of anthropomorphic systems, basic concepts of bipedal walking control, stability aspects, gait generation in different terrains, humanoid balance and push recovery, motion primitives and optimal control-based approaches, motion imitation and learning. The course will also give some insights in basic principles of passive dynamic walking, human motion generation and control and human motion modeling. Students will work with different robotics tools and perform a graduate level research project related to a whole-body humanoid robot.
This module is complementary to the course “4.290 Robotik II - Humanoide Robotik” which focuses on upper body motions and cognitive architectures while this course focuses on the specific aspects of legged humanoids and whole-body motions. The modules can be taken at the same time.

Additional Information
Limitation to 30 participants

Workload
Estimated effort for this module is 180 hours:
60h - Lecture and exercises (2+2 SWS)
40h - Repetition of lecture contents, preparation of assignments
80h – Work on final project, documentation and presentation

Recommendations
Attendance of the lectures Robotics I - Introduction to Robotics and Mechano-Informatics in Robotics is required.

13.78 Module: Imaging Techniques in Light Microscopy (Sp-ITL) [M-CHEMBIO-101905]

Responsible: Prof. Dr. Martin Bastmeyer
Organisation: KIT Department of Chemistry and Biosciences
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-CHEMBIO-105197	Imaging Techniques in Light Microscopy	3 CP	Bastmeyer

Assessment
Written exam over 120 minutes (depending on the number of participants oral exam over approx.45 min).

Modality of Exam: Depending on the number of participants, a written or an oral exam is accomplished. The exact modality of the exam will be announced at the beginning of the semester. The written exam is scheduled for the beginning of the break after the WS. A resit exam is offered at the end of the break.

Prerequisites
none

Competence Goal
The students
• are able to derive the description of geometric- and wave-optical principles of a compound microscope
• know the physical principles of fluorescent dyes
• understand the configuration of laser scanning microscopes
• comprehend digital imaging and image processing
• have experienced a hands on laboratory praxis of the different microscopic techniques
• understand the biological principles of GFP-expression
• know the latest developments in light microscopy
• understand how technical development of microscopes has driven basic biological research

Content
This lecture series is designed to gain familiarity with fundamentals of biological light microscopy and modern fluorescence techniques. Depending on the content, the students will have lab demonstrations of different microscopes or imaging techniques covered in the lecture.
I. Introduction (History and Basic Principles of Compound Microscopes, Resolution and Contrast, Biological Sample Preparation)
II. Imaging Modes and Contrast Techniques (Biological Amplitude and Phase Objects, Phase Contrast, Interference Contrast, Polarization Microscopy)
III. Fluorescence Microscopy (Microscopic Principles, Fluorescent Dyes and Proteins, Biological Sample Preparation)
IV. Laser-Scanning-Microscopy (Basic Principles, Spinning Disk, 2-Photon Microscopy, Optical Sectioning Techniques)
V. Live Cell Imaging (Video Microscopy, Fluorescent Proteins)
VI. Special Fluorescence Techniques (FRET, TIRF, FCS)
VII. Super Resolution Microscopy (SIM, PALM, dSTORM, STED)
VII. Digital images (Image Processing, Data Analysis and Quantification)

Workload
Total 90 h, hereof 30h contact hours (30h lecture), and 60h homework and self-studies

Recommendations
Attendance to the lecture. Basic knowledge in physics and biology.

Teaching and Learning Methods
Lecture (including demonstration of microscopic techniques in the laboratory)

Literature
Lecture presentations will be accessible in pdf-format
Recent review articles will be distributed before the lectures
Books:
Alan R. Hibbs: Confocal Microscopy for Biologists, Springer Press
Rafael Yuste (Ed.): Imaging, a laboratory manual, CSH Press
James Pawley: Handbook of biological confocal microscopy, Plenum Press

M 13.79 Module: Industrial Circuitry [M-ETIT-100399]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100716	Industrial Circuitry	3 CP	Liske

Prerequisites
none

Module Grade Calculation
Die Modulnote ist die Note der mündlichen Prüfung.

M 13.80 Module: Information Fusion [M-ETIT-103264]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-106499	Information Fusion	4 CP	Heizmann

Prerequisites
none

13.81 Module: Information Technology in Industrial Automation Systems [M-ETIT-100367]

Responsible: Dr.-Ing. Peter-Axel Bort
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100698	Information Technology in Industrial Automation Systems	3 CP	Bort

Prerequisites
none

M 13.82 Module: Integrated Intelligent Sensors [M-ETIT-100457]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100961	Integrated Intelligent Sensors	3 CP	Stork

Assessment
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

M 13.83 Module: Integrated Systems and Circuits [M-ETIT-100474]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100972	Integrated Systems and Circuits	4 CP	Kempf

Prerequisites
none

M 13.84 Module: Intellectual Property Rights and Strategies in Industrial Companies [M-MACH-105419]

Responsible: Dipl.-Ing. Frank Zacharias
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German	4	2

Mandatory			
T-MACH-105442	Intellectual Property Rights and Strategies in Industrial Companies	4 CP	Zacharias

Assessment
see individual partial performance

Prerequisites
None

Competence Goal
The students understand and are able to describe the basics of intellectual property, particularly with regard to the filing and obtaining of property rights. They can name the criteria of project-integrated intellectual property management and strategic patenting in innovative companies. Students are also able to describe the key regulations of the law regarding employee invention and to illustrate the challenges of intellectual properties with reference to examples.

Content
The lecture will describe the requirements to be fulfilled and how protection is obtained for patents, design rights and trademarks, with a particular focus on Germany, Europe and the EU. Active, project-integrated intellectual property management and the use of strategic patenting by technologically oriented companies will also be discussed. Furthermore, the significance of innovations and intellectual property for both business and industry will be demonstrated using practical examples, before going on to consider the international challenges posed by intellectual

property and current trends in the sector. Within the context of licensing and infringement, insight will be provided as to the relevance of communication, professional negotiations and dispute resolution procedures, such as mediation for example. The final item on the agenda will cover those aspects of corporate law that are relevant to intellectual property.

Lecture overview:

1. Introduction to intellectual property
2. The profession of the patent attorney
3. Filing and obtaining intellectual property rights
4. Patent literature as a source of knowledge and information
5. The law regarding employee inventions
6. Active, project-integrated intellectual property management
7. Strategic patenting
8. The significance of intellectual property
9. International challenges and trends
10. Professional negotiations and dispute resolution procedures
11. Aspects of corporate law

Additional Information
None

Workload
Lecture attendance: 30 h

Self-study: 90 h

Recommendations
None

Teaching and Learning Methods
Lecture

Literature
None

M 13.85 Module: Interdisciplinary Qualifications [M-ETIT-105803]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Qualifications

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	pass/fail	Each term	1 term	German/English	4	3

Election Notes
For self assignment of taken interdisciplinary qualifications of HoC, FORUM (formerly ZAK), or SPZ the courses ('Teilleistungen') with the title 'Self Assignment-...' have to be selected according to the grading scale, graded or ungraded. Title and credits of the achievement are adopted.
Students can access the module via the menu item "Exam Registration and Unregistration" at the Study Portal.

Interdisciplinary Qualifications (Election: at least 6 credits)			
T-MACH-105721	Engineer's Field of Work	2 CP	Doppelbauer, Geimer
T-ETIT-111316	Introduction to the Scientific Method (Seminar, German)	1 CP	Nahm
T-WIWI-100796	Industrial Business Administration	3 CP	Fichtner
T-ETIT-111317	Introduction to the Scientific Method (Seminar, Englisch)	1 CP	Nahm
T-MACH-105442	Intellectual Property Rights and Strategies in Industrial Companies	4 CP	Zacharias
T-MACH-106738	ProVIL - Product Development in a Virtual Idea Laboratory	4 CP	Albers, Düser
T-ETIT-100814	Seminar Project Management for Engineers	3 CP	Noe
T-ETIT-108820	Seminar Project Management for Engineers	3 CP	Day, Noe
T-ETIT-111369	Strategy Derivation for Engineers	3 CP	Arndt
T-ETIT-100754	Seminar Creating a Patent Specification	3 CP	Stork
T-ETIT-111923	Ethics of Technology - ARs ReflecTIonis	2 CP	Kühler
T-ETIT-100797	Educational Development for Student Teachers - Basic Level	2 CP	
T-ETIT-111529	Self Assignment-HOC-SPZ-FORUM-graded	2 CP	
T-ETIT-111688	Self Assignment-HOC-SPZ-FORUM-graded	2 CP	
T-ETIT-111689	Self Assignment-HOC-SPZ-FORUM-graded	2 CP	
T-ETIT-111533	Self Assignment-HOC-SPZ-FORUM-ungraded	2 CP	
T-ETIT-111690	Self Assignment-HOC-SPZ-Forum-ungraded	2 CP	
T-ETIT-111691	Self Assignment-HOC-SPZ-FORUM-ungraded	2 CP	
T-ETIT-112898	Self Assignment-HOC-SPZ-FORUM-ungraded	2 CP	
T-ETIT-112899	Self Assignment-HOC-SPZ-FORUM-ungraded	2 CP	

M 13.86 Module: Introduction to Bionics [M-MACH-106525]

Responsible: apl. Prof. Dr. Hendrik Hölscher
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-111807	Introduction to Bionics	4 CP	Hölscher

Assessment
The successfull attandence of the lecture is controlled by a written examination.

Prerequisites
Basic knowledge in physics and chemistry

Competence Goal
The students should be able analyze, judge, plan and develop biomimetic strategies and products.

Content
Bionics focuses on the design of technical products following the example of nature. For this purpose we have to learn from nature and to understand its basic design rules. Therefore, the lecture focuses on the analysis of the fascinating effects used by many plants and animals. Possible implementations into technical products are discussed in the end.

Module Grade Calculation
The module grade corresponds to the grade of the partial performance.

Workload
30 h attendance time

90 h self-study.

Teaching and Learning Methods
Lecture

Literature
Slides and literature are provided byILIAS.

M 13.87 Module: Introduction to Microsystem Technology I [M-MACH-102691]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-114100	Introduction to Microsystem Technology I	4 CP	Badilita, Korvink

Assessment
Written exam: 60 min

Prerequisites
None

Competence Goal
The lecture gives an introduction into the basics of microsystems technology. In analogy to processes employed in fabrication of microelectronics circuits the core technologies as well as materials for producing microstructures and components are presented. Finally, various techniques for Silicon micromachining are explained and illustrated with examples for micro-components and micro-systems.

Content
- Introduction in Nano- and Microtechnologies
- Silicon and processes for fabricating microelectronics circuits
- Basic physics background and crystal structure
- Materials for micromachining
- Processing technologies for microfabrication
- Silicon micromachining
- Examples

Workload
Time of attendance: 15 * 1,5 h = 22,5 h

Preparation and follow up: 15 * 5,5 h = 82,5 h

Exam Preaparation and Exam: 15 h

Total: 120 h = 4 LP

Literature
M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

M 13.88 Module: Introduction to Microsystem Technology II [M-MACH-102706]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105183	Introduction to Microsystem Technology II	4 CP	Badilita, Korvink

Assessment
Written exam: 60 min

Prerequisites
none

Competence Goal
The lecture gives an introduction into the basics of microsystems technology. In the first part, methods for lithographic pattern transfer are summarized. Then specific techniques such as the LIGA process, micro-machining, and laser-patterning are explained and examples are given. Finally assembly and packaging methods are presented leading into a discussion of entire microsystems.

Content
- Introduction in Nano- and Microtechnologies
- Lithography
- LIGA-technique
- Mechanical microfabrication
- Patterning with lasers
- Assembly and packaging
- Microsystems

Workload
Time of attendance: 15 * 1,5 h = 22,5 h

Preparation and follow up: 15 * 5,5 h = 82,5 h

Exam Preaparation and Exam: 15 h

Total: 120 h = 4 LP

Literature
M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

M 13.89 Module: Introduction to Nanotechnology [M-MACH-107207]

Responsible: apl. Prof. Dr. Hendrik Hölscher
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-111814	Introduction to Nanotechnology	4 CP	Hölscher

Assessment
see individual course

Prerequisites
none

Content
Nanotechnology deals with the fabrication and analysis of nanostructures. The topics of the lecture include

- the most common measurement principles of nanotechnology especially scanning probe methods
- the analysis of physical and chemical properties of surfaces
- interatomic forces and their influence on nanostructures
- methods of micro- and nanofabrication and lithography
- basic models of contact mechanics and nanotribology
- important functional characteristics of nanodevices

Basic knowledge in mathematics and physics is assumed

Module Grade Calculation
see individual course

Additional Information
Course T-MACH-111814 may not be started

Workload
120 h
(for details see individual course)

Literature
Slides and literature will be made available in ILIAS.

M 13.90 Module: Introduction to the Finite Element Method [M-MACH-106209]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-MACH-105320	Introduction to the Finite Element Method	3 CP	Böhlke, Langhoff
T-MACH-110330	Tutorial Introduction to the Finite Element Method	1 CP	Böhlke, Langhoff

Assessment
written exam, 90 min. The tutorials T-MACH-110330 are prerequisites to the exam.

Prerequisites
none

Competence Goal
After having finished this module, the students know the mathematical and mechanical basics of the finite element method and can effectively perform stiffness as well as temperature analyses using a commercial FEM software package. The students can derive the weak formulation of a boundary value problem and set up the linear system of the FEM. The students know the different approximation approaches within the finite element method and can effectively apply numerical solution methods for linear systems of equations.

Content
This module aims to teach the students the theoretical and numerical aspects of the linear finite element method. At first, typical boundary value problems of solid mechanics are discussed. Weak forms are derived and their properties are discussed.Afterwards, the different approximation approaches within the finite element method are presented. Properties of the FEM-solution as well as numerical aspects are treated. Finally, an introduction into the numerical solution of linear systems is given.

Workload
1. Attendance lecture and tutorials: 15 * 2 h + 15* 2 h = 60 h
2. Preparation and recap of lecture and tutorials: 15 * 1 h + 15 * 1 h = 30 h
3. Exam preparation and presence during exam: 30 h

Teaching and Learning Methods
lecture, tutorial, lab course, consultation hours

M 13.91 Module: IT/OT-Security Seminar [M-ETIT-106789]

Responsible: Prof. Dr.-Ing. Mike Barth
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113648	IT/OT-Security Seminar	4 CP	Barth

Assessment
The examination takes place in the form of an oral examination.

Prerequisites
none

Competence Goal
The students:
- know the definitions of terms and use-cases in the IT/OT-Security Domain
- know security requirements of both: the industrial information technology perspecitiv as well as the production related operational technology domain
- can apply basic cryptographic mechanisms with focus on industrial IT networks
- know protection goals of IT/OT-security
- know various aspects of system security (buffer overflow, return-oriented programming, ...)
- can differentiate between classic information technology (IT) and operational technology (OT) in an industrial environment
- are familiar with attacks on industrial automation and control systems (Industrial Control Systems - ICS)
- are familiar with various concepts (defense-in-depth, security by design, ...) and specific security mechanisms (Public-Key-Infrastucture, network segmentation, ...) of OT security
- are familiar with current international security standards for ICS, in particular IEC 62443
- know the different roles involved and their challenges in the life cycle of ICS
- know and understand the concept of a risk analysis for security
- can evaluate the quality of security mechanisms and architectures for industrial systems
- know typical industrial communication protocols and can analyze and evaluate their security mechanisms

Content
- Industrial control and automation systems (ICS) are widely used in numerous domains and industries. They play a crucial role in areas such as industrial production, the process industry, critical infrastructures such as energy and water management, building automation and medical devices.
- In recent years, the frequency of vulnerabilities and attacks on these systems has increased, especially since the emergence of Stuxnet in 2014. As a result, the protection of ICS has become increasingly important.
- Compared to conventional IT systems, ICS have different boundary conditions and requirements. In particular, the focus is on availability and maintaining functional safety. Therefore, classic approaches to information security cannot be applied to industrial control systems without adaptation.
- This module first provides basic knowledge of security. Building on this, concepts, mechanisms and standards for the specific domain of ICS are introduced. This includes, for example:

o Defense-in-Depth concepts
o Risk-based approaches
o IEC 62443
o Structure and operation of cyber security management systems
o Security engineering
o Use of security information and event management systems in the industrial environment
o Secure use of Industry 4.0 technologies such as OPC UA

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
The workload includes:

1. attendance in seminar lectures and exercises: 12*2 h = 24 h
2. preparation / follow-up of seminar lectures: 12*3 h = 36 h
3. implementation of challenges and exercises: 12*3 h = 36 h
4. preparation of exam: 24 h.

A total of 120 h = 4 CR

Recommendations
Enjoy working with networked software systems in the production and industrial IT environment. Curiosity in the interplay between attackers and defenders as well as a general affinity to software related topics.

M 13.92 Module: Lab Computer-Aided Methods for Measurement and Control [M-MACH-105291]

Responsible: Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

Organisation:

Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	pass/fail	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105341	Lab Computer-Aided Methods for Measurement and Control	4 CP	Merkert, Stiller

Assessment
Successful passed Colloquia

Prerequisites
none

Competence Goal
Powerful and cheap computation resources have led to major changes in the domain of measurement
and control. Engineers in various fields are nowadays confronted with the application of computer-aided methods. This lab tries to give an insight into the modern domain of measurement and control by means of practically oriented and flexible experiments. Based on experiments
on measurement instrumentation and digital signal processing, elementary knowledge in the domain of visual inspection and image processing will be taught. Thereby, commonly used software like MATLAB/Simulink will be used in both simulation and realization of control loops. The lab closes with selected applications, like control of a robot or supersonic computer
tomography.

Content

1. Digital technology
2. Digital storage oscilloscope and digital spectrum analyzer
3. Supersonic computer tomography
4. Lighting and image acquisition
5. Digital image processing
6. Image interpretation
7. Control synthesis and simulation
8. Robot: Sensors
9 Robot: Actuating elements and path planning
The lab comprises 9 experiments.

Workload
120 hours

Recommendations
Basic studies and preliminary examination; basic lectures in automatic control

Teaching and Learning Methods
Tutorial

Literature
Instructions to the experiments are available on the institute's website

M 13.93 Module: Lab Course on Nanoelectronics [M-ETIT-100468]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-100757	Lab Course on Nanoelectronics	6 CP	Kempf

Assessment
The control of success takes place in form of the evaluation of a written report (approx. 10-20 pages) which introduces the topic, discusses the execution of the lab course and the scientific results puts the results into the overall context.

Prerequisites
none

Competence Goal
After successful completion of the module, students will be familiar with elementary processes of microsystems and thin-film technology and will be able to optimize the fabrication of thin-film structures independently and without external guidance. In addition, they will be able analyze and critically evaluate their results using adequate measuring tools. By working on the practical course in small groups, students also acquire or improve their teamwork skills.

Content
The students learn the basic procedures and processes for the fabrication of integrated circuits as they are also used in industry. After an introduction, they work on specified tasks in the clean room and technology laboratory of the Institute for Micro- and Nanoelectronic Systems and work independently on a set of tasks agreed upon in advance with the supervisor. In detail, the students learn the following methods or processes:

- Fabrication of thin films and multilayer systems by sputtering and thermal vapor deposition.
- Fotolithography
- Characterization of the manufactured devices at room temperature and low temperatures.
- Independent analyses, measurements and evaluations of characteristic quantities of the fabricated structures such as critical temperature, residual resistance ratio, current-voltage characteristics, etc.

The results are subsequently summarized by the students in a final report, put into context and critically discussed.

Module Grade Calculation
The module grade is the grade of the written report.

Additional Information
Two weeks block course in lecture-free time

Workload
A workload of approx. 180h is required for the successful completion of the module. This is composed as follows:

- Preparation of the lab course: 20h
- Discussion and lab course planning with supervisor: 10h
- Attendance time in the lab course: 70h
- Preparation of the written report: 80h

Recommendations
Successful completion of the module M-ETIT-103451 - Thin Films: technology, physics and application I or M-ETIT-105608 - Physics, Technology and Applications of Thin Films is recommended.

M 13.94 Module: Lab Course on Noise Thermometry [M-ETIT-106263]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-112714	Lab Course on Noise Thermometry	6 CP	Kempf

Assessment
The examination takes place in form of other types of examination. This consists of oral questions and a report on the contents and results of each of the three independent parts of the internship. The overall impression is evaluated.

Prerequisites
none

Competence Goal
After successful completion of the module, students will know the basics of noise thermometry as well as how modern, SQUID based noise thermometers can be built and operated. They will particularly know how to interpret measured temperature values and critically evaluate the noise budget. By working on the practical course in small groups, the students will also acquire or improve their teamwork skills.

Content
Noise thermometry is a proven method for primary thermometry and is therefore intensively used and further developed in many metrology institutes. The principle of this method is based on the measurement of the voltage or current noise of an electrical resistor. Within the scope of this practical course, the students will gain a detailed insight into noise thermometry. In the first part, they will design a transistor or operational amplifier-based circuit for measuring the thermal noise of a high-impedance resistor at room temperature. Using this circuit, the students will then measure the thermal noise of some resistors to verify the Nyquist theorem, Based on this, the students will design a noise thermometer for the temperature range between 4 K and 10 K in the second part of the lab course. It will be based on a superconducting quantum interference device (SQUID). With the help of this highly sensitive current sensor, the students will measure the thermal noise of a low-resistance resistor at different temperatures below 10 K and thus practically experience the basic principle of noise thermometry. Finally, in the last part of the practical course, the students will become familiar with the construction of a commercial noise thermometer in the range from 100 mK to 4 K with this noise thermometer. All three parts of the experiment will be accompanied by explanations and discussions of the underlying physical principles, the special features of the circuit design, etc. The students will also have the opportunity to learn more about the cryostats.

Module Grade Calculation
The oral discussion as well as the protocols of the three experimental parts are included in the evaluation of the examination performance of another kind. Details will be given during the lecture.

Workload
A workload of approx. 180 h is required for the successful completion of the module. This is composed as follows:

1. Preparation of the lab course: 40 h
2. Discussion and lab course planning with supervisor: 10 h
3. Attendance time in the lab course: 70 h
4. Preparation of the written report: 60 h

Recommendations
The contents of the module “Quantum Detectors and Sensors” or “Nano- and Quantum Electronics” might be helpful.

M 13.95 Module: Lab course on superconducting materials [M-ETIT-105614]

Responsible: Prof. Dr. Bernhard Holzapfel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-111242	Lab course on superconducting materials	6 CP	Kempf

Assessment
The control of success takes place in form of the evaluation of a written report (approx. 10-20 pages) which introduces the topic, discusses the execution of the lab course and the scientific results puts the results into the overall context.

Prerequisites
None

Competence Goal
After successful completion of the module, students will know how elementary synthesis and characterization methods of superconducting materials work and will be able to synthesize and characterize superconducting materials in thin film and bulk form independently and without external guidance. They know how to interpret measured parameters and relate them to the structural and superconducting properties of superconducting materials. Furthermore, the students understand elementary aspects of the underlying synthesis and characterization techniques of superconducting materials at variable temperatures and have an insight into the realization of concrete applications of superconducting materials. By working on the practical course in small groups, students also acquire or improve their teamwork skills.

Content
Superconducting energy and electronic applications play an important role in many areas of research, society and industry today. Superconducting magnets for medical MRI applications, or modern high-performance power engineering components such as superconducting motors and cables are just a few examples. In all superconducting applications, the specific properties of the underlying superconducting materials are critical to the performance and potential range of applications of the corresponding superconducting electrical engineering components.

Against this background, students in this module learn the basic synthesis and characterization techniques of superconducting materials and how to use them to produce superconducting materials and characterize their essential application-relevant superconducting properties independently and without outside guidance. In concrete terms, the students synthesize superconducting HTSL thin films or solid materials in consultation with the supervisor and characterize their structural and superconducting properties. For example, phase purity and growth textures can be analyzed by X-ray methods, and superconducting transition temperatures and temperature-dependent critical current densities can be analyzed by magnetic and transport measurements, respectively. The students characterize the superconductors they have synthesized and compare the results with literature values. In this environment, the students also gain insight into the methods of cryogenic engineering, which plays an essential role in the field of superconducting materials.

Module Grade Calculation
The module grade is the grade of the written report.

Workload
A workload of approx. 180h is required for the successful completion of the module. This is composed as follows:

- Preparation of the lab course: 20h
- Discussion and lab course planning with supervisor: 10h
- Attendance time in the lab course: 70h
- Preparation of the written report: 80h

Recommendations
Successful completion of the modules "Superconductivity for engineers" and " Superconducting Materials " is recommended.

13.96 Module: Lab Course Printed Flexible Electronics [M-ETIT-106464]

Responsible: Prof. Dr. Gerardo Hernandez Sosa
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	pass/fail	Each term	1 term	English	4	3

Mandatory			
T-ETIT-113075	Lab Course Printed Flexible Electronics	6 CP	Hernandez Sosa

Assessment
The examination consists of a written journal article and an oral presentation of the student's work, both given in English. The overall impression is rated.

Competence Goal
The students will gain practical experience in the use of measuring instruments and manufacturing processes for printed electronics technology and the methods for determining the physical and optical properties of the fabricated components. They will be able to fabricate devices such as photodetectors and thin film transistors, and electrically characterize them. Furthermore, they will evaluate measurement results and correlate the fabrication process conditions to the device characteristics. They will be able to critically evaluate their results using adequate measurement tools. In addition, they will have the competence to report the results in written form and to interpret the knowledge gained from the experiments. By working on the practical course in small groups, students also acquire or improve their teamwork skills.

Content
This module is designed to teach students the theoretical and practical aspects of laboratory work in the field of Printed and Flexible Electronics by means of guided and independently conducted practical experiments. In the four experiments, the student will learn to handle real measurement and fabrication technology on the scientific equipment of the institute such as various printers, probe stations, characterization methods and formulation of inks. The module also teaches the competence to write a scientific report, as well as the rules to visualize data sets in a meaningful way.

The working titles of the experiments are:

1) Ink formulation and characterization of Functional Inks
2) Printing optimization of an Inkjet Printer for functional Electronics
3) Fabrication and characterization of a printed sensor device.

Fabrication of a printed thin film transistor device with subsequent electrical characterization

Module Grade Calculation
The module is passed with successful assessment of the written paper and the oral presentation. Details will be given during the lecture. The module is ungraded.

Additional Information
- The lab is limited to a number of 6 participants due to capacity reasons. If necessary, a selection procedure will be carried out. Places will be allocated taking into account the students' academic progress. Details will be announced on the lecture website.
- The Lab course will take place in the clean room Facilities of InnovationLab in Heidelberg. Speyerer str. 4, 69115 Heidelberg where the research laboratories of Prof. Hernandez-Sosa are located.
- The 4 th experiment will take place at KIT Campus North, Institute of Nanotechnology, in the research unit and laboratories of Prof. Jasmin Aghassi-Hagmann.

Attendance of at least 80% is compulsory during the seminar course. Compulsory attendance is necessary for actively contributing to the discussion of the topics presented by all students.

Workload

Due to the self-administration of the groups (max. 3 students):

1 x 5 hours are required for organizational tasks. This includes the attendance of the information event, the attendance of 2 safety briefings (general safety and clean room) as well as the organizational tasks for the individual appointment between the experiment supervisor and the small group.

For the 4 experiments in the module, the workload is calculated as follows:

4 x 5 h familiarization with the topic and literature study on the basics incl. preparation for the entrance examination.

4 x 8 h presence for the execution of experiments at the institute

4 x 1 h discussion of results and learned concepts

4 x 10 h data preparation and visualization

4 x 15 h writing of an individual report on the basis of the measured data and the research question.

4 x 1 h final discussion on the experiment with feedback on the report

4 x 4 h Rework of the report on the basis of the feedback on the report.

Total hours = 181 h = 6 LP

Recommendations

Basic knowledge in the field of conventional and/or organic (opto) electronic or printed devices and sensors is helpful. The course Modern VLSI is recommended but not necessary.

It is recommanded to have started "M-ETIT-100475 Modul: Plastic Electronics / Polymerelektronik"

M 13.97 Module: Lab Course Robotic Winding Technology for Superconducting Wires [M-ETIT-107135]

Responsible: Prof. Dr. Tabea Arndt
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German/English	4	2

Mandatory			
T-ETIT-114158	Lab Course Robotic Winding Technology for Superconducting Wires	6 CP	Arndt

Assessment
Success control takes place in the form of other types of examination. It takes place in form of 3 experimental works. The overall performance gives the grade.

Prerequisites
The module "Superconducting Magnet Technology" must be passed.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module M-ETIT-106684 - Superconducting Magnet Technology must have been passed.

Competence Goal

- The students have a solid knowledge of architecture and design aspects of windings applied in magnets, coils and energy technology devices.
- The students have a clear understanding of opportunities, benefits and limitations of superconducting windings.
- The students are able to perform the required design estimations.

Content
As the superconducting wires become increasingly mature and powerful, using superconductivity in a variety of applications of electrical engineering is of rising interest and benefit, too. Most components and applications require dedicated coil windings. This module focuses on

- Wire properties to consider in advance
- Specification and design of windings (planar & non-planar geometries) & important sensing (current, voltage, temperature)
- Description of the winding process
- In advance testing of winding process in „digital twin“ environment (RobotStudio to control two 6-axis robots and a 2-axis positioner)
- Preparation of simple coils (by Copper-wire or by High-Temperature Superconductor wire; depending on the realized funding options of the module).
- Vacuum-Pressure-Impregnation of coils to prepare a robust sample device
- Performance test (Voltage vs. Current) immersed in liquid nitrogen
- Detailed report on work performed and achieved results.

Part of the (experimental) work has to be conducted in working groups.

The contents may be adopted without further announcement.
Additional materials for reference and study will be offered partly on ILIAS.

Module Grade Calculation
The assessment of the oral contributions and the written reports are included in the module grade. Further details will be provided at the beginning of the course.

Workload
180h

1. Attendance in teaching/ exercises: 48 h
2. Design/ Preparation/ Documentation/ Clean-up: 120 h
3. Reporting (post-process): 12 h

13.98 Module: Laboratory FPGA Based Circuit Design [M-ETIT-100470]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German	4	1

Mandatory			
T-ETIT-100759	Laboratory FPGA Based Circuit Design	6 CP	Kempf

Prerequisites
none

M 13.99 Module: Laboratory in Software Engineering [M-ETIT-100460]

Responsible: Prof. Dr.-Ing. Eric Sax
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100681	Laboratory in Software Engineering	6 CP	Sax

Prerequisites
none

M 13.100 Module: Laboratory Information Systems in Power Engineering [M-ETIT-107159]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German/English	4	1

Mandatory			
T-ETIT-114183	Laboratory Information Systems in Power Engineering	6 CP	Leibfried

Assessment
Success control takes place in the form of other types of examination and is assessed in form of 3 experiments.

Prerequisites
none

Competence Goal
Students have a basic understanding of how to use common calculation programs in the fields of network calculation, field calculation and automation and control. They are able to carry out basic calculations in the respective sub-areas and are familiar with the underlying theory.

Content
The focus of the lecture is to impart sound knowledge in the field of field calculation using the finite element method, load flow and short flow calculation, as well as the implementation of control programs for PLC systems. The theoretical basics of the sub-areas are taught and the practical application is practiced using common programs based on case studies.

Module Grade Calculation
The module grade results of the assessment of the 3 experiments.

- 20 points are awarded for each experiment (max. 10 for preparation and max. 10 for performance).
- This results in a total of 60 points.
- At least 27 points must be achieved in order to pass the module.

Workload
The workload is 180 hours and is made up as follows:

- Attendance time 40 h
- Self-study time 140 h

Recommendations
Basic knowledge on high-voltage technology, calculation of electrical networks and energy transmission and network control, computer skills

M 13.101 Module: Laboratory Lighting Technology [M-ETIT-102356]

Responsible: Prof. Dr. Cornelius Neumann
Dr.-Ing. Klaus Trampert

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-104726	Laboratory Lighting Technology	6 CP	Neumann

Assessment
Success is assessed on the basis of a total of four experiments. The overall impression is graded.

Prerequisites
none

Competence Goal
Students have practical experience in using photometric measurement equipment and methods for determining the photometric and electrical properties of lamps and luminaires. They also have basic experience in the simulation of luminaires with CAE tools.

They will be able to assess the plausibility of measurement results and estimate the influence of the measurement method on the uncertainty of the result.

They also have the competence to summarise the results in written form and to interpret the knowledge gained from the measurements scientifically and to explain the physical and photometric properties of lamps and luminaires.

Content
This module is designed to teach students the theoretical and practical aspects of laboratory work in the field of lighting technology by means of independently performed practical experiments. In the four experiments, the handling of real measurement technology is trained on the institute's scientific equipment. The module also teaches the skills required to write a scientific report and the rules for the appropriate visualisation of data sets.

The working titles of the experiments are:

1. thermal spectral behaviour of LEDs
2. far-field goniophotometry
3. near-field goniophotometry
4. simulation of optical systems

Module Grade Calculation
Oral examinations and the assessment of written assignments are included in the module grade. Further details will be provided at the beginning of the course.

Workload
Due to the self-administration of the small groups:

1 x 5 h are required for organizational tasks. This includes attending the information event, attending 2 safety briefings (laser and clean room) and making individual appointments between the experiment supervisor and the small group.

The workload for the 4 experiments in the module is calculated as follows:

4 x 5 h familiarization with the topic and literature study on the basics including preparation for the admission test.

4 x 8 h attendance at the institute

4 x 10 h data preparation and visualization

4 x 16 h Writing an individual report on the basis of the measurement data and the research question for the experiment.

4 x 1 h final discussion on the experiment with feedback on the report

4 x 4 h Improvement of the report based on the feedback on the report

Total hours required = 181 h = 6 CR

Recommendations

Knowledge of the theoretical principles of the individual experiments is helpful. It is highly recommended to attend the module after attending the lectures relevant to the subject, as knowledge of the theoretical basics is helpful but not mandatory. If the basics from the corresponding modules are not present, a longer preparation time for the respective experiment is needed.

Helpful modules: Light technology, optoelectronic measurement technology, photometry and radiometry

M 13.102 Module: Laboratory Mechatronic Measurement Systems [M-ETIT-103448]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-ETIT-106854	Laboratory Mechatronic Measurement Systems	6 CP	Heizmann

Assessment
The success control is carried out in the form of a written test of 120 minutes. If there are fewer than 20 candidates, an oral exam of around 20 minutes can alternatively take place. The module grade is the grade of the written or oral exam.

Prerequisites
none

Competence Goal

- Students have in-depth knowledge of different methods for measuring objects, especially surfaces.
- Students master different procedures for the metrological recording of objects and know the relevant requirements, procedures and results.
- Students are able to implement procedures for evaluating sensor data from (surface) measuring devices and to evaluate the quality of the measurement result.

Content
A large number of different measuring methods and systems can be used for the quality inspection of technically manufactured objects and their surfaces. Examples are white light interferometry, confocal microscopy and systems based on focus variation. The measurement methods and systems naturally differ in terms of the physical measurement principle used, but also in terms of the evaluation of the raw sensor data recorded.

In this internship, different systems for the metrological recording of (technical) surfaces are presented and their properties are characterized. In the test dates, the students themselves create procedures and algorithms for processing the sensor data in order to obtain information about the desired geometric and / or optical properties of the examined surface. The algorithms obtained are evaluated on the basis of sensor data from exemplary objects and characterized in terms of the quality of the measurement statements achieved.

Module Grade Calculation
The module grade is the grade of the written or oral exam.

Additional Information
The submission of the protocols of all experiments is required for admission to the examination. The quality of the protocols is assessed; for the admission to the exam, the quality must be acceptable. Attendance of all laboratory dates including the introductory event is required. Already in the event of a single unexcused absence, admission to the examination will not be granted.

Workload
Total: approx. 160 hours, of which

1. Attendance time in introductory session: 1.5 hours
2. Preparation of the test dates: 32 h
3. Attendance time in test appointments (8 appointments of 4 hours each): 32 hours
4. Follow-up of the test dates, Creation of the minutes: 32 h
5. Exam preparation and attendance in the same: 60 h

Recommendations
Knowledge from the lectures "Metrology" or "Metrology in Mechatronics" and "Manufacturing Metrology" as well as basic knowledge of programming (e.g. in Matlab, C / C ++) are helpful.

M 13.103 Module: Laboratory Modern Software Tools in Power Engineering [M-ETIT-105402]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-110898	Laboratory Modern Software Tools in Power Engineering	6 CP	Leibfried

Assessment
The control of success is carried out in the form of a total of 3 grades of the experiments (1 grade per experiment) in accordance with § 4 Paragraph 2 No. 3 SPO-Master2015-016, 2018

Prerequisites
none

Competence Goal
Students have a basic understanding of how to use common calculation programs from the domain of grid calculation, field calculation and EMT calculation in energy systems. They are able to perform basic calculations in the respective sub-areas and are familiar with the underlying theory.

Content
The main focus of the lecture is to teach profound knowledge in the domain of field calculation using the finite element method, load flow and short circuit calculation as well as the design of controllers in EMT simulations. The theoretical basics of the sub-areas will be taught and the practical application with the help of common programs will be practiced by means of case studies.

Module Grade Calculation
Scoring results from the subscores of the experiments.

Additional Information
For capacity reasons, the laboratory is limited to a number of 5 students. If necessary, a selection procedure will be carried out. Places will be allocated taking into account the study progress of the applicants.

Workload
Time of attendance: 40 hours

Self study time: 140 hours

Total 180 hours = 6 credits

Recommendations
Basic knowledge from the lectures High Voltage Engineering, Calculation of Electrical Grids and Electric Power Transmission and Grid Control. PC knowledge and English skills.

13.104 Module: Laboratory Nanotechnology [M-ETIT-100478]

Responsible: Prof. Dr. Ulrich Lemmer
Dr.-Ing. Klaus Trampert

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-100765	Laboratory Nanotechnology	6 CP	Lemmer

Assessment
Success control takes place in the form of a total of four tests. The overall impression is rated.

Prerequisites
none

Competence Goal
The students have practical experience in the use of measuring devices and manufacturing processes in nanotechnology and the methods for determining the physical and optical properties of optoelectronic components with functional nanotechnology components.

They can evaluate measurement results with regard to their plausibility and assess the influence of the measurement method on the uncertainty of the result.

You will also be able to reproduce the results in written form and interpret the knowledge gained from the measurements scientifically and explain the physical properties and the influence of the nanotechnology components.

Content
This module is designed to teach students the theoretical and practical aspects of laboratory work in the field of nanotechnology by means of independently conducted practical experiments. In the four experiments, students practise working with real measurement technology using the scientific equipment of the institute. The module also teaches students how to write a scientific report and the rules for the meaningful visualization of data sets.

The working titles of the experiments are

1. Production and characterization of an OLED
2. Optical mask lithography
3. Fabrication and characterization of an electrochromic device
4. Nanoimprint lithography and scanning electron microscopy

Module Grade Calculation
Oral examinations and the assessment of written assignments are included in the module grade. Further details will be provided at the beginning of the course.

Workload
Due to the self-administration of the small groups:

1 x 5 h are required for organizational tasks. This includes attending the information event, attending 2 safety briefings (laser and clean room) and making individual appointments between the experiment supervisor and the small group.

The workload for the 4 experiments in the module is calculated as follows:

4 x 5 h familiarization with the topic and literature study on the basics including preparation for the admission test.

4 x 8 h attendance at the institute

4 x 10 h data preparation and visualization

4 x 16 h Writing an individual report on the basis of the measurement data and the research question for the experiment.

4 x 1 h final discussion on the experiment with feedback on the report

4 x 4 h Improvement of the report based on the feedback on the report

Total hours required = 181 h = 6 CR

Recommendations

Knowledge of the theoretical principles of the individual experiments is helpful. It is advisable to attend the module after attending the subject-relevant courses, as knowledge of the theoretical basics is helpful but not mandatory. If the basics from the corresponding modules are not available, this means a longer preparation time for the respective experiment.

Helpful modules: Solid state electronics

M 13.105 Module: Laboratory Optoelectronics [M-ETIT-100477]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-100764	Laboratory Optoelectronics	6 CP	Trampert

Assessment
Success control takes place in the form of a total of four tests. The overall impression is rated.

Prerequisites
none

Competence Goal
Students have practical experience in using optoelectronic measuring devices and methods for determining the photometric and electrical properties of light sources and their operating devices.

They will be able to assess the plausibility of measurement results and estimate the influence of the measurement method on the uncertainty of the results.

You will also be able to reproduce the results in written form and interpret the knowledge gained from the measurements scientifically and use this to explain the physical properties of the light sources or the control gear.

Content
This module is designed to teach students the theoretical and practical aspects of laboratory work in the field of optoelectronics by means of independently conducted practical experiments. In the four experiments, students practise using real measurement technology on the scientific equipment of the institute. The module also teaches students how to write a scientific report and the rules for the meaningful visualization of data sets.

The working titles of the experiments are

1. Operating behavior of fluorescent lamps
2. Spectrophotometer | spectral transmission and reflection
3. Characterization of organic lasers
4. Spectroscopy & photosensor technology.

Module Grade Calculation
Oral examinations and the assessment of written assignments are included in the module grade. Further details will be provided at the beginning of the course.

Workload
Due to the self-administration of the small groups:

1 x 5 h are required for organizational tasks. This includes attending the information event, attending 2 safety briefings (laser and clean room) and making individual appointments between the experiment supervisor and the small group.

The workload for the 4 experiments in the module is calculated as follows:

4 x 5 h familiarization with the topic and literature study on the basics including preparation for the admission test.

4 x 8 h attendance at the institute

4 x 10 h data preparation and visualization

4 x 16 h Writing an individual report on the basis of the measurement data and the research question for the experiment.

4 x 1 h final discussion on the experiment with feedback on the report

4 x 4 h Improvement of the report based on the feedback on the report

Total hours required = 181 h = 6 CR

Recommendations
Knowledge of the theoretical principles of the individual experiments is helpful. It is advisable to attend the module after attending the subject-relevant courses, as knowledge of the theoretical basics is helpful but not mandatory. If the basics from the corresponding modules are not available, this means a longer preparation time for the respective experiment.

Helpful modules: Solid-state electronics, optoelectronic measurement technology, plasma radiation sources

M 13.106 Module: Laser Metrology [M-ETIT-100434]

Responsible: Prof. Dr. Marc Eichhorn
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-100643	Laser Metrology	3 CP	Eichhorn

Assessment
The exam will be taken as an oral examination (about 20 minutes). The individual appointments for examination are offered regularly at two previously determined dates.

Prerequisites
none

Competence Goal
The students understand the fundamental properties of laser light and possess the knowledge necessary to understand the metrologically obtainable information, understand the basics of various detectors as well as their limits and have the knowledge necessary to understand a multitude of laser metrological setups, mainly for interferometry, Moiré methods, distance and velocity measurements and absorption as well as scattering techniques.

Content
In the module several aspects of laser diagnostics will be discussed, beginning with the fundamental properties of laser light and the related metrologically useful information. In addition beam diagnostics and interferometric setups in general, as well as Moiré methods in particular, will be discussed. Further topics of the lecture will be commonly used setups, mainly for laser distance and velocity measurements along with widely used absorption and scattered light methods.

1. Laser diagnostics - theoretical considerations (laser beam properties, coherence, spectral emission of lasers, mode structure and selection, coherence length)
2. Metrological accessible information (propagation in homogeneous and isotropic, in inhomogeneous and in anisotropic media)
3. Beam diagnostics (photoelectric detectors, information theory, granulation properties of laser light)
4. Laser-Interferometer (fundamentals, two-beam Interferometer, interferometry applications in plasma physics, two- and multiwavelength-interferometry, laser gyroscopes)
5. Moiré technique (Moiré deflectometry, Fresnel- and Fraunhofer diffraction, applications and evaluation of the Moiré technique)
6. Laser range measurements (fundamentals, atmospheric influence on propagation, optical distance measurement techniques, accuracy, sensitivity, heterodyne detection, selected heterodyne detection schemes, tomoscopy)
7. Laser velocity measurement techniques (Doppler principle, measuring flow velocities using Doppler effect, the two-focus technique or laser anemometry; time-resolved imaging particle-trace anemometry)
8. Absorption and scattering techniques (absorption techniques, LIDARs, scattering processes in laser diagnostics, spontaneous scattering techniques, spectroscopic techniques, stimulated scattering, nonlinear optical laser light scattering techniques)

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
About 90 h in total, consisting of

30 h lectures

60 h recapitulation and self-studies

Literature
M. Eichhorn, *Laser metrology* - Scriptum

A. E. Siegman, *Lasers* (university Science Books)

B. E. A. Saleh, M. C. Teich, *Fundamentals of Photonics* (Wiley-Interscience)

M 13.107 Module: Laser Physics [M-ETIT-100435]

Responsible: Prof. Dr. Marc Eichhorn
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-100741	Laser Physics	4 CP	Eichhorn

Assessment
The exam will be taken as an oral examination (about 20 minutes). The individual appointments for examination are offered at two previously determined dates.

Prerequisites
none

Competence Goal
The students understand the fundamental relations and basics of a laser. They obtain the knowledge necessary for understanding and designing lasers (laser media, optical resonators, pumping schemes) and understand the basics and schemes for pulse generation in a laser. They have the knowledge needed for a multitude of lasers: gas, solid-state, fiber and disc lasers from the visible up to the mid-Infrared spectrum.

Content
Within the module the physical basics of lasers, the fundamental processes of light amplification and the formalisms necessary to describe lasers and laser resonators are covered. The generation of laser pulses and various laser architectures as well as realisations are presented in detail.

The exercises specifically discuss the topics of laser description, theoretical background as well as the realization of different laser designs. The tasks of the exercise will be handed out at the end of each lecture as well as uploaded to the lecture website and are to be solved for the following exercise, in which the solution will be discussed.

Contents:

1 Quantum-mechanical fundamentals of lasers

1.1 Einstein relations and Planck´s law

1.2 Transition probabilities and matrix elements

1.3 Mode structure of space and the origin of spontaneous emission

1.4 Cross sections and broadening of spectral lines

2 The laser principles

2.1 Population in version and feedback

2.2 Spectroscopic laser rate equations

2.3 Potential model of the laser

3 Optical Resonators

3.1 Linear resonators and stability criterion

3.2 Mode structure and intensity distribution

3.3 Line width of the laser emission

4 Generation of short and ultra-short pulses

4.1 Basics of Q-switching

4.2 Basics of mode locking and ultra-short pulses

5 Laser examples and their applications

5.1 Gas lasers: The Helium-Neon-Laser

5.2 Solid-state lasers

5.2.1 The Nd3+-Laser

5.2.2 The Tm3+-Laser

5.2.3 The Ti3+:Al2O3 Laser

5.3 Special realisations of lasers

5.3.1 Thermal lensing and thermal stress

5.3.2 The fiber laser

5.3.3 The thin-dis laser

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
About 120 h in total, consisting of

30 h lectures

15 h tutorial

75 h recapitulation and self-studies

Literature
M. Eichhorn, Laser physics (Springer)
M. Eichhorn, Laserphysik (Springer)
A. E. Siegman, Lasers (University Science Books)
B. E. A. Saleh, M. C. Teich,Fundamentals of Photonics (Wiley-Interscience)
F. K. Kneubühl, M. W. Sigrist, Laser (Teubner)

M 13.108 Module: Light and Display Engineering [M-ETIT-100512]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-100644	Light and Display Engineering	4 CP	Kling

Assessment
Type of Examination: Oral exam

Duration of Examination: approx. 25 minutes

Modality of Exam: The oral exam is flexibly held by student request after the WS.

Prerequisites
none

Competence Goal
The students will apply their comprehensive knowledge of physics of optical phenomena to applied optical systems in light and display engineering. These applications span from human sensing with the eye to light technologies with lamps, luminaires and displays. The course gives a broad overview how optics can be applied in modern technology fields. The subjects taught are further clarified by demonstrations, models and experiments.

The students

- can derive the description of basic of light engineering starting from the eye and the visual system
- know how to handle basic metrical units and know how to measure them
- understand the visible sensing in contrast to radiation measurements
- comprehend the concepts of colour and colour control
- are familiar with all types of light sources from low pressure lamps to LED modules
- conceive the operation principle of various types of drivers
- know how to set up a luminaire and how simulate a reflector
- they understand how active (Plasma Displays) and passive displays (TFT Display) work and how to operate them
- have a good visualization of numerous optical design approaches

Content

1. Motivation: Light & Display Engineering
2. Light, the Eye and the Visual System (including Melatonin)
3. Fundamentals in Light Engineering
4. Light in non - visual Processes (UV Processes)
5. Color and Brightness
6. Light Sources (Halogen, Low Pressure and High Pressure Lamps, LED Engines) and electronic Drivers
7. Displays (Active and Passive Displays: AMOLED, E-ink, TFT Display, Plasma Display)
8. Luminaries (Fundamentals, Design Rules, Simulations)
9. Optical Design (Ray tracing, Reflector design, Computed Ray tracing)

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
total 120 h, hereof 45 h contact hours (lecture and tutorial), and 75 h homework and self-studies

Recommendations
Basic physics background

Literature

Simons, Lighting Engineering: Applied Calculations, 2001

Shunsuke Kobayashi: LCD Backlights, 2009

Winchip, Fundamentals of Lighting, 2nd Edition, 2011

Malacara, Handbook of Optical Design, 2004

M 13.109 Module: Lighting Design - Theory and Applications [M-ETIT-100577]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-100997	Lighting Design - Theory and Applications	3 CP	Kling

Assessment
Type of Examination: Oral exam

Duration of Examination: approx. 25 minutes

Modality of Exam: The oral exam is flexibly held by student request after the WS.

Prerequisites
none

Competence Goal
The students will apply a comprehensive knowledge of Lighting Design from theory, standards and applications in Indoor and Outdoor lighting. Examples and own Lighting design examples as projects. So a practical and theoretical background is applied to Lighting Design. From metrics too Light Planning projects in small exercise groups. The subjects taught are further clarified by demonstrations, models and experiments. Attending students get the knowledge to Lighting Design, in a shorter theoretical part and practical lighting design simulations with examples from all over the world.

The students

- can derive the description of basics of Lighting Design
- know how to handle basic metrical units and know how to measure them
- understand the Lighting Design metrics to apply on projects
- have a good visualization of numerous design approaches
- realize good Lighting Design with codes and standards.
- can see energy savings levels for Lighting Design
- comprehend the lighting design by practical self-computing lessons:
- can realize own indoor Lighting design concepts for different applications like Office, School, Shops, Gyms & Industry
- can realize own outdoor Lighting Design concepts for Street lighting, Tunnels, Stade and Parkings
- can use for realization Relux and Dialux light planning software so set up Project Planning for Lighting Design.

Content
1. Lighting Design - Introduction form all over the world

2. Lighting Fundamentals

3. Lighting Design Theory

4. Energy Savings and Lighting design

5. Lighting Design Tools

6. Computing Standards

7. Lighting Design Applications (Practical Part)

7.1 Interior Lighting

7.2 Exterior lighting

7.3 IlluminationOwn Calculation Examples (Practical Part)Motivation: Light & Display Engineering

8. Own Calculation Examples (Practical Part)Motivation: Light & Display Engineering

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
total 90 h, hereof 45 h contact hours (Seminar), and 45 h homework and self-studies

Recommendations
Hearing first M-ETIT-100512 - Light and Display Engineering lecture is beneficial.

Literature

J. Livingstone: Designing With Light: The Art, Science and Practice of Architectural Lighting Design, 2014

S. Russel: The Architecture Of Light: Interior Designer and Lighting Designer, 2012

M. Karlen: Lighting Design Basics, Indoor Lightin, 2004

R.H. Simons Lighting Engineering, 2001Simons, Lighting Engineering: Applied Calculations, 2001

R. Winchip, Fundamentals of Lighting, 2nd Edition, 2011

13.110 Module: Lighting Engineering [M-ETIT-100485]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100772	Lighting Engineering	4 CP	Neumann

Prerequisites
none

M 13.111 Module: Machine Learning - Foundations and Algorithms [M-INFO-105778]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-INFO-111558	Machine Learning - Foundations and Algorithms	6 CP	Neumann

Assessment
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Competence Goal
• Students acquire knowledge of the basic methods of Machine Learning
• Students acquire the mathematical knowledge to understand the theoretical foundations of Machine Learning
• Students can categorize, formally describe and evaluate methods of Machine Learning
• Students can apply their knowledge to select appropriate models and methods for selected problems in the field of Machine Learning.

Content
The field of Machine Learning has made enormous progress in recent years and good knowledge of Machine Learning is becoming increasingly in demand on the job market. Machine Learning describes the acquisition of knowledge by an artificial system based on experience or data. Rules or certain calculations no longer have to be manually coded but can be extracted from data by intelligent systems.

This lecture provides an overview of essential and current methods of Machine Learning. After reviewing the necessary mathematical background, the lecture primarily deals with algorithms for classification, regression, and density estimation, with a focus on the mathematical understanding of probabilistic methods and neural networks.

Examples of topics include:
- Basics in Linear Algebra, Probability Theory, Optimization and Constraint Optimization
- Linear Regression
- Linear Classification
- Model Selection, Overfitting, and Regularization
- Support Vector Machines
- Kernel Methods
- Bayesian Learning and Gaussian Processes
- Neural Networks
- Dimensionality Reduction
- Density estimation
- Clustering
- Expectation Maximization
- Graphical Models

Workload
180h, divided into:
- ca 45h lecture attendance
- approx. 15h attending exercises
- approx. 90h post-processing and working on the exercise sheets
- ca 30h exam preparation

M 13.112 Module: Machine Learning 1 [M-WIWI-105003]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-WIWI-106340	Machine Learning 1 - Basic Methods	5 CP	Zöllner

Assessment
The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation or an oral exam (20 min) following §4, Abs. 2, 2 of the examination regulation.

The exam takes place every semester and can be repeated at every regular examination date.

Prerequisites
None

Competence Goal

- Students gain knowledge of the basic methods in the field of machine learning.
- Students understand advanced concepts of machine learning and their application.
- Students can classify, formally describe and evaluate methods of machine learning.
- Students can use their knowledge to select suitable models and methods for selected problems in the field of machine learning.

Content
The course prepares students for the rapidly evolving field of machine learning by providing a solid foundation, covering core concepts and techniques to get started in the field. Students delve into different methods in supervised, unsupervised, and reinforcement learning, as well as various model types, ranging from basic linear classifiers to more complex methods, such as deep neural networks. Topics include general learning theory, support vector machines, decision trees, neural network fundamentals, convolutional neural networks, recurrent neural networks, unsupervised learning, reinforcement learning, and Bayesian learning.

The course is accompanied by a corresponding exercise, where students gain hands-on experience by implementing and experimenting with different machine learning algorithms, helping them to apply machine learning algorithms on real world problems.

By the end of the course, students will have acquired a solid foundation in machine learning, enabling them to apply state-of-the-art algorithms to solve complex problems, contribute to research efforts, and explore advanced topics in the field.

Workload
The total workload for this module is approximately 150 hours.

Literature
Further reading

- Machine Learning - Tom Mitchell
- Deep Learning - Ian Goodfellow, Yoshua Bengio, Aaron Courville
- Pattern Recognition and Machine Learning - Christopher M. Bishop
- Artificial Intelligence: A Modern Approach - Peter Norvig and Stuart J. Russell
- Reinforcement Learning: An Introduction - Richard S. Sutton and Andrew G. Barto

Further (specific) literature on individual topics will be given in the lecture.

M 13.113 Module: Machine Learning 2 [M-WIWI-105006]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-WIWI-106341	Machine Learning 2 – Advanced Methods	5 CP	Zöllner

Assessment
The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation or an oral exam (20 min) following §4, Abs. 2, 2 of the examination regulation.

The exam takes place every semester and can be repeated at every regular examination date.

Prerequisites
None

Competence Goal

- Students gain knowledge of the basic methods in the field of machine learning.
- Students understand advanced concepts of machine learning and their application.
- Students can classify, formally describe and evaluate methods of machine learning.
- Students can use their knowledge to select suitable models and methods for selected problems in the field of machine learning.

Content
The subject area of machine intelligence and, in particular, machine learning, taking into account real challenges of complex application domains, is a rapidly expanding field of knowledge and the subject of numerous research and development projects.

The lecture "Machine Learning 2" deals with modern advanced methods of machine learning such as semi-supervised and active learning, deep neural networks (deep learning, CNNs, GANs, diffusion models, transformer, adversarial attacks) and hierarchical approaches, e.g. reinforcement learning. Another focus is the embedding and application of machine learning methods in real systems.

The lecture introduces the latest basic principles as well as extended basic structures and elucidates previously developed algorithms. The structure and the mode of operation of the methods and methods are presented and explained by means of some application scenarios, especially in the field of technical (sub) autonomous systems (vehicles, robotics, neurorobotics, image processing, etc.).

Workload
The total workload for this module is approximately 150 hours.

Literature

- Deep Learning - Ian Goodfellow
- Artificial Intelligence: A Modern Approach - Peter Norvig and Stuart J. Russell
- Machine Learning - Tom Mitchell
- Pattern Recognition and Machine Learning - Christopher M. Bishop
- Reinforcement Learning: An Introduction - Richard S. Sutton and Andrew G. Barto
- Deep Learning - Ian Goodfellow, Yoshua Bengio, Aaron Courville

13.114 Module: Machine Learning and Optimization in Communications [M-ETIT-104988]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	4

Mandatory			
T-ETIT-110123	Machine Learning and Optimization in Communications	4 CP	Schmalen

Assessment
Written examination of 120 minutes.

Prerequisites
Knowledge of basic engineering mathematics probability theory as well as basic knowledge of communications engineering (e.g. "M-ETIT-102103 – Nachrichtentechnik I" and "M-ETIT-102104 – Wahrscheinlichkeitstheorie").

Competence Goal
The students will be able to apply the methods and tools of machine learning, artificial intelligence and optimization in communications engineering. You will learn various tools and solution methods of machine learning, artificial intelligence and numerical optimization, and you can use these tools to solve telecommunications problems.

Content
The course broadens the questions dealt with in the lecture Communication Engineering I. The focus here is on methods that arise when considering communication networks. For this purpose, partially known techniques have to be extended, in some cases new methods have to be learned. The first part of the lecture deals with modern methods of machine learning, e.g. deep neural networks, and uses examples to show how they are used in communication networks. The second part of the lecture considers numerical optimization methods and their application to telecommunication questions. In the exercise concrete questions from practice are considered and solved together with the students. The focus of the problems lies in the field of communications engineering. Many of the applications are illustrated with example implementations in software (python).

Module Grade Calculation
The module grade is the grade of the written examination.

A bonus can be earned by successfully participating in the tutorial session. The exact criteria for awarding a bonus will be announced at the beginning ft he lecture period. If the grade in the exam is between 4.0 and 1.3, the bonus improves the grade by one grade (0.3 or 0.4). Bonus points do not expire and are retained for any examinations taken at a later date. The final assessment ft he bonus performance is carried out by the examiner and demonstrably documented.

Workload
- Lecture attendance: 15 * 2 h = 30 h
- Presence time exercise: 15 * 1 h = 15 h
- Lecture preparation/-revision phase: 15 * 2 h = 30 h
- Exercise preparation/-revision phase: 15 * 1 h = 15 h
- Exam preparation and attendance: 30 h

Total workload: approx. 120 h

Recommendations
Knowledge from the modules "M-ETIT-100444 – Angewandte Informationstheorie" and "M-ETIT-105982 – Measurement Technology" is helpful.

M 13.115 Module: Machine Vision (Sp-MV) [M-MACH-101923]

Responsible: Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-105223	Machine Vision	8 CP	Lauer, Stiller

Assessment
Type of Examination: written exam
Duration of Examination: 60 minutes

Prerequisites
None

Competence Goal
After having participated in th lecture the participants have gained knowledge on modern techniques of machine vision and pattern recognition which can be used to evaluatecamera images. This especially includes techniques in the areas of gray level image analysis, analysis of color images, segementation of images, describing the geometrical relationship between the image and the 3-dimensional world, and pattern recognition with various classification techniques. The participants have learned to analyze the algorithms mathematically, to implement them in software, and to apply them to tasks in video analysis. The participants are able to analyze real-world problems and to develop appropriate solutions.

Content
The lecture on machine vision covers basic techniques of machine vision. It focuses on the following topics:

image preprocessing

edge and corner detection

curve and parameter fitting

color processing

image segmentation

camera optics

pattern recognition

deep learning

Image preprocessing:

The chapter on image processing discusses techniques and algorithms to filter and enhance the image quality. Starting from an analysis of the typical phenomena of digital camera based image capturing the lecture introduces the Fourier transform and the Shannon-Nyquist sampling theorem. Furthermore, it introduces gray level histogram based techniques including high dynamic range imaging. The disussion of image convolution and typical filters for image enhancement concludes the chapter.

Edge and corner detection:

Gray level edges and gray level corners play an important role in machine vision since gray level edges often reveal valueable information about the boundaries and shape of objects. Gray level corners can be used as feature points since they can be identified easily in other images. This chapter introduces filters and algorithms to reveal gray level edges and gray level corners like the Canny edge detector and the Harris corner detector.

Curve and parameter fitting:

In order to describe an image by means of geometric primitives (e.g. lines, circles, ellipses) instead of just pixels robust curve and parameter fitting algorithms are necessary. The lecture introduces and discusses the Hough transform, total least sum of squares parameter fitting as well as robust alternatives (M-estimators, least trimmed sum of squares, RANSAC)

Color processing:

The short chapter on color processing discusses the role of color information in machine vision and introduces various models for color understanding and color representation. It concludes with the topic of color consistency.

Image Segmentation:

Image segmentation belongs to the core techniques of machine vision. The goal of image segmentation is to subdivide the image into several areas. Each area shares common properties, i.e. similar color, similar hatching, or similar semantic interpretation. Various ideas for image segmentation exist which can be used to create more or less complex algorithms. The lecture introduces the most important approaches ranging from the simpler algorithms like region growing, connected components labeling, and morphological operations up to highly flexible and powerful methods like level set approaches and random fields.

Camera optics:

The content of an image is related by the optics of the camera to the 3-dimensional world. In this chapter the lecture introduces optical models that describe the relationship between the world and the image including the pinhole camera model, the thin lens model, telecentric cameras, and catadioptric sensors. Furthermore, the lecture introduces camera calibration methods that can be used to determine the optical mapping of a real camera.

Pattern recognition:

Pattern recognition aims at recognizing semantic information in an image, i.e. not just analyzing gray values or colors of pixels but revealing which kind of object is shown by the pixels. This task goes beyond classical measurement theory and enters the large field of artificial intelligence. Rather than just being developped and optimized by a programmer, the algorithms are adapting themselves to their specific task using training algorithms that are based on large collections of sample images.

The chapter of pattern recognition introduces standard techniques of pattern recognition in the context of image understanding like the support vector machine (SVM), decision trees, ensemble and boosting techniques. It combines those classifiers with powerful feature representation techniques like the histogram of oriented gradients (HOG) features, locally binary patterns (LBP), and Haar features.

Deep learning:

Throughout recent years standard pattern recognition technqiues have more and more been outperformed by deep learning techniques. Deep learning is based on artificial neural networks, a very generic and powerful form of a classifier. The lecture introduces multi layer perceptrons as the most relevant form of artificial neural networks, discusses training algorithms and strategies to achieve powerful classifiers based on deep learning including deep auto encoders, convolutional networks, and multi task learning, among others.

Workload
240 hours, omposed out of

hours of lecture: 15*4 h = 60 h

preparation time prior to and after lecture: 15*6 h = 90 h

exam preparation and exam: 90 h

Teaching and Learning Methods
Lecture

Literature
Main results are summarized in the slides that are made available as pdf-files. Further recommendations will be presented in the lecture.

M 13.116 Module: Master's Thesis [M-ETIT-107356]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Master's Thesis

Credits	Grading	Recurrence	Duration	Language	Level	Version
30 CP	graded	Each term	1 term	English	4	1

Mandatory			
T-ETIT-114436	Master's Thesis	30 CP	Nahm

Assessment
The Master's Thesis module has 30 credits. It consists of the Master's Thesis and a presentation. The presentation must be carried out within the processing time in accordance with SPO Section §14(4).

Prerequisites
According to SPO Section §14(1) the prerequisite for admission to the Master's Thesis module is that the student has successfully completed module examinations totaling 75 credits.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. You need to have earned at least 75 credits in the following fields:
    - Elective Modules
    - Interdisciplinary Qualifications
    - Profiling Modules

Competence Goal
After successful completion of the module, students are able to work independently on a challenging task in the field of electrical engineering or information technology within a given period of time using scientific methods and in compliance with the rules of good scientific practice under guidance and by applying the theoretical and methodological knowledge acquired in the Master's program. Students are able to do research, analyze and abstract the information and to compile and recognize basic principles and laws from less structured information. Students are able to get an overview of a problem, select complex scientific methods and procedures and use them to find solutions or show further potentials. In principle, this also takes into account social and/or ethical aspects.

The students are able to interpret and evaluate their results. They are also able to document their results in a clearly structured, written elaboration using the appropriate technical terminology. Furthermore, students are able to present and defend their results in front of a scientific audience. They have also deepened their problem-solving skills and their competence in transferring the theoretical and methodological knowledge of electrical engineering and information technology into concrete applications.

In addition to the subject-related qualification goals, the students also gain knowledge and experience in the areas of project management as well as self and time management. This also includes knowledge and methods of various presentation techniques.

Content
The students work independently and with scientific methods on a research topic agreed with the subject examiner, which deals with a problem from the area of the Master's program in Biomedical Engineering.

Module Grade Calculation
The Master's Thesis is examined by at least one university professor of the KIT Department of Electrical Engineering and Information Technology or a habilitated member of the KIT Department and another examiner (SPO Section §14(7)). As a rule, one of the examiners is Person who has awarded the work in accordance with SPO Section §14(2). If the assessment of these two people does not match, the examination board determines the grade of the Master's Thesis in the context of the assessment of these two persons; additionally it can order another reviewer The assessment must be completed within eight weeks of the submission of the Master's Thesis respectively. SPO Section §14 regulates further details.

The module grade consists of the Master's Thesis and a presentation (SPO §14(1a)).

M 13.117 Module: Materials Characterization [M-MACH-103714]

Responsible: Prof. Dr. Astrid Pundt
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	4

Election Notes
The module can be passed either in English or in German. The selection is set by the combined allocation of the corresponding courses in English or in German including all associated assessments. The courses in English and in German are mutually exclusive. The preparatory courses ("exercises") are compulsory and are a prerequisite for the superordinate course in the same teaching language.

Compulsory Elective Subjects (Election: 2 items as well as 6 credits)			
T-MACH-107684	Materials Characterization	4 CP	Gibmeier, Schneider
T-MACH-107685	Exercises for Materials Characterization	2 CP	Gibmeier, Schneider
T-MACH-110946	Materials Characterization	4 CP	Gibmeier, Schneider
T-MACH-110945	Exercises for Materials Characterization	2 CP	Gibmeier, Schneider

Assessment
The assessment consists of a certificate and an oral exam (about 25 minutes).

Prerequisites
none

Competence Goal
The students have fundamental knowledge about methods of material analysis. They have a basic understanding to transfer this fundamental knowledge on problems in engineering science. Furthermore, the students have the ability to describe technical material by its microscopic and submicroscopic structure.

Content
The following methods will be introduced within this module:

- microscopic methods: optical microscopy, electron microscopy (SEM/TEM), atomic force microscopy
- material and microstructure analyses by means of X-ray, neutron and electron beams
- analysis methods at SEM/TEM (e.g. EELS)
- spectroscopic methods (e.g. EDS / WDS)

Workload
The workload for the module "Materials Characterization" is 180 h per semester and consists of the presence during the lectures (21 h) and tutorials (12 h) as well as self-study for the lecture (99 h) and for the tutorials (48 h).

Teaching and Learning Methods
Lectures (Obligatory)
Tutorials (Obligatory)

Literature
Lecture notes (will be provided at the beginning of the lecture).

Literature will be announced at the beginning of the lecture.

13.118 Module: Mathematical Methods in Continuum Mechanics [M-MACH-106210]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	3

Mandatory			
T-MACH-110375	Mathematical Methods in Continuum Mechanics	4 CP	Böhlke
T-MACH-110376	Tutorial Mathematical Methods in Continuum Mechanics	2 CP	Böhlke

Prerequisites
M-MACH-106764 must not be started.

M 13.119 Module: Measurement Technology [M-ETIT-105982]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-112147	Measurement Technology	5 CP	Heizmann

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

Prerequisites
M-ETIT-102652 - Messtechnik (German version) must not have started.

Competence Goal

- Students have a sound knowledge of the theoretical foundations of measurement technology, including modeling of measurement systems, consideration of nonlinearities, stochastic deviations and stochastic signals, acquisition of analog signals, and frequency and rotational speed measurement.
- Students are proficient in the approaches to measurement system design in terms of model assumptions, methods, and achievable results.
- Students are able to analyze and formally describe measurement technology tasks, synthesize possible solutions for measurement systems and assess the properties of the solution obtained.

Content
The module deals with the formal, methodical and mathematical fundamentals for the analysis and design of measurement systems. Focal points of the course are

- Measurement systems and deviations (including scales, the SI systems, modeling of measurement systems)
- Curve fitting (approximation, interpolation)
- Stationary behavior of measurement systems (characteristic curve, errors of the characteristic curve, nonlinearities, adjustment)
- Stochastic measurement errors (probabilistic analysis, samples, statistical test methods, statistic process control, error propagation)
- Stochastic processes (correlational measurements, spectral description of stochastic signals, system identification, matched filter, Wiener filter)
- Digitization of analog signals (sampling, quantization, analog-digital converters, digital-analog converters)
- Frequency and rotational speed measurement (generalized frequency concept, digital speed measurement, detection of direction)

Module Grade Calculation
The module grade is the grade of the written examination.

Additional Information
In the module a lecture, an exercise and an examination are offered.

Workload
The workload includes:

1. attendance in lectures and exercises: 34 h
2. preparation / follow-up of lectures and exercises: 51 h
3. preparation of and attendance in examination: 65 h

total: 150 h = 5 CR

Recommendations
Basic knowledge in the fields of “Probability Theory” as well as “Signals and Systems” is helpful.

M 13.120 Module: Medical Image Processing for Guidance and Navigation [M-ETIT-106672]

Responsible: Prof. Dr.-Ing. Maria Francesca Spadea
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-113425	Medical Image Processing for Guidance and Navigation	9 CP	Spadea

Assessment
The examination takes place within the framework of an oral overall examination of approx. 30 minutes about the lecture including a presentation and discussion of the project developed during the course. The overall impression is rated.

Prerequisites
none

Competence Goal

- The students will be able to analyze, structure and formally describe problems in the field of image guided surgery and therapy.
- The students can apply the methods form medical image processing, surgical navigation, augmented reality for surgery and therapy, medical data science.
- The student will be able to communicate in English technical language.
- The students are able to perform calculations and use the necessary tools for this in a methodologically appropriate way.
- The students are able to critically evaluate them

Content

- This module is designed to provide students with the theoretical and practical aspects of image guidance for minimally invasive surgery and therapy
- This module gives an overview about current status of technology in operation rooms (OR) and advanced radiotherapy bunkers
- Furthermore, this module gives knowledge about image process for quantitative information extraction
- Table of contents
    - Introduction to the course: minimally invasive surgery and medical data science
    - Git introduction
    - Image characteristics
    - Basic point, histogram and masked based operations
    - Similarity metrics, projections
    - Planning imaging, Dicom format, pre processing pipeline
    - Case study: planning in radiotherapy
    - Path planning
    - Pixel based image segmentation: manual segmentation, threshold, region growing
    - Convolution based segmentation: edge detection, morphological filters
    - Case study: neurosurgery and tractography
    - Image registration
    - Atlas based segmentation: SABS, MABS, atlas selection
    - Rendering and computer graphics
    - In room imaging technology
    - Reference system, notation and transformation
    - Localizing systems, tracking and calibration
    - Case study: patient monitoring in radiotherapy, adaptive treatments
    - Lab demonstration
    - Point based registration
    - Surface registration
    - Image features and descriptors (example with SIFT SURF)
    - Radiomics Features
    - Deep Learning in image processing
    - The role of deep learning in radiotherapy
    - Augmentet reality

Module Grade Calculation

The module grade is the grade of the oral exam.

A bonus can be earned for submitting homework that will be provided during the lecture time.

The exact criteria for awarding a bonus will be announced at the beginning of the lecture period. If the grade in the oral exam is between 4.0 and 1.3, the bonus improves the grade by 0.3 or 0.4.

Bonus points do not expire and are retained for any examinations taken at a later date.

Additional Information

The course is limited to a number of 30 participants due to capacity reasons. If necessary, a selection procedure will be carried out. Places will be allocated taking into account the students' study program (students of “Biomedical Engineering” specialization will be preferred, students from Computer Science Program and interest in medical applications will be preferred) and academic progress. Details will be announced on the lecture website.

Workload
The workload includes:

1. attendance in lectures and exercises: 15*6 h = 90 h
2. preparation / follow-up: 15*8 h = 120 h
3. preparation of and attendance in examination: 60 h

A total of 270 h = 9 CR

Recommendations

- Basic knowledge in the field of medical imaging;
- Knowledge of basic programming concept;
- Familiarity with Linux environment;
- Basic knowledge of linear algebra (transformations);
- Attitude towards teamwork and code management in Git;
- It is recommended to have access to a personal computer or desktop

Teaching and Learning Methods
Lectures in “Medical Image Processing” (3 SWS), Seminars in “In room imaging modalities” (1 SWS), Tutorials/ Demostrations in Medical image processing and navigation (2 SWS)

M 13.121 Module: Medical Measurement Technology Lab [M-ETIT-106779]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each winter term	2 terms	English	4	1

Mandatory			
T-ETIT-113721	Preparatory Lecture Medical Measurement Technology *This item will not influence the grade calculation of this parent.*	2 CP	Nahm
T-ETIT-113758	Preparatory Lab Medical Measurement Technology *This item will not influence the grade calculation of this parent.*	1 CP	Nahm
T-ETIT-113626	Development Lab Medical Measurement Technology	6 CP	Nahm

Assessment

1. The examination of the Preparatory Lecture takes place in form of other types of examinations. It consists of an ungraded written test.
2. The examination of the Preparatory Lab takes place in form of other types of examinations. It consists of an ungraded practical test.
3. The examination of the Development Lab takes place in form of other types of examinations. It consists of 6 graded protocols to the 6 experiments.
   The grade for the Development Lab is the average grade of the 6 protocols.

Prerequisites
none

Competence Goal
The aim of the practical course is to develop and implement a measuring system for the continuous recording of pulse transit time (PTT). For this purpose, the time difference between the electrocardiographically measured heart excitation (ECG) and the photoplethysmographically measured peripheral volume pulse (PPG) is determined and displayed. To validate the tested and verified system, the students develop a practical self-experiment.

This module promotes the development of both engineering and application-oriented professional competencies.

- Engineering competence:
  Students can design, set up, test and operate electronic measuring systems, including signal processing software.
- Medical application competence:
  Students can translate medical application problems into technical requirements. They know the sources of biosignals and their signal properties.
- Methodological competence for the development of medical devices: Students know the normative and regulatory requirements for the development of medical devices and are able to implement them.

Content
The Preparatory Lecture consists of 6 weekly classes and the written test. It will cover the following topics:

- Development of blood pressure
- Blood pressure as a biosignal
- Blood volume as a biosignal
- ECG as a biosignal
- Measurement principles and non-invasive methods for blood pressure measurement
- Measuring principle and measuring method of photoplethysmography
- Basics of analog and digital circuit technology
- Advantages, disadvantages, limitations of the methods
- Interference sources and measures for suppression
- Specifications and measures for electrical safety

The Prep Lab consists of 6 experiments and the practical test. The following program is completed as part of the Preparatory Labs:

- Laboratory safety briefing
- Construction of electronic circuits on a breadboard
- Rules for a clear layout and error prevention
- Operation and use of the oscilloscope
- Operation and use of the function generator
- Systematic troubleshooting

The Development Lab consists of 8 experiments and imparts the following know-how:

- Design and construction of sensor technology and analog circuits.
- Software design and implementation of digital signal processing
- Design and implementation of testing, verification and validation of systems and system components
- Design, implementation and testing of electrical safety measures

Module Grade Calculation
The module grade is the grade for the Development Lab.

Additional Information
For capacity reasons, the laboratory is limited to 32 students. If necessary, a selection procedure will be carried out. Places will be allocated according to the progress of the students (semester and subject-specific programming knowledge). Details will be announced in the first course and on the course website.

Students may only take part in the Development Lab (in summer term) if they have successfully completed the Preparatory Lecture and the Preparatory Lab (both in winter term).

Workload
Preparatory Lecture (winter term)

- In-class time: 7 x 1,5h = 10,5h
- Preparation and revision of the lecture units and preparation of and participation in the test exam: 7 x 5h + 2,5h = 37,5h
- Total time: 10,5h + 37,5h = 48h

Preparatory Lab (winter term)

- In-presence lab time: 7 x 1,5h = 10,5h
- Preparation and revision of the lab units, preparation of the protocols and preparation of and participation in the test exam: 7 x 4,5 h = 31,5h
- Total time: 10,5h + 31,5h = 42h

Development Lab (summer term)

- In-presence lab time: 8 x 7,5h = 60h
- Preparation and revision of the lab units and preparation of the protocols: 8x 15h = 120h
- Total time: 120h + 60h = 180h

Total effort
48h + 42h + 180h = 270h, equivalent 9 ECTS

Recommendations
Basic knowledge of analog circuit technology, digital signal processing and physiology and anatomy is strongly recommended.

M 13.122 Module: Microscale Fluid Mechanics [M-MACH-106539]

Responsible: Dr.-Ing. Philipp Marthaler
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-113144	Microscale Fluid Mechanics	4 CP	Marthaler

Assessment
Oral examination, duration: 30 minutes

Competence Goal
After this course, the participants can

(1) identify microfluidic and/or electrochemical problems

(2) describe those phenomena with the respective terminology and classify them as either Stokes flow, electrohydrodynamic or electrokinetic

(3) recognize and apply the appropriate modeling approaches and solution methods

(4) analyze the multiphysical and multiscale behavior and discuss the influence of different effects, such as electric forces, surface tension or electric boundary layers

(5) assess the importance of these effects in the context of biological phenomena and evaluate design choices in microfluidic devices

Content
The lecture covers microfluidic phenomena, particularly Stokes flow and electrical phenomena that occur in fluids. Understanding the mentioned effects is crucial for the development of microfluidic systems with application fields ranging from clinical diagnostics to cell research and environmental monitoring. The basic operations performed in microsystems are particle separation and mixing, chemical analyses, characterization of biological samples, and cell capturing. The sample environment is in fluid form, in the case of fluid samples multiphase phenomena occur.

The lecture gives an overview of the basic physics, i.e., Stokes flow, analysis of hydraulic circuits, surface tension effects, transport of passive scalars, electroosmosis and electrophoresis, structure of the electric double layer, electrokinetics, the Taylor-Melcher model for the description of droplets under the influence of an electric field.

Phenomena with electric boundary layers are discussed using asymptotic methods that are introduced in the lecture. A basic understanding of fluid mechanics and differential equations is required.

13.123 Module: Microsystem Technology [M-ETIT-100454]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100752	Microsystem Technology	3 CP	Stork

Assessment
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

13.124 Module: Microwave Engineering Lab [M-ETIT-106973]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	English	4	1

Mandatory			
T-ETIT-113938	Microwave Engineering Lab	6 CP	Zwick

Assessment
In preparation for the laboratory experiments, each laboratory group must work together on a number of tasks as homework before the experiment and submit a single copy to the supervisor immediately before the start of the experiment. The tasks for the experiment itself are completed and recorded during the experiment. The protocol should be handed in to the supervisor immediately after the experiment. Before each experiment is carried out, there is a written or oral examination (approx. 20 minutes, no aids) on the content of the experiment.

Prerequisites
none

Competence Goal
Students will have in-depth knowledge of high-frequency components and systems as well as the functionality of the most important high-frequency measuring devices (network analyzer, spectrum analyzer, noise measurement, power measurement, oscilloscope, antenna measurement). They are also familiar with the use of high-frequency measuring devices and components. They are able to independently select and operate measuring devices based on specific applications and interpret the measurement results. Furthermore, they are able to work together in a self-organized team.

Content
Under the motto: “Practical relevance through state-of-the-art equipment and current problems”, students are offered a modern and technically sophisticated high-frequency laboratory at Master's level. The aim of the experiments is to deepen the theory taught in the lectures in a practical way and to train the handling of high-frequency measuring devices and HF components. In groups of 2-4 students, various experiments are carried out and recorded over 8 afternoons. The order and topics of the experiments may vary.

Module Grade Calculation
The grade for the experiments is made up of the preparation, the protocol and the written or oral assessment of the learning objectives for each experiment. The final grade for the entire laboratory results from the overall impression of the performance. Students who appear unprepared for the respective experiment may not take part in the experiment. The experiment must be repeated at another time.

Workload
The workload includes:

- attendance study time laboratory: 45 h
- test preparation protocols, test preparation: 135 h

A total of 180 h = 6 LP

Recommendations
Knowledge of microwave measurement technology and RF components and systems is helpful.

13.125 Module: Microwave Module Design [M-ETIT-105701]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-111375	Microwave Module Design	3 CP	Geist, Zwick

Assessment
The success control is carried out as part of an oral overall examination (approx. 20 minutes) of the selected courses, which is in total meet the minimum requirement for LP.

Prerequisites
none

Competence Goal
After successful completion of the module, students will be able to design complex microwave modules. This includes in particular complete transmit and receive modules consisting of amplifiers, mixers, filters, signal generation, etc. They have a deep understanding of the technological and circuit aspects as well as for embedding in the overall system. The students are able to understand and describe the operation of the individual components and the systems. They are able to transfer this knowledge to other areas of high-frequency technology and thus to analyze and solve high-frequency technical problems. They are able to apply what they have learned in a practical manner.

Content
Applied course on microwave module design: lines on substrates, connectors, limiters, PIN switches, SIW components and filter design, amplifiers, frequency response compensation, phase noise, signal generation, planar mixers, and receiver noise figure.

In addition, during the lecture examples of microwave module design will be implemented and discussed in detail in a state-of-the-art software environment.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
The workload includes:

Attendance study time lecture: 30 h

Self-study time including exam preparation: 60 h

A total of 90 h = 3 LP

Recommendations
Knowledge of the basics of radio frequency technology and communications technology is helpful.

M 13.126 Module: Miniaturized Passive Microwave Circuits [M-ETIT-101968]

Responsible: Dr.-Ing. Stefan Wünsch
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-ETIT-108389	Miniaturized passive microwave circuits	4 CP	Wünsch

Prerequisites
none

13.127 Module: Mixed-Signal IC Design [M-ETIT-105893]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-111845	Mixed-Signal IC Design	3 CP	Ulusoy

Assessment
The success criteria will be determined by an oral examination (30 min.)

Prerequisites
none

Competence Goal
- The students acquire the competencies to mixed-signal advanced microelectronics integrated circuits.
- They have a good understanding of circuit design with linear circuits and "switched-capacitor" circuit techniques.
- They can design a sample-and-hold and track-and-hold circuits and discuss how it can improve an A/D converter's performance.
- They can design an A/D or D/A converter to a given performance specification, choosing an overall architecture, number of stages and internal precision.
- They can design phase lock loop (PLL) circuits, including design details and benefits and disadvantages of each type.
- They are familiar with time-to-digital converters and applications.
- They are familiar with the design of low-power circuits.
- They are able to develop test procedures, test structures and test patterns (ATPG - Automatic Test Pattern Generation) for ASICs.
- They have the basic understanding of the printed circuit board design practices, die-attached and high-density interconnection technology in order to connect the final ASIC to other chips and measurement equipment.

Content
This course covers fundamentals of data converters, Nyquist-rate converters, discrete-time signal processing, central concept of oversampling and noise-shaping, and delta-sigma modulators, phasedlocked loops, assembly and testing procedures of such mixed-signal ICs. Intended for engineers working with digital and analog signals, seeking to learn more about mixed-signal (analog plus digital) circuit design, analysis, and application.

Module Grade Calculation
The module grade is the grade of the oral examination.

Workload
Each credit point corresponds to an approximately 25-30h of workload in average. Based on this, the amount of work for this lecture is calculated as follows:
1. Attendance to the lectures (15*2=30h)
3. Preparation to the lectures (15*2=30h)
4. Preparation to the oral exam (25h)
Total: 85h

Recommendations
Basic knowledge on analog and digital circuits are recommended.

Literature
1. CMOS Analog Integrated Circuits; Razavi; McGraw-Hill Education
2. Principles of Data Conversion System Design; Razavi; Wiley-IEEE Press
3. Time-to-Digital Converters; Stephan Henzler; Springer Series in Advanced Microelectronics
4. VLSI Technology; Sze; McGraw-Hill

M 13.128 Module: MMIC Design Laboratory [M-ETIT-105464]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	English	4	1

Mandatory			
T-ETIT-111006	MMIC Design Laboratory	6 CP	Ulusoy

Assessment
The written report and the oral presentation are used to mark the course. The overall impression is assessed.

Prerequisites
none

Competence Goal
The students have a comprehensive understanding on the design of monolithic microwave integrated circuits.

The students are able to deduce specifications of individual building blocks in a microwave system and are able to connect these with system level considerations.

They are familiar with various IC fabrication technologies, and are able to identify pros and cons of the various state of the art technologies that are available today.

The students are able to perform the design of a complete microwave sub-system from conception to schematic level design and layout design, and are able to apply high-level design verification methods.

The students can apply their theoretical knowledge on RF engineering using modern design tools.

Content
In this laboratory course, the students will be assigned an RF system and will propose a hardware solution that will meet the requirements of the assigned RF system. The students will then perform schematic level design and system-level simulations of the proposed hardware. The laboratory course will be finalized with a layout implementation and verification of the proposed hardware. The students will learn to use state of the art CAD tools for system level simulations, schematic design, electromagnetic simulations, and layout design and verification in modern IC process technologies. Each RF sub-system will be developed by a group of 3-4 students.

Module Grade Calculation
The written report and the oral presentation are used to mark the course. The overall impression is assessed.

Workload
Each credit point corresponds approximately to 30h of the student's workload. Here, the average student is expected to reach an average performance. This contains:

1. Attendance to the laboratory tutorials (10*(3)=30h)
2. Preparation to the laboratory tutorials (10*(2)=20h)
3. Implementation of assigned design tasks after each tutorial (10*(8)=80h)
4. Preparation of report and oral presentation (20h)

Total: 150h

Recommendations
Radio-Frequency Integrated Circuits and Systems, Modern Radio Systems Engineering, Microwave Engineering, Electromagnetics and Numerical Calculation of Fields

13.129 Module: Mobile Communications [M-ETIT-105971]

Responsible: Prof. Dr.-Ing. Peter Rost
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-112127	Mobile Communications	4 CP	Rost

Assessment
The success control takes place in the form of an oral examination lasting 25 minutes. Before the examination, there is a preparation phase of 15 minutes in which preparatory tasks are solved.

Prerequisites
none

Competence Goal
Students are enabled to analyze and assess functionalities of mobile communication systems. They learn how to apply and implement fundamental methods of the lecture “Communications Engineering I” in mobile radio networks. Furthermore, students will be enabled to understand requirements and limitations of mobile applications.

Content
At the beginning, this course describes exemplary applications of mobile communications and elaborates on resulting requirements. Based on a solid understanding of those requirements, selected approaches and techniques will be presented that are solving the respective challenges in mobile communication systems. To this end, algorithms as well as system architectures are discussed in order to acquire solid knowledge on the radio network, the core network and the integration with applications and services.

Module Grade Calculation
Grade of the module corresponds to the grade of the oral exam.

Workload

1. Attendance time in lectures: 15 * 2 h = 30 h
2. Preparation and follow-up of lectures: 15 * 2 h = 30 h
3. Attendance time in excercises: 15 * 1 h = 15 h
4. Preparation and follow-up of excercises: 15 * 1 h = 15 h
5. Preparation for the oral exam: 30 h

In total: 120 h = 4 LP

Recommendations
Knowledge of basic engineering as well as basic knowledge of communications engineering and Previous attendance of the lecture "Communication Engineering I" is recommended. Sound English language skills are required.

M 13.130 Module: Mobile Communications II [M-ETIT-106244]

Responsible: Prof. Dr.-Ing. Peter Rost
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-112679	Mobile Communications II	3 CP	Rost

Assessment
The success control takes place in the form of an oral examination lasting 25 minutes. Before the examination, there is a preparation phase of 15 minutes in which preparatory tasks are solved.

Prerequisites
Basic knowledge of communications engineering. For this purpose previous attendance of the modules "M-ETIT-102103 - Communication Engineering I" and “M-ETIT-105971 - Mobile Communications” is strongly recommended.

Competence Goal
Students are able to analyze and assess functionalities of mobile communication systems. They know how to apply and implement fundamental methods of the lecture “Communications Engineering” in mobile radio networks. Furthermore, students are able to understand requirements and limitations of mobile applications.

This lecture complements the contents of the lecture "Mobile Communications", which mainly deals with aspects of communications access networks. Building on this, the focus of this lecture is on mobile communication architectures, core networks, and specific application scenarios and relevant technologies.

Content
The subject of the lecture is to first introduce a basic mobile communication system architecture including core network and the integration into applications. Based on this, specific core network functions are explained in detail, e.g. user administration, security, quality of service. Finally, specific applications are introduced and it is explained how mobile communication services are integrated in, e.g. industrial networks, connected cars, wide-area IoT applications.

Module Grade Calculation
Grade of the module corresponds to the grade of the oral exam.

Workload

1. Attendance to the lecture: 15 * 2 h = 30 h
2. Preparation and review: 15 * 2 h = 30 h
3. Preparation for the exam: included in preparation and review = 30 h

In total: 90 h = 3 LP

Recommendations

M 13.131 Module: Mobile Communications Workshop [M-ETIT-106456]

Responsible: Prof. Dr.-Ing. Peter Rost
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-113063	Mobile Communications Workshop	4 CP	Rost

Assessment
The success controll takes place in the form of other types of examination. The exam consists of report covering the individual experiments. The reports are evaluated as a whole.

Prerequisites
none

Competence Goal
The students are enabled to understand communication protocols and systems. They will be able to comprehend the structure and functioning of mobile radio systems with the help of simple experimental setups. This allows for better understanding of requirements and design principles of mobile radio systems.

Content
The workshop consists of 5 experiments:

- *Setting up a cellular connection using a cellular modem and control commands via a connected computer. Observing the behavior of the modem in different setups.*
- *Measurement and recording of typical features of a mobile phone connection, e.g. received signal power and quality.*
- *Building and analyzing a map showing the different quality indicators in a limited area.*
- *Comparison and synthesis of different maps to understand measurements on different frequency bands and using different setups.*
- *Building an ML algorithm based on measured values to predict quality indicators of the mobile network. This part is divided into a part of building the algorithm and conducting experiments to evaluate its performance.*

Module Grade Calculation
The grade of the module corresponds to the grade given for all reports (no individual grades for each report are given).

Additional Information
Attendance is compulsory during all laboratory sessions, including the introductory session. Compulsory attendance is necessary both for carrying out the work in the team on site and for the practical teaching of techniques and skills that cannot be learned in pure self-study.

Workload

1. *Attendance: 6 * 3 h = 18 h*
2. *Prepration: 6 * 6 h = 36 h*
3. *Execution of experiments: 6 * 6 h = 36 h*
4. *Review of experiments / report: 6 * 6 h = 36 h*

Overall: 126 h = 4 LP

Recommendations
Basic knowledge of communications engineering. Previous attendance of the lecture "Communication Engineering I" and “Mobile Communications” is recommended. Sound English language skills are required.

13.132 Module: Modeling Physiological Systems [M-ETIT-106782]

Responsible: Dr.-Ing. Axel Loewe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113630	Modeling Physiological Systems	6 CP	Loewe

Assessment
The examination takes place in form of a written examination lasting 90 min. The submission of the workshop tasks before the exam is mandatory.

Prerequisites
none

Competence Goal
The students will be able to

- Describe physiological functional principles of selected organs
- Formalize physiological relationships using engineering methods (e.g. mathematical equations, standardized diagram forms, etc.)
- Implement these models with adequate numerical schemes
- Apply formalized models to develop a deeper understanding of physiological relationships; e.g. by means of simulation studies
- Describe pathomechanisms of selected diseases
- Characterize selected pathologies qualitatively and quantitatively by using physiological models

Content
The module provides knowledge and methods for modeling physiological processes and pathomechanisms. Physiological functional principles are described using the example of 2-3 organ systems and then implemented in mathematical-technical models. The model types of ordinary differential equations, electrical equivalent circuits and control loops are taken up and deepened in practical tasks. The course is deepened both fundamentally by working on theoretical tasks with pen and paper as well as through programming and simulation studies.

At least one clinical picture is introduced for each example organ system and examined using modeling and simulation.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
Attendance in lectures and exercises: 22*2h = 44h

Preparation / follow-up: 22*2h = 44h

Preparation of and attendance in examination: 40h

Programming exercises 20h+15h+17h= 52h

A total of 180 h = 6 CR

Recommendations
Basic knowledge of

- ordinary differential equations
- system dynamics and control engineering
- programming in a scripting language (e.g. Python, Matlab)
- human anatomy & physiology

13.133 Module: Modelling and Simulation of Electrochemical Systems [M-ETIT-100508]

Responsible: Dr.-Ing. Andre Weber
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100781	Modelling and Simulation of Electrochemical Systems	3 CP	Weber

Prerequisites
none

M 13.134 Module: Modern Radio Systems Engineering [M-ETIT-100427]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	English	4	2

Mandatory			
T-ETIT-100735	Modern Radio Systems Engineering	6 CP	Zwick

Assessment
The success control takes place in the form of an oral examination of approx. 20 minutes.

Prerequisites
none

Competence Goal
After attending this course, students will be able to design an analog front end for a radio transmission system at the block diagram level. In particular, the non-idealities of typical components of high-frequency technology and their effects on the overall system performance are part of the knowledge imparted. The students also have an in-depth understanding of wave propagation.

Content
The course gives a general overview of radio transmission systems and their components including the radio channel and wave propagation. A brief repetition of microwave basics is also included. The focus is on the system components realized in analog technology and their non-idealities. Based on the physical functioning of the various system components, parameters are derived that allow an examination of their influence on the overall system performance.

The exercise is closely linked to the lecture and mainly consists of computer-based exercises that allow a visualization of the influences of various non-idealities on the overall system performance and demonstrate the practical system design of modern radio transmission systems.

Module Grade Calculation
The module grade is the grade of the oral examination.

Workload
The workload includes:

- Attendance study time lecture: 45 h
- Attendance study time computer exercise SystemVue ESL Design Software / MATLAB: 15 h
- Self-study time including exam preparation: 120 h

A total of 180 h

Recommendations
Knowledge of the basics of radio frequency technology and communications technology is recommended.

M 13.135 Module: Modern VLSI Technologies [M-ETIT-106921]

Responsible: Prof. Dr. Jasmin Aghassi-Hagmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113864	Modern VLSI Technologies	6 CP	Aghassi-Hagmann

Assessment
Success control takes place in form of an oral examination with a duration of approx. 20 minutes. Exercises have to be sucessfully completed before the exam is taken. Further details will be provided at the beginning of the course.

Prerequisites
none

Competence Goal

- The students will gain distinct knowledge in the field of modern CMOS technologies (FinFETs, High-k Gate-Stacks, Below 20nm nodes, Nanosheets).
- They will gain a good understanding of device physics and how to apply the most important design rules to design physical layouts of components and simple circuits.
- The students will be able to compare the functionality (current, performance, noise) of electrically characterized components with simulated devices, while assessing advantages and disadvantages.
- Students will learn to compare different technologies and to perform technology assessments based on benchmark circuit analyses. Understanding of critical paths in circuits for power-performance assessments.

Content
The lecture introduces CMOS technology with the latest technological innovations (high-k materials, gate-last processes, stress engineering, FinFETs, Gate all around FETs, nanosheets, etc.). A detailed understanding of interactions between novel materials, device architectures, and the functionality of basic components will be studied. In addition to physical and circuit properties (variations, self-heating, noise, performance), so-called layout effects, which play a crucial role in advanced CMOS are introduced. Special emphasis is put on the respresentation of technologies in design systems (electronic design automation) as well as SPICE simulations according to the BSIM (Berkeley Simulation Transistor Models) and PSP (Advanced Surface-Potential-Based MOSFET Model) standards. In addition, the use of industrial software (PDKs) for electrical simulation and circuit design will be introduced and practiced in the Excercises. Finally, highly integrated low power systems and their special requirements, wiring concepts and variation modeling are explained.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
The workload includes:

1. Attendance time in laboratory (15h*2=30h)
2. Attendance time in lectures (15h*2=30h)
3. Preparation/follow-up, lecture and exercises (15h*(2+2)=60h)
4. Preparation, written exercises and oral exam (60h)

   Total: 180h

Recommendations
Previous knowledge from the lectures "Festkörperelektronik und Bauelemente" and "Elektronische Schaltungen" is recommended.

M 13.136 Module: Modules in English Language: [M-ETIT-107301]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Profiling Modules (Engineering Modules)
Profiling Modules (Medical Technology and Clinical Modules)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
0 CP	pass/fail	see Annotations	1 term	English	4	1

Additional Information
serves as a marker, not selectable

M 13.137 Module: Modules in German Language: [M-ETIT-107300]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Profiling Modules (Engineering Modules)
Profiling Modules (Medical Technology and Clinical Modules)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
0 CP	pass/fail	see Annotations	1 term	German	4	1

Additional Information
serves as a marker, not selectable

M 13.138 Module: Nano- and Quantum Electronics [M-ETIT-105604]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-111232	Nano- and Quantum Electronics	6 CP	Kempf

Assessment
The assessment of success takes place in the form of a written examination lasting 120min. The grade corresponds to the result of the written examination.

Prerequisites
none

Competence Goal
Students will understand the physical limits of CMOS scaling and will be able to analyze the function of conventional nanoelectronic devices. Students will also understand the operation of novel nanoelectronic and quantum electronic devices and will be able to design this kind of devices that are based on quantum mechanical effects. They develop the ability to design nanoelectronic sensors and devices and can understand and analyze the fabrication methods for nano- and quantum electronic devices.

Content
Nanoelectronics deals with integrated circuits whose typical length scale is well below 100nm. In this regime, physical effects, in particular of quantum mechanical origin, occur and strongly influence the scaling of classical microelectronic devices. This ultimately leads to a new form of electronic components as well as novel operation principles. A special form of nanoelectronics is quantum electronics in which quantum mechanical effects are exploited on purpose to build an entirely new class of devices whose performance reaches far beyond any other microelectronics devices. Well-known examples are superconducting digital electronics which enables to build, for example, microprocessors with clock rates exceeding several 100GHz, or the quantum computer, which will lead to a change of paradigms in the field of information processing.

Within this context, the module "Nano- and quantum electronics" intends to give students an overview of the theoretical and practical aspects of nano- and quantum electronics. In particular, it discusses the following topics:

- Limitations of conventional CMOS technology
- Quantum mechanical effects in the field of nano- and quantum electronics (quantized conductance, Coulomb blockade, tunnel effect, etc.)
- Hot-electron effect
- Nano- and quantum-technological manufacturing and analysis methods
- Nanostructure field-effect transistors
- Quantum dots
- Carbon nanotube field-effect transistor
- Resonant tunnel diodes
- Unipolar resonant tunnel transistor
- Single Electron Transistor (SET)
- Josephson junction based analog and digital electronics
- Quantum bits, quantum computers and quantum computing

The tutorial is closely linked to the lecture and deals with special aspects concerning the development of nano- and quantum electronics. In particular, the development and system integration of such devices for various applications is discussed by means of exercises.

Module Grade Calculation
The module grade is the grade of the written examination.

Workload
A workload of approx. 175h is required for the successful completion of the module. This is composed as follows:

- Attendance time in lectures and exercises: 18*1.5h + 6*1.5h = 36h
- Preparation and follow-up of lectures: 21*3h= 54h
- Preparation and follow-up of tutorials: 7*5h= 35h
- Preparation for the exam: 50h

Recommendations
Successful completion of the modules "Superconductivity for Engineers" and „Einführung in die Quantentheorie für Elektrotechniker“ is recommended.

M 13.139 Module: Navigation and Localization Techniques [M-ETIT-105881]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-111829	Navigation and Localization Techniques	3 CP	Zwick

Assessment
The success control is carried out as part of an oral overall examination (approx. 20 minutes) of the selected courses, which in total meet the minimum requirement for LP.

Prerequisites
none

Competence Goal
The students are able to understand navigation-related problems and develop appropriate solutions. They have a solid understanding of navigation and positioning principles, corresponding location-dependent measurements, parameter and position estimation as well as position tracking algorithms. With suitable performance measures, they can compare different navigation and localization solutions. For example, the students have sound knowledge on GNSS receivers, IMUs, sensor fusion, and radio navigation for aerospace and land-based applications. In case they face advanced problems, they have ideas how to approach them.

Content
Today navigation systems are an integral part of our daily live. Most of us use a global navigation satellite system (GNSS) receiver integrated in our smartphones to find our way in cities and outdoors. Often, these systems are augmented by localization information from radio systems such as WLAN access points, correction information for assisted GNSS (A-GNSS) or inertial measurement units (IMUs) and magnetometers. In the near future navigation technologies become a key enabler for more efficient, safe, and environmentally friendly automated transport, be it autonomous driving cars and trains or automated landing of airplanes and space vehicles. Therefore, this lecture addresses the following topics:

The first chapter will introduce navigation systems, define common terms, and provide an outline of the lecture as well as organizational details.

The second chapter will discuss navigation and positioning principles based on dead reckoning, landmarks, and electromagnetic waves.

Subsequently, Chapter 3 will present first the estimation problem and lower bounds for estimating location dependent parameters and then suitable estimation methods for location dependent parameters, e.g. received power, time of flight, and direction of arrival of radio signals.

Building on Chapter 3, Chapter 4 will explain snapshot position estimation algorithms including triangulation, trilateration, multilateration, and signature matching. To enable comparisons between different methods, performance bounds and measures are discussed.

Chapter 5 will address the continuous position tracking first with a performance bound and second with different tracking filters such as the Kalman filter and particle filter.

Being familiar with navigation and positioning principles, estimation of location dependent parameters and positions as well as position tracking, Chapter 6 elaborates the architecture and functionality of GNSSs, GNSS receivers, and augmentation systems.

In Chapter 7, inertial navigation and the sensor fusion between IMU and GNSS receiver data is discussed including loosely and tightly coupled approaches.

Particular navigation aspects and systems in the aerospace domain are explained in Chapter 8 whereas Chapter 9 explains navigation and localization for railways and road transport as well as indoors.

Finally, Chapter 10 introduces some advanced research topics in navigation and how to approach them. For instance, multipath and non-line-of-sight propagation, mitigation, and exploitation or cooperative and swarm navigation may be discussed. The topics may be adapted based on current research work and discussions throughout the course.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
Each credit point corresponds to approximately 25-30 hours of work (of the student). This is based on the average student who achieves an average performance. The workload includes:

Attendance study time lecture: 30 h

Self-study time including exam preparation: 60 h

A total of 90 h = 3 LP

Recommendations
Basic knowledge of linear algebra, stochastic, radio frequency technology, and communications technology is helpful.

13.140 Module: Nonlinear Control Systems [M-ETIT-100371]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100980	Nonlinear Control Systems	3 CP	Kluwe

Prerequisites
none

M 13.141 Module: Nonlinear Optics [M-ETIT-100430]

Responsible: Prof. Dr.-Ing. Christian Koos
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-101906	Nonlinear Optics	6 CP	Koos

Assessment
The oral exam is offered continuously upon individual appointment.

Prerequisites
none

Competence Goal
The students

- understand and can mathematically describe the effect of basic nonlinear-optical phenomena using optical susceptibility tensors,
- understand and can mathematically describe wave propagation in nonlinear anisotropic materials,
- have an overview and can quantitatively describe common second-order nonlinear effects comprising the electro-optic effect, second-harmonic generation, sum- and difference frequency generation, parametric amplification and optical rectification,
- have an overview and can quantitatively describe the Kerr effect and other common third-order nonlinear effects, comprising self- and cross-phase modulation, four-wave mixing, self-focussing, and third-harmonic generation,
- have an overview and can describe nonlinear-optical interaction in active devices such as semiconductor optical amplifiers
- conceive the basic principles of various phase-matching techniques and can apply them to practical design problems,
- conceive the basic principles electro-optic modulators, can apply them to practical design problems, and have an overview on state-of-the art devices,
- conceive the basic principles third-order nonlinear signal processing and can apply them to practical design problems.

Content

1. The nonlinear optical susceptibility: Maxwell´s equations and constitutive relations, relation between electric field and polarization, formal definition and properties of the nonlinear optical susceptibility tensor,
2. Wave propagation in nonlinear anisotropic materials
3. Second-order nonlinear effects and devices: Linear electro-optic effect / Pockels effect, second-harmonic generation, sum- and difference-frequency generation, phase matching, parametric amplification, optical rectification
4. Third-order nonlinear effects and devices: Nonlinear refractive index and Kerr effect, self- and cross-phase modulation, four-wave mixing, self-focussing, third-harmonic generation
5. Nonlinear effects in active optical devices

Module Grade Calculation
The module grade is the grade of the oral exam.

There is a bonus system based on the problem sets that are solved during the tutorials: During the term, 3 problem sets will be collected in the tutorial and graded without prior announcement. If for each of these sets more than 70% of the problems have been solved correctly, a bonus of 0.3 grades will be granted on the final mark of the oral exam.

Workload
Approx. 180 h – 30 h lectures, 30 h exercises, 120 h homework and self-studies

Literature
R. Boyd. Nonlinear Optics. Academic Press, New York, 1992.
E.H. Li S. Chiang Y. Guo, C.K. Kao. Nonlinear Photonics. Springer Verlag, 2002
G. Agrawal, Nonlinear Fiber Optics, Academic Press, San Diego, 1995.

M 13.142 Module: Novel Actuators and Sensors [M-MACH-105292]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-102152	Novel Actuators and Sensors	4 CP	Kohl, Sommer

Assessment
Written exam, 60 min

Prerequisites
None

Competence Goal
- Knowledge of the actuation and sensing principles including pros and cons
- Knowledge of important fabrication technologies
- Explanation of layout and function of the actuators and sensors
- Calculation of important properties (time constants, forces, displacements, sensitivity etc.)
- Development of a layout based on specifications

Content
The content of the lecture is among others:

- Piezo actuators
- Magnetostriktive actuators
- Shape memory actuators
- Electro-/Magnetorheologicical actuators
- Sensors: Concepts, materials, fabrication
- Micromechanical sensors: Pressure, force, inertial sensors
- Temperature sensors
- Sensors for bioanalytics
- Mechano-magnetic sensors

Workload
lecture time 18 h

self preparation: 102 h

Teaching and Learning Methods
Lecture

Literature
- Vorlesungsskript "Neue Aktoren" und Folienskript "Sensoren"
- Micro Mechatronics, K. Uchino, 2nd ed., CRC Press, Taylor & Francis Group, 2019.
- Donald J. Leo, Engineering Analysis of Smart Material Systems, John Wiley & Sons, Inc., 2007
- "Sensors Update", Edited by H.Baltes, W. Göpel, J. Hesse, VCH, 1996, ISBN: 3-527-29432-5
- "Multivariate Datenanalyse – Methodik und Anwendungen in der Chemie", R. Henrion, G. Henrion, Springer 1994, ISBN 3-540-58188-X

M 13.143 Module: Numerical Fluid Mechanics [M-MACH-107036]

Responsible: Prof. Dr.-Ing. Bettina Frohnapfel
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105338	Numerical Fluid Mechanics	4 CP	Frohnapfel, Gatti

Assessment
oral exam - 30 minutes

Prerequisites
none

Competence Goal
The students deepen their understanding of the building blocks of numerical solutions for fluid mechanics problems. They can classify the fundamental equations of fluid mechanics based on their mathematical characteristics and recognize the implications for designing a numerical method. They can mathematically describe discretization approaches using finite differences and finite volumes and apply them to the incompressible Navier-Stokes equations. They can critically evaluate numerical methods in terms of their stability, accuracy, and efficiency.

Content
The course covers the following topics:

1. basic equations of computational fluid dynamics
2. main discretization methods for fluid mechanics problems, with focus on finite differences and finite volumes
3. boundary and initial conditions
4. mesh generation and mesh treatment
6. solution algorithms for linear and nonlinear systems of equations
7. solution strategies for the incompressible Navier-Stokes equations
8. introduction to the solution of the compressible Navier-Stokes equations
9. examples of numerical simulation in practice

Module Grade Calculation
result of exam

Workload
The work load is about 120 hours, corresponding to 4 credit points.

Teaching and Learning Methods
Lectures + tutorials

Literature
Ferziger, Peric: Computational Methods for Fluid Dynamics. Springer-Verlag, 1999.
Hirsch: Numerical Computation of Internal and External Flows. John Wiley & Sons Inc., 1997.
Versteg, Malalasekera: An introduction to computational fluid dynamics. The finite volume method. John Wiley & Sons Inc., 1995

M 13.144 Module: Numerical Methods [M-MATH-105831]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-MATH-111700	Numerical Methods - Exam	5 CP	Kunstmann, Liao, Reichel

Assessment
Success control takes the form of a written examination (120 minutes).

Prerequisites
none

Competence Goal
Students who pass the module are familiar with basic concepts and ways of thinking on the topic of numerical mathematics. They know different procedures for solving linear and nonlinear problems in numerical mathematics. They are furthermore able to use numerical methods for solving problems from applications in an independent, critical, and needs-based way.

Content
In the lecture basic ideas and numerical methods for the following topics will be presented:

- systems of linear equations, Gauss-algorithm, LR-decomposition, Cholesky decomposition
- eigenvalue problems, von-Mises iteration
- linear optimization (also called linear programming)
- error analysis
- Newton's method
- quadrature, Newton-Cotes formulas
- numerical solution of initial value problems, Runge-Kutta methods
- finite difference method for solving boundary value problems
- finite elements

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
Approximately 150h workload. The workload includes:

45h - attendance in lectures, exercises and examination

105h – self studies:

- follow-up and deepening of the course content
- solving problem sheets
- literature study and internet research on the course content
- preparation for the module examination

M 13.145 Module: Numerical Methods for Partial Differential Equations [M-ETIT-102311]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-104595	Numerical Methods for Partial Differential Equations	4 CP	Hohmann

Prerequisites
none

M 13.146 Module: Numerical Methods with Programming Practice [M-MATH-106972]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-MATH-111700	Numerical Methods - Exam	5 CP	Kunstmann, Liao, Reichel
T-MATH-113937	Numerical Methods - Workshop *This item will not influence the grade calculation of this parent.*	1 CP	Kunstmann, Liao, Reichel

Assessment
Success control takes the form of a written examination (120 minutes)and mandatory participation in the programming workshop. Successful participation in the workshop is confirmed by signing the attendance sheet provided at each practice session.

Prerequisites
none

Competence Goal
Students who pass the module are familiar with basic concepts and ways of thinking on the topic of numerical mathematics. They know different procedures for solving linear and nonlinear problems in numerical mathematics. They are furthermore able to use numerical methods for solving problems from applications in an independent, critical, and needs-based way. The students are capable to implement the numerical procedures they have learned in programming workshop.

Content
In the lecture basic ideas and numerical methods for the following topics will be presented:

- systems of linear equations, Gauss-algorithm, LR-decomposition, Cholesky decomposition
- eigenvalue problems, von-Mises iteration
- linear optimization (also called linear programming)
- error analysis
- Newton's method
- quadrature, Newton-Cotes formulas
- numerical solution of initial value problems, Runge-Kutta methods
- finite difference method for solving boundary value problems
- finite elements

Module Grade Calculation
The module grade is the grade of the written exam.

Additional Information
The workshop is held twice during the semester, offering students the opportunity to earn an additional credit point (+1) upon successful participation. Students are expected to work on the programming exercises on their own laptops prior to the workshop. During the workshop, solutions to the programming exercises are discussed with the students.

Workload
Approximately 180h workload. The workload includes:

45h - attendance in lectures, exercises and examination

4h - attendance in workshop

131h – self studies:

- follow-up and deepening of the course content
- solving problem sheets
- literature study and internet research on the course content
- preparation for the module examination
- preparation of workshop

M 13.147 Module: Operations Research in Health Care Management [M-WIWI-106853]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each term	1 term	English	4	1

Mandatory			
T-WIWI-102884	Operations Research in Health Care Management	5 CP	Nickel

Assessment
The assessment is a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

The examination is held in every semester.

Competence Goal
The lecture "Operations Research in Health Care Management" has the following qualification objectives:

1. **Cost-effectiveness, quality and patient orientation**: in addition to pure efficiency, the focus is also on cost-effectiveness, treatment quality and patient satisfaction. The application of operations research methods should lead to sustainable improvements in these areas.
2. **Analysis and optimization of processes**: Students learn to analyze existing processes in the healthcare sector and make them more efficient. This includes aspects such as scheduling, internal patient transport, surgery planning, duty scheduling for doctors and nursing staff and layout planning.
3. **Strategic aspects and structural optimization**: The lecture also deals with the location planning of healthcare facilities such as hospitals, doctors' surgeries and outpatient clinics.

Overall, the course provides students with the tools and concepts to tackle complex challenges in healthcare with the help of operations research

Content
The lecture "Operations Research in Health Care Management" deals with the application of operations research methods to planning problems in the healthcare sector. First, the German health care system is discussed in order to understand the responsibilities of the actors and institutions as well as the financing principles. The focus is on hospitals. In recent years, reforms in the healthcare system have put hospitals under increasing cost and competitive pressure. For example, the introduction of diagnosis-related flat rates (DRGs), a performance-related remuneration system, has abolished the cost recovery principle in order to create incentives for economic behavior that were often lacking in the past.

The aim is to sustainably improve the quality, transparency and efficiency of inpatient services in hospitals. To achieve this, it is necessary to analyze existing processes and make them more efficient where necessary. Operations research offers numerous methods for this. Their application can lead to considerable improvements. In addition to economic efficiency, however, the quality of treatment and patient satisfaction are also crucial. The following aspects are covered in the lecture: Scheduling, internal patient transport, OR scheduling, rostering and physician scheduling, layout planning, quantitative optimization, simulation, and queuing and graph theory. Finally, we will look at site planning (of hospitals, doctors' surgeries, outpatient clinics, etc.).

Additional Information
The range of courses planned for three academic years in advance can be found on the Internet at http://dol.ior.kit.edu/Lehrveranstaltungen.php.

Workload
Total workload for 5 credit points: approx. 150 hours.

Recommendations
Knowledge of Operations Research, as taught for example in the module "Introduction to Operations Research", is recommended.

13.148 Module: Optical Design Lab [M-ETIT-100464]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-100756	Optical Design Lab	6 CP	Stork

Assessment
The examination consists of an oral exam (20 min).

Prerequisites
none

Competence Goal
The students can apply previous theoretical knowledge in optics to design optical systems based on ray tracing, using a typical optics design software.

The students can apply typical analysis methods to evaluate the imaging performance of optical systems.

The students can recognize aberrations in optical systems and apply methods to compensate them.

Content
The students participating in this lab are given the opportunity to gain practical experience in the use of software tools commonly used in industry for the design of optical elements and systems. Thus improving their knowledge in optical engineering.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
Approximately 162 h workload of the student.

The workload includes:

1. attendance in lectures an exercises: 36 h
   - 9 excercises of 4 h
2. preparation / follow-up: 51 h
   - preparation 9x3 h
   - writing lab reports: 8x3 h
3. preparation of and attendance in examination: 75h

Recommendations
Basic knowledge in optics. The participation in the course Optical Engineering is strongly adviced.

13.149 Module: Optical Engineering and Machine Vision [M-ETIT-106974]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113941	Optical Engineering and Machine Vision	6 CP	Heizmann

Assessment
The examination takes place in form of a written examination lasting 90 minutes.

Prerequisites
none

Competence Goal

- Students have a sound knowledge of the fundamentals (physical basics of optics, optical imaging, image sensors) and procedures of optical engineering and machine vision.
- Students are proficient in diverse methods for optical imaging, image acquisition, pre-processing and image evaluation and can characterize them based on their prerequisites, model assumptions and results.
- Students are able to analyze and structure optical engineering and machine vision tasks, synthesize possible solutions from optics principles and image processing methods and assess their suitability.

Content
Optical engineering and machine vision are collective terms for using optical signals to solve tasks of information retrieval for technical and other application. They comprise the propagation of light in optical systems, the acquisition of image signals using optical imaging and cameras, the processing of the recorded image signals using (digital) image processing and the evaluation of the image data to obtain useful information from the recorded images.

The module teaches the basics, procedures and exemplary applications of optical engineering and image processing.

The module include in detail:

- Optical Imaging
    - Imaging with a pinhole camera, central projection
    - Imaging using a (single) lens
- Color
    - Photometry
    - Color perception and color spaces
    - Filters
- Sensors for Image Acquisition
    - CCD, CMOS sensors
    - Color sensors and color cameras
    - Quality criteria for image sensors
- Methods of Image Acquisition
    - Measuring optical properties
    - 3D shape capturing
- Image Signals
    - Mathematical model of image signals
    - Systems theory
    - Two-dimensional Fourier transform
    - Noise of digital imaging sensors (EMVA 1288)
- Preprocessing and Image Enhancement
    - Simple image enhancement methods
    - Reduction of systematic errors
    - Attenuation of random disturbances
- Segmentation
    - Region-based segmentation
    - Edge-oriented methods
- Morphological Image Processing
-
    - Binary morphology
    - Gray-scale morphology
- Texture analysis
    - Types of textures
    - Model-based texture analysis
    - Feature-based texture analysis
- Detection
    - Detection of known objects by linear filters
    - Detection of unknown objects (defects)
    - Detection of straight lines (Radon and Hough transform)

Module Grade Calculation
The module grade is the grade of the written examination.

Workload
The workload includes:

1. attendance in lectures and exercises: 15*4 h = 60 h
2. preparation / follow-up: 15*4 h = 60 h
3. preparation of and attendance in examination: 60 h

A total of 180 h = 6 CR

Recommendations
Basic knowledge of systems theory and signal processing (e.g. from the module “Signals and Systems”) as well as optics is helpful.

Teaching and Learning Methods
lecture (3 SWS) and exercise (1 SWS)

M 13.150 Module: Optical Networks and Systems [M-ETIT-103270]

Responsible: Prof. Dr.-Ing. Sebastian Randel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-106506	Optical Networks and Systems	4 CP	Randel

Assessment
Type of Examination: oral exam

Duration of Examination: 20 min (approx.)

Modality of Exam: Oral exams (approx. 20 minutes) are offered throughout the year upon individual appointment.

Prerequisites
none

Competence Goal
The module provides knowledge about optical networks and systems with applications ranging from photonic interconnects, to fiber-to-the-home (FTTH), optical metro and long-haul networks, and automotive and industrial automation. The role of various network layers will be discussed in conjunction with relevant standards and protocols. Physical-layer specifications of relevant photonic components and system design trade-offs will be introduced.

The students

- get familiar with optical network architectures and protocols
- learn how to design optical communication systems in a variety of application scenarios
- understand how application constraints (performance, cost, energy-efficiency) drive technology innovation
- comprehend the benefits and challenges of using optical communication compared to alternatives (e.g. electrical, and wireless)
- are familiar with relevant standardization bodies and are able to interpret essential aspects of standard documents.

Content
Photonic interconnects: rack-to-rack, board-to-board, chip-to-chip, datacenter interconnects, intensity modulation, direct detection, single-mode fiber vs. multi-mode fiber, serial vs. parallel optics, space-division multiplexing vs. wavelength-division multiplexing, Ethernet (10G, 40G, 100G), Fibre Channel, scaling and energy efficiency.

Access neetworks: fiber-to-the-X, passive optical networks (GPON, EPON, NG-PON2, WDM PON), statistical multiplexing vs. point-to-point

Metro- and long-haul networks:

- System-design aspects: dense WDM (ITU grid), optical amplifiers, chromatic dispersion, coherent detection, optical vs. electronic impairment mitigation, capacity limits.
- Wavelength switching: wavelength selective switch (WSS), reconfigurable optical add-drop multiplexer (ROADM).
- Standards and protocols: synchronous optical networking and synchronous digital hierarchy (SONET/SDH), optical transport network (OTN), generalized multi-protocol label switching (GMPLS), software-defined networking (SDN).

Optical networks in automotive and industrial automotion: polymer-optical fiber (POF), MOST Bus, Profibus and Profinet, optical vs. electrical communication links, overcoming bandwidth limitations using digital signal processing.

Module Grade Calculation
The module grade is the grade of the oral exam.

Additional Information
Will be changed to 6 CR in winter term 25/26.

Workload
total 120 h, hereof 30 h lecture, 15 h problems class and 75 h recapitulation and self-studies.

Recommendations
Interest in communications engineering, networking, and photonics.

Literature

Ivan Kaminow, Tingye Li, Alan E. Willner (Editors), Optical Fiber Telecommunications (Sixth Edition), Elsevier

Rajiv Ramaswami, Kumar N. Sivarajan and Galen H. Sasaki, Optical Networks (Third Edition), Elsevier

M 13.151 Module: Optical Systems in Medicine and Life Science [M-ETIT-103252]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	5

Mandatory			
T-ETIT-106462	Optical Systems in Medicine and Life Science	3 CP	Nahm

Assessment
Written exam (60 minutes)

Prerequisites
Only one out of the two modules "M-ETIT-100552 - Optische Systeme für Medizintechnik und Life Sciences" and "M-ETIT-103252 - Optical Systems in Medicine and Life Science" is allowed.

Competence Goal
Overall Course Objectives:

This course will allow the students to understand how the basic optical and optoelectronic principles are applied in the design of modern medical devices and routine diagnostic equipment. Besides extending and deepening their expert knowledge in engineering sciences and physics this course will provide profound insight into the applicative, the regulatory and safety and the cost requirements. This will help to be able to understand how the systems are designed to fulfill the requirements.

Furthermore, in this course the students will be introduced into case-based learning. The in-class journal club helps to make the students become more familiar with the advanced literature in the field of study. This interactive format helps to improve the students' skills of understanding and debating current topics of active interest.

Teaching Targets:

The successful participation in this course enables the students to

- derive and formulate system requirements
- layout the system architecture of optical devices
- explain the underlying physical and physiological principles and mechanisms
- elaborate technical and methodological constraints and limitations

present, challenge and debate recent research results

Content
Optical Systems:

- Surgical microscope
- Scanning laser ophthalmoscope (SLO) / Confocal endomicroscope (CEM)
- Optical coherence tomography (OCT) / Optical biometer
- Refractive surgical laser
- Flow-Cytometry

Applied Optical Technologies:

- Magnification and illumination
- Fluorescence and diffuse reflectance imaging
- Confocal laser microscopy
- Low coherence interferometry
- fs-Laser
- Laser scattering (Mie-Therory)

Systems Design and Engineering:

- System architecture

V-Model of Product Development Process

Module Grade Calculation
The module grade is the grade of the written exam.

Additional Information
Language English

Workload
Each credit point corresponds approximately to 30h of the student's workload. Here, the average student is expected to reach an average performance. This contains:

1. Presence during lectures (15 x 1.5 = 22.5h)
2. Preparation and wrap-up of subject matter (57.5h)

Preparation and presentation of one contribution to the in-class journal club (1 x 10h)

Recommendations
Good understanding of optics and optoelectronics.

Literature
M. Kaschke, Optical Devices in Opthalmology and Optometry, Willey-VCH

M 13.152 Module: Optical Transmitters and Receivers [M-ETIT-100436]

Responsible: Prof.Dr.Dr.h.c. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-100639	Optical Transmitters and Receivers	6 CP	Freude

Assessment
Oral examination (approx. 20 minutes). The individual dates for the oral examination are offered regularly.

Prerequisites
none

Competence Goal
The students

- understand the peculiarities of optical communications, and how optical signals are generated, transmitted and received,
- know about sampling, quantization and coding,
- learn the basics about noise on reception,
- understand the properties of a linear and a nonlinear optical fibre channel,grasp the idea of channel capacity and spectral efficiency,
- know about various forms of modulation,
- acquire knowledge of optical transmitter elements,
- understand the function of optical amplifiers,
- have a basic understanding of optical receivers,
- know the sensitivity limits of optical systems, and
- understand how these limits are measured.

Content
The course concentrates on basic optical communication concepts and connects them with the properties of physical components. The following topics are discussed:

- Advantages and limitations of optical communication systems
- Optical transmitters comprising lasers and modulators
- Optical receivers comprising direct and heterodyne reception
- Characterization of signal quality

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
Approx. 120 hours workload for the student. The amount of work is included:

30 h - Attendance times in lectures
15 h - Exercises
75 h - Preparation / revision phase

Recommendations
Knowledge of the physics of the pn-junction

Literature
Detailed textbook-style lecture notes can be downloaded from the IPQ lecture pages.
Grau, G.; Freude, W.: Optische Nachrichtentechnik, 3. Ed. Berlin: Springer-Verlag 1991. In German. Since 1997 out of print. Electronic version available via w.freude@kit.edu.
Kaminow, I. P.; Li, Tingye; Willner, A. E. (Eds.): Optical Fiber Telecommunications VI A: Components and Subsystems +VI B: Systems and Networks', 6th Ed. Elsevier (Imprint: Academic Press), Amsterdam 2013

M 13.153 Module: Optics and Vision in Biology (Sp-OVB) [M-CHEMBIO-101906]

Responsible: Prof. Dr. Martin Bastmeyer
Organisation: KIT Department of Chemistry and Biosciences
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-CHEMBIO-105198	Optics and Vision in Biology	4 CP	Bastmeyer

Assessment
Type of Examination: Written exam

Duration of Examination: 120 Minutes

Modality of Exam: The written exam is scheduled for the break after the WS. A resit exam will be offered, when needed.

Prerequisites
none

Competence Goal
The students
• understand the anatomy and optics of the vertebrate eye and its aberrations
• comprehend retinal microanatomy and its relation to retinal computation
• are familiar with the wiring of the retinofugal pathways in vertebrates
• know their roles in circadian rhythm, pupillary relex and gaze control
• concieve the details of higher visual processing in the thalamocortical pathway
• know how cortical processing achieves visual scene segmentation and feature binding
• understand the psychophysics of the perception of brightness, color, shape, depth and motion
• are acquainted with the different types of eyes in lower animals
• can distinguish microvillated and ciliated photoreceptors
• are able to analyse the function of compound eyes and the insect visual system
• can conceptualize the molecular details of phototransduction in the different types of photoreceptors
• understand the quantum bump as the signature of single-photon sensitivity
• comprehend microbial light sensing and its influence on circadian clocks, phototropism, reproduction
• know the underlying phytochromes and associated proteins
• understand how light can regulate gene expression in microorganisms
• have grasped the mechanisms of green plant photosynthesis
• conceive the structure and function of chloroplasts, antenna complexes and photosystems
• have conceptualized the underlying energy transfer cascades, electron transport chain as well as the Calvin cycle of carbon fixation
• comprehend the light path in leaves
• know the Kautsky effect involving fluorescence and photosynthesis
• understand the advantages and disadvantages of biofuels
• are familiar with the principles of optogenetics as a means to genetically engineer organisms to induce light sensitivity.

Content
Evolution has developed abundant ways of harnessing light for the benefits of life. Through plant photosynthesis, life manifestations of all higher species are powered by solar energy. Light sensing has evolved a bewildering variety of forms ranging from light control of reproduction, germination, development in microorganisms to sophisticated visual processing in higher animals. In this course, students will develop a conceptual understanding of the overwhelming importance of light in these natural biological processes. Learning from nature might enable them in the future to generate novel ideas for technological applications of light, ranging from sustainable energy conversion to computer vision.

I. The vertebrate eye and retina
II. Central visual pathways in vertebrates
III. Visual processing and perception in the human cortex
IV. Invertebrate eyes – evolution, architecture and function
V. Phototransduction
VI. Microbial phytochromes and light sensing
VII. Photosynthesis
VIII. Optogenetics

Workload
Total 120 h, hereof 40 h contact hours and 80 h homework and self-studies.

Recommendations
Passed exam of the Adjustment Course in "Basic Molecular Cell Biology" AdjC-BMCB.

Attendance to the lecture.

Teaching and Learning Methods
Lecture

Literature
ecture presentations are provided in pdf-format
Neuroscience, Purves, D. et al., Sinauer, 2011
Biology, Campbell NA and Reece JB, Prentice Hall International, 2011

M 13.154 Module: Optimal Control and Estimation [M-ETIT-102310]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-104594	Optimal Control and Estimation	3 CP	Hohmann

Prerequisites
none

M 13.155 Module: Optimization of Dynamic Systems [M-ETIT-100531]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-100685	Optimization of Dynamic Systems	5 CP	Hohmann

Assessment
The assessment consists of a written exam (120 min) taking place in the recess period.

Prerequisites
none

Competence Goal
- The students know as well the mathematical basics as the fundamental methods and algorithms to solve constraint and unconstraint nonlinear static optimization problems.

- They can solve constraint and unconstraint dynamic optimization by using the calculus of variations approach and the Dynamic Programming method.

- Also they are able to transfer dynamic optimization problem to static problems.

- The students know the mathematic relations, the pros and cons and the limits of the particular optimization methods.

- They can transfer problems from other fields of their studies in a convenient optimization problem formulation and they are able to select and implement suitable optimization algorithms for them by using common software tools.

Content
The module teaches the mathematical basics that are required to solve optimization problems. The first part of the lecture treats methods for solving static optimization problems. The second part of the lecture focuses on solving dynamic optimization problems by using the method of Euler-Lagrange and the Hamilton method as well as the dynamic programming approach.

Module Grade Calculation
The module grade is the grade of the written exam.

Additional Information
Will be changed to 6 CR in winter term 25/26.

Workload
Each credit point stands for an amount of work of 30h of the student. The amount of work includes

1. presence in lecture/exercises/tutorial(optional) (2+1 SWS: 45h1.5 LP)
2. preparation/postprocessing of lecture/exercises (90h3 LP)
3. preparation/presence in the written exam (15h0.5 LP)

M 13.156 Module: Optoelectronic Components [M-ETIT-100509]

Responsible: Prof. Dr.-Ing. Sebastian Randel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-101907	Optoelectronic Components	4 CP	Randel

Assessment
Type of Examination: oral exam

Duration of Examination: approx. 30 minutes

Modality of Exam: Oral examination, usually one examination day per month during the Summer and Winter terms. An extra questions-and-answers session will be held if students wish so.

Prerequisites
none

Competence Goal
Comprehending the physical layer of optical communication systems. Developing a basic understanding which enables a designer to read a device´s data sheet, to make most of its properties, and to avoid hitting its limitations.

The students

- understand the components of the physical layer of optical communication systems
- acquire the knowledge of operation principles and impairments of optical waveguides
- know the basics of laser diodes, luminescence diodes and semiconductor optical amplifiers
- understand pin-photodiodes
- know the systems´sesitivity limits, which are caused by optical and electrical noise

Content
The course concentrates on the most basic optical communication components. Emphasis is on physical understanding, exploiting results from electromagnetic field theory, (light waveguides), solid-state physics (laser diodes, LED, and photodiodes), and communication theory (receivers, noise). The following components are discussed:

- Light waveguides: Wave propagation, slab waveguides, strip wave-guides, integrated optical waveguides, fibre waveguides
- Light sources and amplifiers: Luminescence and laser radiation, luminescent diodes, laser diodes, stationary and dynamic behavior, semiconductor optical amplifiers
- Receivers: pin photodiodes, electronic amplifiers, noise

Module Grade Calculation
The module grade is the grade of the oral exam.

Additional Information
There are no prerequisites, but solution of the problems on the exercise sheet, which can be downloaded as homework each week, is highly recommended. Also, active participation in the problem classes and studying in learning groups are strongly advised.

Workload
total 120 h, hereof 45 h contact hours (30 h lecture, 15 h problem class), and 75 h homework and self-studies

Recommendations
Minimal background required: Calculus, differential equations, Fourier transforms and p-n junction physics.

Literature
Detailed textbook-style lecture notes as well as the presentation slides can be downloaded from the IPQ lecture pages.

Agrawal, G.P.: Lightwave technology. Hoboken: John Wiley & Sons 2004

Iizuka, K.: Elements of photonics. Vol. I, especially Vol. II. Hoboken: John Wiley & Sons 2002

Further textbooks in German (also in electronic form) can be named on request.

M 13.157 Module: Optoelectronic Measurement Engineering [M-ETIT-100484]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100771	Optoelectronic Measurement Engineering	3 CP	Trampert

Prerequisites
none

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
Based on 15 courses per semester, each with 1.5 h presence in the lecture, 2.5 h each Before and after, as well as approx. 2 hours of literature reading and self-exercises, the total workload is 90 hours

M 13.158 Module: Organ Support Systems [M-MACH-102702]

Responsible: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-MACH-105228	Organ Support Systems	4 CP	Pylatiuk

Assessment
A performance assessment is held in form of a written examination of 60 minutes.

Prerequisites
none

Competence Goal
Students have comprehensive knowledge of the functioning of support systems and their components (e.g. sensors, actuators) for different human organs (e.g. heart, kidney, liver, eye, ear, locomotor system). They know the physical basics, the technical solutions and the essential aspects of these medical technology systems and their current limitations. Furthermore, they know bioreactors and other methods of using the body's own cells to support organs (tissue engineering). Furthermore, they have comprehensive knowledge of organ transplantation and its limitations.

Content
Hemodialysis, liver dialysis, heart-lung machine, artificial hearts, biomaterials, definition and classification of organ support and organ replacement, hearing prostheses, visual prostheses, exoskeletons, neuroprostheses, endoprostheses, tissue engineering.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload

1. Attendance time Lecture: 15 * 2h = 30h
2. Pre- and postprocessing time Lecture: 15 * 3h= 45h
3. Exam preparation and attendance exam: 45h

Total: 120h = 4 LP

Recommendations
The content of module MMACH-105235 complements this lecture.

Literature

- Jürgen Werner: Kooperative und autonome Systeme der Medizintechnik: Funktionswiederherstellung und Organersatz. Oldenbourg Verlag.
- Rüdiger Kramme: Medizintechnik: Verfahren - Systeme – Informationsverarbeitung. Springer Verlag.
- E. Wintermantel, Suk-Woo Ha: Medizintechnik. Springer Verlag.

13.159 Module: Packaging and Interconnects for Power Electronic Systems [M-ETIT-102200]

Responsible: Dr. Thomas Blank
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-104518	Packaging and Interconnects for Power Electronic Systems	3 CP	Blank

Prerequisites
none

M 13.160 Module: Pattern Recognition (24675) [M-INFO-100825]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-INFO-101362	Pattern Recognition	6 CP	Beyerer, Zander

M 13.161 Module: Photometry and Radiometry [M-ETIT-100519]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100789	Photometry and Radiometry	3 CP	Trampert

Prerequisites
none

M 13.162 Module: Photonic Integrated Circuit Design and Applications [M-ETIT-105914]

Responsible: Prof. Dr.-Ing. Christian Koos
Prof. Dr.-Ing. Sebastian Randel

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-111896	Photonic Integrated Circuit Design and Applications	6 CP	

Assessment

- Part 1 – Solutions of problem sets: We will grade your solutions of the various problem sets and design projects. To this end, please upload your solution via the online teaching platform of your respective institution (see above) before the respective deadline. Please merge all pages into a single pdf file, and please use a scanner. Smartphone made snapshots are often illegible, and in this case your solutions cannot not be evaluated. In case there are any technical difficulties with the platforms, you may also submit your solutions by e-mail to picda@ipq.kit.edu before the respective deadline.
- Part 2 - Presentation of one pre-assigned problem set: At the beginning of the term, design projects will be pre-assigned to groups of participants. Each of these groups will explain their approach and results to lecturers and peer students in a short presentation (approx. 15 min), followed by approx. 10 min of public discussion with peer students and professors, and an individual private interview of each group member (approx. 10 min per person).

The overall impression is rated.

Competence Goal

The students understand the basic principles of photonic component design and can apply them to concrete design tasks of increasing complexity and independence, that they will solve in small groups and present to their peers. Doing so they will learn to translate theoretical knowledge gained during the lecture into actionable knowledge used to solve hands-on design tasks. In addition to design principles, students will learn how to satisfy key requirements for making photonic integrated circuits manufacturable and useable in a system environment, such as corner analysis of manufacturing tolerances, design for testability, design for manufacturability, and packaging. In short, we aim at teaching students the skills for hands-on design of manufacturable and application relevant photonic integrated circuits, preparing them to productively contribute to a design team. In addition, we will convey the most recent trends in the application of photonic integrated circuits and let students design a circuit addressing one of these application spaces, giving them a feeling for both the potential as well as the limitations of the technology, so that they may take informed decisions on what systems to integrate in the future.

Content
Lectures:

- Lecture 1: Introduction to silicon photonics
- Lecture 2: Silicon photonics – technology overview
- Lecture 3: Wave propagation in silicon photonic waveguides
- Lecture 4: Mode expansion and orthogonality
- Lecture 5: Coupled-mode theory
- Lecture 6: Selected passive devices
- Lecture 7: Modulators
- Lecture 8: Photodetectors
- Lecture 9: Optical amplifiers and lasers
- Lecture 10: Test and packaging
- Lecture 11: Optical communications
- Lecture 12: Optical metrology
- Lecture 13: Biophotonics and neurophotonics
- Lecture 14: Integrated quantum optics and optical computing

Design lab:

- Problem Set 1: Mode fields and mode expansion
- Problem Set 2: Coupling efficiency and coupled-mode theory
- Design Project A: Optical filter
- Design Project B: Optical transceiver
- Design Project C: Optical communication link

Module Grade Calculation
The module grade results of the assessment of the solutions of the design projects and problem sets, the presentation of one design project with discussion, and the individual oral interview.

Details will be given during the lecture.

Workload
Each credit point corresponds to approximately 30 hours of work (of the students). This is based on average students who achieve an average performance. The workload includes (e.g. 2 SWS):

1. attendance in lectures an exercises: 15*2 h = 30 h
2. preparation / follow-up: 15*2 h = 30 h
3. preparation of and attendance in examination: 120 h

A total of 180 h = 6 CR

Teaching and Learning Methods
In addition to the teaching of fundamental concepts to the extent necessary to enable students to perform practical designs, the lecture will focus from the start on a specific technology platform (silicon-on-insulator) in which the students will solve design problems of increasing complexity with the design suite Lumerical. As the final hands-on problem, students will design an entire photonic subsystem for an application of their choice, leaving free room for creative thinking and self-driven work. Since each group of students will present one of the solved designed problems to their peers, students will get exposed to solutions found for and practical problems encountered in a variety of design tasks, providing them with a wider experience base to draw on for future design.

Since the class will be taught by lecturers from several Universities, all lectures will be streamed live (with the possibility to interact and to ask questions) and made available online. Design tasks will be performed with the Design Suite Lumerical, for which introductory videos will be made available. An online forum will be provided to allow students to ask questions offline to the lecturers as well as to interact with each other, inside and across Universities.

M 13.163 Module: Photonics and Communications Lab [M-ETIT-104485]

Responsible: Prof. Dr.-Ing. Christian Koos
Prof. Dr.-Ing. Sebastian Randel

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-109173	Photonics and Communications Lab	6 CP	Koos, Randel

Prerequisites
none

M 13.164 Module: Physical Basics of Laser Technology [M-MACH-107064]

Responsible: Dr.-Ing. Johannes Schneider
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-102102	Physical Basics of Laser Technology	5 CP	Schneider

Assessment
The assessment consists of an oral exam (ca. 30 min).

Prerequisites
none

Competence Goal
The student

- can explain the principles of light generation, the conditions for light amplification as well as the basic structure and function of different laser sources.
- can describe the influence of laser, material and process parameters for the most important methods of laser-based materials processing and choose laser sources suitable for specific applications.
- can illustrate the possible applications of laser sources in measurement and medicine technology
- can explain the requirements for safe handling of laser radiation and for the design of safe laser systems.

Content
Based on the description of the physical basics about the formation and the properties of laser light the lecture goes through the different types of laser beam sources used in industry these days. The lecture focuses on the usage of lasers especially in materials engineering. Other areas like measurement technology or medical applications are also mentioned.

- physical basics of laser technology
- laser beam sources (solid state, diode, gas, liquid and other lasers)
- beam properties, guiding and shaping
- lasers in materials processing
- lasers in measurement technology
- lasers for medical applications
- savety aspects

The lecture is complemented by a tutorial.

Module Grade Calculation
see individual course

Workload
Regular attendance: 33,5 hours
Self-study: 116,5 hours

Recommendations
Basic knowledge of physics, chemistry and material science is assumed.

Teaching and Learning Methods
Lecture + Tutorial

Literature
J. Eichler, H.-J. Eichler: Lasers - Basics, Advances and Applications, 2018, Springer

W. T. Silfvast: Laser Fundamentals, 2008, Cambridge University Press

W. M. Steen: Laser Material Processing, 2010, Springer

R. Poprawe, et al.: Tailored Light 1 - High Power Lasers for Production, 2018, Springer

R. Poprawe, et al.: Tailored Light 2 - Laser Applications, 2024, Springer

M 13.165 Module: Physics, Technology and Applications of Thin Films [M-ETIT-105608]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-111237	Physics, Technology and Applications of Thin Films	4 CP	Kempf

Assessment
Oral examination of approximately 20 minutes

Prerequisites
The modul "M-ETIT-102332 - Thin films: technology, physics and applications" and "Thin Films: Technology, Physics and Applications I" may neither be started nor completed.

Competence Goal
Students should be able to discuss interplay between growth conditions of thin films, physical and geometrical properties of nanostructure made of these films, and performance and suitable areas of application of detectors of radiation based on interaction of these nanostructures with electromagnetic power. The knowledge obtained by students should provide a theoretical basis for the most important steps in development of thin film nanoelectronic devices.

Content
Students will get practically oriented information about technology of thin films including different methods of deposition of thin films like magnetron sputtering, thermal evaporation, pulsed laser ablation, about basics of vacuum technology, and about mechanisms of growth of thin films of different materials at different conditions.

Patterning methods (photo- and e-beam lithography, reactive ion etching, ion milling, and lift-off techniques) suitable for nanometer scale features of electronic devices will be considered in details.

Experimental methods of characterization of material, geometrical, optical, physical, superconducting, electron and phonon properties of thin films, nanostructures made of these films, and devices based on these nanostructures will be discussed.

Consideration of technology and physics of thin film structures will be done on example of development of three types of fast and sensitive detectors of electro-magnetic radiation for applications in optical and THz spectral ranges: superconducting nanowire single-photon detector, hot-electron bolometer, and YBCO ps-fast detector of synchrotron emission. Dependence of detector’s performance on their fabrication condition will be analyzed in frame of physical models which describe response mechanisms of the detectors to absorbed radiation.

Practical actualization of the knowledge is possible in frame of Praktikum Nanoelektronik (LVN 23669).

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
A workload of approx. 90 h is required for the successful completion of the module. This is composed as follows

1. attendance time in lecture/exercise 18 h
2. pre-/postprocessing of the lecture 24 h
3. preparation/attendance oral exam 48 h

13.166 Module: Plasma Sources [M-ETIT-100481]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100768	Plasma Sources	4 CP	Heering, Kling

Prerequisites
none

M 13.167 Module: Plastic Electronics / Polymerelectronics [M-ETIT-100475]

Responsible: Prof. Dr. Gerardo Hernandez Sosa
Prof. Dr. Ulrich Lemmer

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-ETIT-100763	Plastic Electronics / Polymerelectronics	3 CP	Lemmer

Assessment
Type of Examination: oral exam (approx. 20 minutes)

Prerequisites
none

Competence Goal
The students

- understand the electronic and optical characteristics of organic semiconductors
- know the fundamental differences between organic and conventional inorganic semiconductors.
- have basic knowledge of manufacturing and processing technologies,
- have knowledge of organic light-emitting diodes, organic solar cells and photodiodes, organic field-effect transistors and organic lasers.
- have an overview of the possible applications, markets and development lines for these components.
- are able to work in multidisciplinary teams with engineers, chemists and physicists

Content

1. Introduction
2. Optoelectronic properties of organic semiconductors
3. Organic light emitting diodes (OLEDs
4. Applications in Lighting and Displays
5. Organic FETs
6. Organic photodetectors and solar cells
7. Lasers and integrated optics

Module Grade Calculation
The module grade is the grade of the oral exam.

Additional Information
Lecture and excersises are held as required in German or English.

Workload
1. lecture: 21 h
2. recapitulation and self-studie: 42 h
3. preparation of examniation: 27 h

Recommendations
Knowledge of semiconductor components

Literature
The corresponding documents are available online in the VAB (https://studium.kit.edu/)

13.168 Module: Polymers in MEMS B: Physics, Microstructuring and Applications (MIT-Export) [M-MACH-107035]

Responsible: Dr.-Ing. Matthias Worgull
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Election Notes
Part of the lecture series Polymers in MEMS. Focus of part B: physical properties of polymers, polymer characterization and polymer processing can be taken independently of the other modules

Mandatory			
T-MACH-102191	Polymers in MEMS B: Physics, Microstructuring and Applications	4 CP	Worgull

Assessment
Oral examination (approx. 30min)

Prerequisites
none

Competence Goal
After attending the lecture the students will be able:

- to understand the properties of polymers as a consequence of their morphology.
- to describe the most important structuring techniques and technologies for polymers in MEMS.
- to understand the mathematical basis of the most important physical models for polymers.
- to correctly judge polymer properties and the applicability of the polymers for their industrial processability.
- to understand the basics of process simulation in polymer structuring.
- to state the most important technical thermoplasts in MEMS and to understand their properties.
- to correctly classify the various types of polymers, blends, composite materials.

Content
This lecture will introduce the basics of physics and material science required for the understanding of the mechanical behavior seen from the engineers view. Micro and nanostructuring of polymers allows the fabrication of micro parts fulfilling their tasks in mostly invisible different applications. But also the fabrication of polymer parts with functional surfaces inspired from Bionics will be presented in this lesson. The lesson will give further an overview over the polymer based structuring processes and will underline the importance by a number of applications e.g. photonic structures or Lotus-like structures.

Module Grade Calculation
The module grade corresponds to the grade of the examination.

Additional Information
The language will depend on the participants present. If interested, an optional laboratory tour on polymer processing can also be offered.

Workload
120 hours

Recommendations
Basics of chemistry and microsystem technology (MST) are beneficial but not requirend

Teaching and Learning Methods
The screen presentations are available for download in English and German after registration

Literature
Bibliography available on request in the lecture

Base For
M-MACH-107034 – Practical Course Polymers in MEMS

13.169 Module: Polymers in MEMS C: Biopolymers and Bioplastics [M-MACH-107085]

Responsible: Dr.-Ing. Matthias Worgull
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German/English	4	1

Election Notes
Recommendation: Basic knowledge of polymers

Mandatory			
T-MACH-102200	Polymers in MEMS C: Biopolymers and Bioplastics	4 CP	Worgull

Assessment
Oral exam: approx. 30min

Prerequisites
none

Competence Goal
Students are given an overview of so-called bioplastics - their resources, production, degradability and applications.

The aim of the lecture is to provide expertise in the field of so-called bioplastics, the use of raw materials, the specific sustainability and the substitution potential compared to conventional plastics. To this end, the individual plastics are presented in detail, from synthesis and processing to application. A further focus is on natural biopolymers from DNA, which can also be used as building blocks. A consideration of bioplastics also includes an analysis of the environmental impact of plastics and the contribution of bioplastics to this scenario.

Content
This lecture describes the most important categories of these so-called biopolymers. A distinction is made between polymers that produce chemically analogous raw materials by natural means (e.g. by fermentation), how these starting materials are chemically processed and polymerized and how the polymers obtained from them are technologically processed. Numerous examples from microtechnology as well as from everyday life are highlighted.

Some of the questions addressed are:

- How can bioplastics influence the environmental balance of plastics
- Are bioplastics sustainable?
- What does biodegradable mean?
- What are biopolyurethanes and how can they be made from castor oil?
- What exactly are “natural adhesives” and how do they differ from chemical adhesives?
- How are car tires made from natural rubber?
- What are the two most important polymers for life on earth?
- Can you make polymers from potatoes?
- Can wood be injection molded?
- How do you make buttons from milk?
- Can you listen to music with biopolymers?
- Where and how can biopolymers be used for tissue engineering, for example?
  How do LEGO bricks made from DNA work?

Module Grade Calculation
corresponds to the examination grade

Additional Information
The lecture is intended to demonstrate the potential and limitations of bioplastics. However, this requires an understanding of organic chemistry and the structure of polymers. The basic knowledge is taught in Polymers in MEMS A or B

Workload
120h

Recommendations
Attendance of the lectures “Polymers in MEMS A” or “Polymers in MEMS B”, but not a prerequisite

Teaching and Learning Methods
The presentations are made available to the students via download. Exhibits will be shown where possible.

The lecture will be held in German or English, depending on the participants. The presentation is held in English.

Literature
Links to literature are given in the lessons

M 13.170 Module: Power Electronics [M-ETIT-104567]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	6

Mandatory			
T-ETIT-109360	Power Electronics	6 CP	Hiller

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

Prerequisites
None

Competence Goal
Students will be familiar with state-of-the-art power semiconductors including their application related features. Furthermore students will be familiar with the circuit topologies for DC/DC and DC/AC power conversion. They know the associated modulation and control methods and characteristics. They are able to analyze the circuit topologies with regard to harmonics and power losses. This also includes the thermal design of power electronic circuits. In addition, they are able to select and combine suitable circuits for given electrical energy conversion requirements.

Content
In the lecture, power electronic circuits for DC/DC and DC/AC power conversion using IGBTs and MOSFETs are presented and analyzed. First, the basic properties of self-commutated circuits under idealized
conditions are elaborated using the DC/DC converter as an example. Then, self-commutated power converters for three-phase applications are presented and analyzed with respect to modulation and their AC
and DC terminal behavior. Based on the real power semiconductor behavior in on- and off-state the device losses are calculated. Furthermore the thermal design of power converters is explained using thermal equivalent circuits of power devices and cooling equipment. The voltage and current stress on the power
semiconductors in switching operation is explained as well as protective snubber circuits allowing a reliable operation within the safe operating area of the devices.

In detail, the following topics are treated:

- Power Semiconductors
- Commutation principles
- DC/DC converters
- Self-commutated 1ph and 3ph DC/AC inverters
- Modulation methods (Fundamental frequency modulation, Pulse width modulation with 3rd harmonic injection, Space vector modulation)
- Multilevel inverters
- Switching behavior in hard and soft switching applications
- Loss calculation
- Thermal equivalent circuits, thermal design
- Snubber circuits.

The lecturer reserves the right to adapt the contents of the lecture to current needs without prior notice.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
14x lecture and 14x exercise à 2 h = 56 h
14x wrap-up of the lecture à 1 h = 14 h
14x preparation of the exercise à 2 h = 28 h
Preparation for the exam = 75 h
Examination time = 2 h
Total = approx. 175 h (corresponds to 6 LP)

M 13.171 Module: Practical Aspects of Electrical Drives [M-ETIT-100394]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-ETIT-100711	Practical Aspects of Electrical Drives	4 CP	Doppelbauer

Assessment
Success is assessed in a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal
Students understand the function of all components of modern electrical drive systems. They have detailed knowledge of the basic electrical machine types and know the function and physical behavior of loads and other drive components. Students will be able to design electrical drive systems for an application-specific use, taking into account all boundary conditions, and calculate their mechanical and electrical behavior.

Content
The lecture is divided into the following areas

- Drive systems
- electric motors
- Transmission elements
- Drive and load
- Starting, braking, positioning
- Thermal and protection
- Variable speed drives
- Electromagnetic compatibility
- Small drives
- Noise
- Drives with limited movement

Module Grade Calculation
The module grade is the grade of the written examination.

Additional Information
Shift from SoSe to WiSe, does not take place in WiSe24/25 and SoSe25.

Workload
14x lecture + 7x exercises of 1.5 h each = 31.5 h

14x post-processing of lectures à 1 h = 14 h

6x preparation of exercises à 2 h = 12 h

Preparation for the exam = 50 h

Total = 107.5 h (corresponds to 4 CP)

Recommendations
To understand the module, basic knowledge in the field of electrical machines is recommended (acquired, for example, by attending the modules "Electrical Machines and Power Electronics"

M 13.172 Module: Practical Course: Biologically Inspired Robots (IN2INTIBP) [M-INFO-105495]

Responsible: Prof. Dr.-Ing. Rüdiger Dillmann
Organisation: KIT Department of Informatics
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-INFO-111039	Practical Course: Biologically Inspired Robots	6 CP	Rönnau

M 13.173 Module: Practical Course: Human-Centred Robotics [M-INFO-106646]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-INFO-113393	Practical Course: Human-Centred Robotics	6 CP	Mombaur

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn to understand and scrutinize complex scientific topics and to reproduce and verify published results. They gain in-depth knowledge and practical experience in the field of motion generation and control of human-centered robots while working on a specific project task. They also learn how to plan, work together and communicate in a team. Students will be able to present their project results in a scientific presentation, demonstrate the practical results and answer detailed questions. They can also summarize their project results in writing using Latex in the style of a scientific paper and place them in a scientific context.

Content
Human-centered robots are robots that directly interact with humans or support humans in their motions. This includes humanoid robots, but also wearable robots (exoskeletons and prostheses) or external physical assistive devices. In this practical course, students learn how to implement theoretical knowledge about human-centered robots and use it to solve a given task based on a individual project with robot hardware. Projects can either focus on code development for a given hardware or on the development or modification of robot hardware along with the basic code. Students learn about the challenges of working with real robot hardware vs model computations, and about working principles and practical implementation of sensors and actuators.

Additional Information
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week.

Workload
Estimated effort for this module is 180 hours:
20h – In person events (kickoff meeting, individual meetings with supervisor, presentations)
130h – Individual project work
30h - Writing report and preparing presentation

Recommendations
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) are very helpful.

M 13.174 Module: Practical Course: Machine Learning and Intelligent Systems [M-INFO-105958]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each term	1 term	German	4	1

Mandatory			
T-INFO-112104	Practical Course: Machine Learning and Intelligent Systems	8 CP	Fennel, Hanebeck

M 13.175 Module: Practical Course: Movement and Technology [M-INFO-106648]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-113394	Practical Course: Movement and Technology	6 CP	Mombaur

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn to analyze and understand complex scientific topics in the area of human motion capture and motion analysis. They gain in-depth knowledge and practical experience with motion capture technology, experiment planning, and analysis. They also learn how to plan, work together and communicate in an interdisciplinary team. Students will be able to present their project results in a scientific presentation, demonstrate the practical results and answer detailed questions. They can also summarize their project results in writing using Latex and place them in a scientific context.

Content
In this joint course between Informatics and Sports Science, and in the sense of research-oriented teaching, students learn about current research projects of the BioRobotics Lab (Informatics) and the BioMotion Center (Sports Science) at the interface of motor control and biomechanics of human movement. This research involves the use of latest motion capture technology, advanced analysis tools, and partly also assistive robotics technology. Students work in in teams (interdisciplinary teams between students from different study programs are highly encouraged) to carry out motion capture experiments, analyze the data and present the results in written and oral form. Depending on the specific project, these motion capture studies are either stand-alone studies just for this course or part of a larger research project at one of the organizing research groups.

Additional Information
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week.

Workload
Estimated effort for this module is 180 hours:
20h – In person events (kickoff meeting, individual meetings with supervisor, presentations)
120h – Individual project work
40h - Writing report and preparing presentation

Recommendations
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) are very helpful.

Programming skills.

M 13.176 Module: Practical Machine Learning [M-ETIT-106673]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-113426	Practical Machine Learning	6 CP	Heizmann

Assessment
Success is assessed by the submission of the scientific essay and the presentation of the team project lasting approx. 30 minutes.

Prerequisites
none

Competence Goal

- After completing the module, students have in-depth knowledge in the field of machine learning.
- They have in-depth knowledge and an overview of various algorithms and methods in the field of machine learning.
- Students are able to describe different concepts and methods of machine learning and recognize connections between different algorithms.
- They are able to communicate with specialists in related disciplines in the field of machine learning and artificial intelligence and to formulate and evaluate solution approaches for tasks in this area.
- Students will gain practical experience in the field of machine learning through the semester-long team project. In particular, students will benefit from mutual feedback on their theoretical work at the end of the semester.

Content
Remarkable progress has been made in the field of artificial intelligence (AI) in recent years. Machine learning (ML) is a sub-discipline of AI that attempts to develop techniques that enable computers to learn from data. The goal of ML methods is to reliably abstract the underlying model for specific tasks.
This lecture covers the theoretical foundations as well as the basic concepts and techniques of machine learning, with a focus on problem solving and practical application. The course offers the opportunity to explore various ML algorithms and their applications in different areas, including computer vision, natural language processing and data mining.
During the course, you will have the opportunity to work on various application tasks and a group project in which you will apply the concepts you have learned to real-world data sets. You will learn how to use common libraries and tools for ML such as Scikit-Learn, TensorFlow and Keras and apply them to real-world datasets. You will also learn how to evaluate the performance of your models and interpret their results.
The lecture style will be a mix of theory and practical applications, with an emphasis on problem solving and hands-on experimentation. The theoretical part of the lecture will be offered as a block course at the beginning of the semester (early/mid April). Students then have the opportunity to work on a problem from the field of
ML alone or in small groups during the semester and present their results in the form of a scientific essay.
The quality assurance of the essay is carried out through a mutual peer review process in which students benefit from mutual feedback both from a technical point of view and with regard to the presentation of content.
The module covers the fundamentals and concepts of machine learning. Topics covered include the following:

- Introduction to machine learning and its applications.
- Data pre-processing and feature engineering techniques.
- Supervised and unsupervised learning algorithms.
- Deep learning techniques such as Convolutional Neural Networks and Recurrent Neural Networks.
- Transfer learning and Tiny ML.
- Probabilistic ML.
- Evaluation metrics for ML models.
- Hyperparameter tuning and model selection techniques.
- Interpreting the results of ML models.
- ... other interesting topics.

Module Grade Calculation
The module grade results from the team project accompanying the semester and the presentation of the team project. The overall impression is assessed. Further details will be provided at the beginning of the course.

Workload

- Attendance of the lectures: approx. 21 hours
- Preparation and follow-up of the lecture: approx. 42 hours
- Team project during the semester: approx. 60 hours
- Peer review of the scientific essays
  and presentation of the team project: approx. 47 hours

Total: approx. 170 hours (6 CP)

Recommendations
Basic knowledge of mathematics and linear algebra (matrices, vectors, etc.)
as well as basic knowledge of Python.

Teaching and Learning Methods
Block lecture (2 SWS) and practical part (by arrangement within the framework of 2 SWS)

M 13.177 Module: Practical Seminar: Health Care Management (with Case Studies) [M-WIWI-106852]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each term	1 term	German	4	1

Mandatory			
T-WIWI-102716	Practical Seminar: Health Care Management (with Case Studies)	5 CP	Nickel

Assessment
The assessment of this module is an examination of another type and consists of the following components:

- a case study to be worked on,
- a seminar paper and
- a final oral examination.

Competence Goal
The practical seminar, which deals with Operations Research (OR) methods in healthcare, has the following learning objectives:

1. **Application of OR methods**: Students will learn how to use mathematical optimization, queueing theory, and simulation to improve logistical processes in hospitals and physician practices. They will use software such as CPLEX Optimization Studio or AnyLogic.
2. **Analyzing and interpreting results**: Students will collect data, analyze existing processes and create OR models. They interpret the results and derive recommendations for action.
3. **Communication and presentation**: Students prepare their results in writing and present them both at the department and at the practice partner.

Content
In the practical seminar, students work in groups of 2 to 4 on questions from our partners in the healthcare sector using operations research (OR) methods. In most cases, practice partners are hospitals, doctors' surgeries or emergency services from the local area. Typical questions from our partners concern the improvement of (logistical) processes and the associated planning of patients and resources. The exact definition of the issue to be addressed is often part of the practical seminar. First, the existing processes must be analyzed and the relevant data collected and evaluated. This information then serves as input for OR models. Mathematical optimization, queuing theory and/or simulation are often used here, using the appropriate software such as CPLEX Optimization Studio or AnyLogic. Finally, the students have to process and interpret the results and derive possible recommendations for action. The results are to be summarized in a written paper and presented at the chair and at the practice partner.

Module Grade Calculation
The overall grade results from the weighted evaluation of the case study, the seminar paper and the presentation. The exact weighting of these individual components for the grade will be announced at the beginning of the course.

Workload
Total workload for 5 credit points: approx. 150 hours.

Recommendations
Interested students should have programming skills (e.g. OPL, Python, Java, C++, AnyLogic) or be prepared to acquire them in order to work on the case studies. Please note that there are a number of dates, all of which are mandatory for passing the seminar. You must also be flexible in terms of time during the semester in order to be able to attend appointments with the practice partner on site, as these are often limited in terms of time. In addition, you must be present in Karlsruhe for the entire time in order to be able to attend important appointments with the practice partner, some of which are at short notice.

M 13.178 Module: Practical Tools for Control Engineers [M-ETIT-106780]

Responsible: Dr.-Ing. Balint Varga
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113628	Practical Tools for Control Engineers	4 CP	Varga

Assessment
The examination takes place in form of other types of examination. It consists of an oral overall examination in the amount of 25 minutes and a homework programming task. The examination includes questions from the lecture slides and the presentation of the homework assignment. The homework must be submitted two weeks before of the oral exam. The overall impression is evaluated.

Prerequisites
none

Competence Goal
1. The students will be able to analyze, structure and formally describe problems in the field of practical control engineering.
2. The students are able to use the necessary tools for software projects with control engineering focus.
3. The students can apply the methods

- Modular software development for control engineering problems
- Model Predictive Controller for practical engineering problems
- Inevitable software engineering tools to able to develop control system

Content

- Practical examples from the control engineering problems and modelling tool
  - Robotics examples
  - Human-machine interaction
  - Automotive
- Control solution concepts for these practical problems
- Software development tool

Module Grade Calculation
The module grade results of the assessment of the oral exam and of the homework programming task. Details will be given during the lecture.

Workload
The workload includes 2 SWS:

1. attendance in lectures and exercises: 15*2 h = 30 h
2. preparation / follow-up: 15*2,5 h = 37,5 h
3. preparation of the homework assignment: 22,5 h
4. preparation of and attendance in examination: 30 h

Sum: 120 h = 4 CR

Recommendations
The contents of the modules “Optimization of Dynamic Systems (ODS)” and “Regelung linearer Mehrgrößensysteme (RLM)” are helpful for the lecture.

M 13.179 Module: Practical Training in Basics of Microsystem Technology [M-MACH-105479]

Responsible: Dr. Arndt Last
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German	4	1

Mandatory			
T-MACH-102164	Practical Training in Basics of Microsystem Technology	4 CP	Last

Assessment
Written exam, 60 min.

Prerequisites
None

Competence Goal
Insight into the real, practical work at the Institute of Microstructure Technology.

Content
In the practical training includes nine experiments:
1. Hot embossing of plastics micro structures
2. Micro electroforming
3. X-ray optics
4. UV-lithography
5. Fluidic polymer components by example of a microfluidic mixer
6. Additive prototyping of microstructures
7. Introduction to SAW biosensors
8. Light diffraction at photomasks
9. Atomic force microscopy
10. Centrifugal microfluidics

Each student takes part in only five experiments.
The experiments are carried out at real workstations at the IMT and coached by IMT-staff.

Additional Information
The internship takes place in the laboratories of the IMT at the CN. Meeting place: Building 307, room 322.

Participation requests to Mrs. Novotny, marie.nowotny@kit.edu

Workload
regular attendance: 20 hours
self-study: 100 hours, Preparation of the five experiments

Recommendations
Attend at least one of the lectures Micro System Technology I or II.

Read the practical course documents provided as pdf-file!

Teaching and Learning Methods
Lab, Self-study of the internship documents and guided experiments during the course.

Literature
Madou, M. (2003). *Fundamentals of Microfabrication*. CRC. ISBN 978-0849308260.
Practical course documents provided as pdf-file.

13.180 Module: Principles of Medicine for Engineers [M-MACH-102720]

Responsible: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105235	Principles of Medicine for Engineers	4 CP	Pylatiuk

Assessment
A performance assessment is held in form of a written examination of 45 minutes.

Prerequisites
none

Competence Goal
Students have a comprehensive understanding of the functioning and anatomical construction of organs, which are assigned to different medical disciplines. Furthermore, they know the physical basics, the technical solutions and the essential aspects of the application of medical technology procedures in diagnostics and therapy. They are familiar with common clinical pictures in the different medical disciplines and their relevance in health care. Through their acquired knowledge, students can communicate with physicians about medical-technical procedures and assess mutual expectations more realistically.

Content
Definition of disease and health and history of medicine, evidence-based medicine" and personalized medicine, nervous system, conduction, musculoskeletal system, cardiovascular system, anesthesia, respiratory system, sensory organs, gynecology, digestive organs, surgery, nephrology, orthopedics, immune system, genetics.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload

1. Attendance time Lecture: 15 * 2h = 30h
2. Pre- and postprocessing time Lecture: 15 * 3h= 45h
3. Exam preparation and attendance exam: 45h

Total: 120h = 4 LP

Recommendations
The content of module MMACH-105228 complements this lecture.

Literature

- Adolf Faller, Michael Schünke: Der Körper des Menschen. Thieme Verlag.
- Renate Huch, Klaus D. Jürgens: Mensch Körper Krankheit. Elsevier Verlag.

M 13.181 Module: Process Analysis: Modeling, Data Mining, Machine Learning [M-ETIT-105594]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-111214	Process Analysis: Modeling, Data Mining, Machine Learning	3 CP	Borchert, Heizmann

Prerequisites
none

Module Grade Calculation
Die Modulnote ist die Note der mündlichen Prüfung.

M 13.182 Module: Product Development – Methods of Product Engineering [M-MACH-102718]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German/English	4	3

Mandatory			
T-MACH-109192	Methods and Processes of PGE - Product Generation Engineering	6 CP	Albers, Burkardt

Assessment
See course ("(Teilleistung")

Prerequisites
None

Competence Goal
The students are able to ...

- classify product development in companies and differentiate between different types of product development.
- name the relevant influencing factors of a market for product development.
- name, compare and use the central methods and process models of product development within moderate complex technical systems.
- explain problem solving techniques and associated development methods.
- explain product profiles and to differentiate and choose suitable creative techniques of solution/idea generation finding on this basis.
- use design guidelines to create simple technical systems and to explain these guidelines.
- name and compare quality assurance methods; to choose and use suitable methods for particular applications.
- explain the differents methods of design of experiment.
- explain the costs in development process.

Content
Basics of Product Development: Basic Terms, Classification of the Product
Development into the industrial environment, generation of costs / responsibility for costs
Concept Development: List of demands / Abstraction of the Problem Definition / Creativity Techniques / Evaluation and selection of solutions
Drafting : Prevailing basic rules of Design / Design Principles as a
problem oriented accessory
Rationalization within the Product Development: Basics of Development
Management/ Simultaneous Engineering and Integrated Product Development/Development of Product
Lines and Modular Construction Systems
Quality Assurance in early Development Phases : Methods of Quality Assurance
in an overview/QFD/FMEA

Workload
1. Time of presence lecture: 15 * 3h= 45 h

2. Prepare/follow-up lecture: 15 * 4,5 h = 67,5 h

3. Time of presence exercise: 4 * 1,5h = 6 h

4. Prepare/follow-up exercise: 4 * 3 h = 12 h

5. Exam preparation and time of presence: 49,5 h
Total: 180 h = 6 LP

Teaching and Learning Methods
Lecture

Tutorial

Literature
Lecture documents
Pahl, Beitz: Konstruktionslehre, Springer-Verlag 1997
Hering, Triemel, Blank: Qualitätssicherung für Ingenieure; VDI-Verlag, 1993

13.183 Module: Product Lifecycle Management [M-MACH-106195]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-105147	Product Lifecycle Management	4 CP	Ovtcharova

Assessment
Written examination 90 min.

Prerequisites
None

Competence Goal
After successful attendance of the course, students can:

- identify the challenges of data management and exchange and describe solution concepts for these challenges.
- clarify the management concept PLM and its goals and highlight the economic benefits.
- explain the processes required to support the product life cycle and describe the most important business software systems (PDM, ERP, ...) and their functions.

Content

- Basics for product data management and data exchange
- IT system solutions for Product Lifecycle Management (PLM)
- Economic viability analysis and implementation problems
- Illustrative scenario for PLM using the example of the institute's own I4.0Lab

Module Grade Calculation
The module grade is the grade of the written exam

Workload
Attendance time in lectures and exercises: 15*3 h = 45 h

Preparation and follow-up of the same: 15*2 h = 30 h

Exam preparation and presence in the same: 45 h

Total: 120 h = 4 LP

Teaching and Learning Methods
Lectures and exercises

M 13.184 Module: Project Management in the Development of Products for Safety-Critical Applications [M-ETIT-104475]

Responsible: Dr.-Ing. Manfred Nolle
Prof. Dr.-Ing. Eric Sax

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-ETIT-109148	Project Management in the Development of Products for Safety-Critical Applications	4 CP	Nolle

M 13.185 Module: Properties [M-MACH-103713]

Responsible: Dr. Patric Gruber
Prof. Dr. Christoph Kirchlechner

Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German/English	4	3

Election Notes
The module can be passed either in English or in German. The selection is set by the combined allocation of the corresponding courses in English or in German including all associated assessments. The courses in English and in German are mutually exclusive. The preparatory courses (“exercises“) are compulsory and are a prerequisite for the superordinate course in the same teaching language.

Compulsory Elective Subjects (Election: 2 items as well as 6 credits)			
T-MACH-107683	Exercises for Microstructure-Property-Relationships	2 CP	Gruber, Kirchlechner
T-MACH-107604	Microstructure-Property-Relationships	4 CP	Gruber, Kirchlechner
T-MACH-110930	Exercises for Microstructure-Property-Relationships	2 CP	Gruber, Kirchlechner
T-MACH-110931	Microstructure-Property-Relationships	4 CP	Gruber, Kirchlechner

Assessment
The assessment consists of a certificate and an oral exam (about 30 minutes).

Prerequisites
None

Competence Goal
The students fundamentally understand the interrelation between the microstructure and the properties of a material. This interrelation will be elaborated for mechanical properties (elasticity, plasticity, fracture, fatigue, creep) as well as functional properties (conductivity, magnetic properties) for all material classes, respectively. The students are able to phenomenological describe the material properties, to explain the underlying physical mechanisms and to understand how the properties can be specifically modified by the microstructure of the material. In the other way they are able to deduce the mechanical and functional properties of a material on the basis of its microstructure

Content
The following microstructure-property-relationships will be discussed for all material classes:

- Elasticity and plasticity
- Fracture mechanics
- Fatigue
- Creep
- Electrical conductivity: Metallic conductors, semiconductors, superconductors, conductive polymers
- Magnetic properties und materials

In addition to the phenomenological description and physical explanation of the material properties an overview on the corresponding experimental techniques will be given.

Workload
The workload for the module “Properties” is 180 h per semester and consists of the presence during the lectures (33 h) and tutorials (12 h) as well as self-study for the lecture (87 h) and for the tutorials (48 h).

Teaching and Learning Methods
Lectures (Obligatory)
Tutorials (Obligatory)

M 13.186 Module: Quality Management [M-MACH-105332]

Responsible: Prof. Dr.-Ing. Gisela Lanza
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-102107	Quality Management	4 CP	Lanza

Assessment
Written Exam (60 min)

Prerequisites
None

Competence Goal
The students …

- are capable to comment on the content covered by the module.
- are capable of substantially quality philosophies.
- are able to apply the QM tools and methods they have learned about in the module to new problems from the context of the module.
- are able to analyze and evaluate the suitability of the methods, procedures and techniques they have learned about in the module for a specific problem.

Content
Based on the quality philosophies Total Quality Management (TQM) and Six-Sigma, the module will specifically address the needs of a modern quality management. The process orientation in a modern company and the process-specific fields of quality assurance are presented in detail. Preventive as well as non-preventive quality management methods, which are state of the art in operational practice today, are content of the module. The use of suitable measurement techniques in production engineering (production measurement technology) as well as their potential levels of integration in the production system are discussed. The use of suitable statistical methods for data analysis and their modern extension by methods of artificial intelligence are be discussed. The contents are complemented by legal aspects in the field of quality management.

Main topics of the module:

- The term "Quality"
- Total Quality Management (TQM)
- Six-Sigma and universal methods and tools within the DMAIC cycle
- QM in early product stages – Determination and realization of customer requirements
- QM in product development
- Production measurement Technology
- QM in production - statistical Methods
- Artificial intelligence and machine learning in quality Management
- Operating behaviour and reliability
- Legal aspects in QM

Workload
1. Presence time lecture: 15 * 2 h = 30 h
2. Pre- and post-processing time lecture: 15 * 3 h = 45 h
3. Exam preparation and presence in the same: 45 h
In total: 120 h = 4 LP

Teaching and Learning Methods
Lecture

M 13.187 Module: Quantum Detectors and Sensors [M-ETIT-105606]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-111234	Quantum Detectors and Sensors	6 CP	Kempf

Assessment
The assessment of success takes place in the form of a written examination lasting 120min. The grade corresponds to the result of the written examination.

Prerequisites
None

Competence Goal
Students know the basics and fundamentals of quantum detectors and sensors and understand how quantum technology can be used to design and realize devices those performance reaches far beyond the limits of any classical sensor or detector. They know the basic components of quantum sensors and detectors, in particular in the field of superconducting quantum technology, and are able to analyze the operation of such detectors and sensors on the basis of circuit diagrams. Students are able to develop quantum sensors and detectors for given applications and know how to consider special requirements in a concrete component.

Content
This module provides a comprehensive overview of the basics and physical principles of quantum detectors and sensors and discusses in detail how quantum technology can be used to design and realize detectors and sensors with performance that reaches far beyond the limits of any classical sensor or detector. The discussion includes particularly an introduction to the basic components of quantum sensors and detectors, especially in the field of superconducting quantum technology, and their fabrication. Using simplified circuit diagrams, the functionality and operation of quantum detectors and sensors such as superconducting quantum interference devices, low-temperature detectors, noise thermometers or superconducting radiation detectors is analyzed. Furthermore, methods and simple models are developed allowing to realize quantum sensors and detectors that are matched to given applications. Within this context, typical applications of quantum detectors and sensors are also discussed.

The tutorial is closely related to the lecture and deals with special aspects concerning the development of quantum detectors and sensors. In particular, the development and system integration of quantum detectors and sensors for applications in precision metrology, particle detection or applied sciences is discussed by means of exercises.

Module Grade Calculation
The module grade is the grade of the written examination.

Workload
A workload of approx. 180h is required for the successful completion of the module. This is composed as follows:

- Attendance time in lectures and exercises: 21*1.5h + 7*1.5h = 42h
- Preparation and follow-up of lectures: 21*3h= 63h
- Preparation and follow-up of tutorials: 7*5h= 35h
- Preparation for the exam: 40h

Recommendations
Successful completion of the module "Superconductivity for Engineers" is recommended.

M 13.188 Module: Quantum Engineering [M-ETIT-106954]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113909	Quantum Engineering	6 CP	Kempf

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal
The students will be able to analyze, structure and formally describe problems in the field of quantum engineering. They will particularly be able to understand the difference between classical and quantum engineering. They will be able to analyze, design and implement concepts, technology, circuits and algorithms in the fields of quantum computing, quantum communication and quantum sensing. Moreover, the students will be able to critically evaluate existing concepts, methods, technologies, and circuits regarding complexity, suitability and applicability.

Content
This module introduces the emerging field of quantum engineering. For this, the module (1) addresses physics basics and the related mathematical framework, (2) discusses recent realizations of engineered quantum systems for the sub-fields of quantum computing, quantum communication and quantum sensing, (3) introduces hardware designs and practical realizations, (4) summarizes quantum information processing aspects, and (5) discusses real implementations and applications.

The module particularly addresses:

1. Basics of quantum mechanics and the mathematical frameworks (state vector, postulates of quantum mechanics, bra-ket-formalism, superposition, entanglement and Bell inequalities, probability density matrix formalism, pure and mixed states, squeezing)
2. Description of light and photons
3. Decoherence and coherence of quantum systems, quantum errors
4. Basics of quantum computers: quantum gates, gate-based quantum computing architecture
5. Quantum algorithms: quantum random number generator, quantum penny flip, Deutsch-Josza-Algorithm, Grover algorithm, quantum Fourier transform, Shor algorithm, quantum phase estimation, HHL algorithm
6. Quantum error correction: Concepts and architectures
7. Hardware realization of quantum bits: DiVincenzo criteria, Cooper pair box, phase qubit, flux qubit, transmon, quantum dots etc.
8. Examples of recent quantum computing architectures
9. Quantum sensing: Atomic clocks, NV centers, SQUIDs, parametric amplifiers, quantum imaging, interaction free quantum measurements, interferometry at the quantum limit, quantum logic spectroscopy,
10. Quantum communication: Quantum cryptography, quantum key distribution, quantum teleportation, entanglement swapping, quantum repeater and quantum networks

As the lecture intends to include recent advancements of the field of quantum engineering, the actual content might slightly differ from the announced topics.

The exercises are closely related to the lecture and deal with special aspects concerning quantum engineering. Moreover, it deepens the student's knowledge by discussing various examples.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
The workload includes:

1. Attendance in lectures: 15 * 3 h = 45 h
2. Attendance in exercices: 15 * 1 h = 15 h
3. Preparation and follow up of lectures and exercises: 90 h
4. Preparation of and attendance in examination: 30 h

A total of 180 h.

Recommendations
Basic knowledge of quantum mechanics and the related mathematical framework, as taught, for example, within the module “M-ETIT-106264 – Introduction to Quantum Information Processing” is strongly recommended.

Teaching and Learning Methods
“Lecture Quantum Engineering” (3 SWS) and “Exercises to Quantum Engineering” (1 SWS)

13.189 Module: Quantum Machine Learning [M-ETIT-105889]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-111838	Quantum Machine Learning	3 CP	Heizmann

Prerequisites
none

Competence Goal

- After completing the module, students will have a sound knowledge of quantum machine learning.
- They have in-depth knowledge and an overview of various algorithms and methods in the field of quantum machine learning.
- Students are able to describe different concepts and methods of Quantum Machine Learning and recognize connections between different algorithms.
- They are able to communicate with specialists in related disciplines in the field of machine learning and artificial intelligence and to formulate and evaluate solution approaches for tasks in this area.

Content
Remarkable progress has been made in the field of artificial intelligence (AI) in recent years. Machine learning (ML) is a sub-discipline of AI that attempts to develop techniques that enable computers to learn from data. The aim of ML methods is to reliably abstract the underlying model for specific tasks. Quantum computing describes information processing with devices based on the laws of quantum theory. Based on the success of ML and quantum computing to date, it can be expected that both technologies will play a huge role in digital data processing in the future. It is therefore exciting to find out how these two techniques can be combined to provide better and more reliable solutions for different tasks.
Quantum Machine Learning (QML) is an interdisciplinary field of research that encompasses physics, mathematics, computer science and electrical engineering. It is dedicated to the use of quantum computers to calculate machine learning algorithms. QML methods help to improve classical ML methods by utilizing the advantages of quantum computing. The use of QML not only enables previous tasks to be solved more quickly, but also allows more aspects of the natural world to be integrated into existing AI methods.
The module covers the fundamentals and concepts of quantum machine learning.

Topics covered include the following.

- Basic concepts of quantum mechanics

- From bits to qubits

- Quantum computers and quantum circuits

- Quantum information theory

- Quantum signal processing

- Repetition of classical machine learning

- Quantum algorithms

- Quantum classification and regression

- Quantum deep learning

- ... other interesting topics.

M 13.190 Module: Radar Systems Engineering [M-ETIT-100420]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-100729	Radar Systems Engineering	6 CP	Zwick

Assessment
Success control is carried out as part of a written overall examination (120 minutes) of the selected course, which in total meets the minimum requirement for LP.

Prerequisites
none

Competence Goal
Students can name the basic radar principles and explain how they work, their primary uses and their advantages and disadvantages. They are able to characterize the basic characteristics and mechanisms of propagation of electromagnetic waves and to apply the relevant equations. You can evaluate the influence of various system parameters on accuracy, resolution, false alarm rate, etc. and optimize systems. You can describe different radar system configurations (CW, FMCW, pulse, SAR) and apply the relevant radar signal processing methods. They are especially able to use and use the technologies and system configurations for the radars of the future for surveillance, automotive and industrial applications for research and development. In this lecture system technology is specifically taught.

Content
Based on electromagnetic field theory, the lecture teaches the basics of radar principles and their system technology. An insight into the system hardware is given and processing techniques are presented. All relevant, known radar systems (CW, FMCW, pulse and synthetic aperture radar) are described in detail. The system technology for the radars of the future is specifically dealt with. The reflective properties of radar targets are analyzed for their classification. In particular, polarimetry is taught. In this lecture, students learn how system technology contributes to the implementation of a radar system.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
Each credit point corresponds to approximately 25-30 hours of work (of the student). This is based on the average student who achieves an average performance. The workload includes:

Attendance study time lecture: 44 h

Attendance time computer exercise: 16 h

Self-study time including exam preparation: 120 h

A total of 180 h = 6 LP

13.191 Module: Radio Frequency Integrated Circuits and Systems [M-ETIT-105123]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-110358	Radio Frequency Integrated Circuits and Systems	6 CP	Ulusoy

Assessment
The success criteria will be determined by an oral examination (approx. 20-30 min.)

Competence Goal

- The students acquire a comprehensive understanding in the design of monolithic integrated circuits for millimeter-wave frequencies, and they can apply the acquired knowledge using modern design tools.
- They have a good understanding of the critical performance parameters of high-frequency circuits such as stability, power gain and efficiency and reflection coefficient.
- They can describe the benefits and disadvantages of modern transistor technologies for millimeter-wave applications.T
- They can identify potential applications of integrated millimeter-wave circuits and understand the specific requirements of each application.
- They are familiar with basic elements of a high-frequency system, which consists of linear and non-linear circuits, low-noise and power amplifiers, as well as oscillators, switches and frequency converting circuits such as frequency multipliers and mixers.

Content
In this lecture the theory and the design methodology of monolithic integrated millimeter-wave circuits will be
studied in detail. The focus of the lecture is on the active linear and non-linear circuits in high-frequency frontends up to an application frequency of 300 GHz. In addition to this, fundamental topics such as impedance matching, stability, performance parameters of high-frequency transistors, and properties of active and passive circuit elements will be studied in detail. The operation principal of critical building blocks of a millimeter-wave system will be introduced including low-noise and power amplifiers, mixers, oscillators and switches. In the workshop, the students will have the chance to apply the acquired theoretical knowledge to design a millimeter-wave frontend using state-of-the art integrated circuit technology.

Module Grade Calculation
The module grade is the grade of the oral examination.

Workload
1. Attendance to the lectures (15*(2)=30h)
2. Attendance to the exercises (15*(2)=30h)
3. Preparation to the lectures and exercises (15*(2+2)=60h)
4. Preparation to the oral exam (40h)

Total: 160h

Recommendations
The lecture materials to „Grundlagen der Hochfrequenztechnik“ and „Halbleiterbauelemente“ are recommended.

M 13.192 Module: Radio Receivers [M-ETIT-103241]

Responsible: Prof. Dr. Friedrich Jondral
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-106431	Radio Receivers	3 CP	Jondral

Prerequisites
none

M 13.193 Module: Radio-Frequency Electronics [M-ETIT-106955]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113910	Radio-Frequency Electronics	6 CP	Ulusoy

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal

- The students have a comprehensive understanding of the theory and the basic design methodology of RF and microwave circuits up to 300 GHz.
- They understand the limitations of active and passive circuit elements at high frequencies and their impact on the applications.
- They understand the limitations and how linear network theory is applied at higher frequencies.
- The students can apply the acquired theoretical knowledge to modern RF design problems.

Content
In this lecture, the theory and design methodology of RF electronic circuits will be studied in detail. The focus of the lecture is on the fundamentals of active and passive linear circuits. The important topics are:

- Phasor analysis and resonance,
- Electromagnetic theory, transmission lines and waveguides,
- Impedance matching networks,
- Two-port parameters of RF components and microwave network analysis,
- Feedback and stability analysis,
- High-frequency behavior of basic amplifier circuits, RF amplifiers design techniques,
- Microwave power dividers, couplers and filters

Module Grade Calculation
The module grade is the grade of the written examination.

Workload
The total effort for this lecture is estimated as following:

1. Attendance to the lectures (15*(3)=45h)
2. Attendance to the exercises (15*(1)=15h)
3. Preparation to the lectures and exercises (17*(3+1)=68h)
4. Preparation to the exam (52h)

A total of 180h

Recommendations
Basic knowledge of linear electrical networks and electronic circuits is recommended (e.g. M-ETIT-106417 – Lineare Elektrische Netze; M-ETIT-104465 – Elektronische Schaltungen).

M 13.194 Module: Regulatory Affairs and Quality Management in Medical Device Product Development [M-ETIT-106920]

Responsible: Dipl.-Ing. Uwe Philippeit
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113872	Regulatory Affairs and Quality Management in Medical Device Product Development	3 CP	Philippeit

Assessment
Success control takes place in the form of other types of examination. The examination consists of:

1. Creation of an excerpted product file intended for the approval of a medical device in groups of 3-5 students. Participants can also suggest products themselves.
2. Presentation of the results after the end of the lecture period.
3. Written exam

The overall impression is rated.

Prerequisites
none

Competence Goal

- Name, compare and use global and European requirements for the documentation of the medical device product development process (MDR, FDA QSR, MDSAP)
- Apply the design process and prepare the relevant milestones (“design controls”)
- Name, compare and use the requirements of the European Medical Device Regulation (MDR) with regards to the medical device development process
- Explain the EU-CE declaration of conformity process
- Understand, create and use the technical documentation as per EU Medical Device Regulation
- Explain and use the requirements for the clinical evaluation and instruction for use (IFU) within the product development process
- Explain and use the fundaments of risk management
- Explain the required vigilance processes
- Manage the product design process incl. the interface to service providers (clinical trials, IFU, validation, etc.)

Content

- Global standards and requirements: IMDRF, MDSAP, FDA, MDR, German legislation
- Requirements of the EU Medical Device Regulation (MDR): basic requirements, traceability, UDI, product registration, notified bodies, clinical evaluation / trials, vigilance, EU-CE-certification process
- Technical documentation for the CE-approval process: product specification, IFU, process specification, product safety and performance, risk management, product validation
- Processes to support the product conformity: product and process development process, employee training, cleanliness, line clearance, rework, packaging, process validation, device master file / record
- Management processes to support product conformity: Leadership, Regulatory Affairs, Supplier Management, Non-conformity management, agile processes

Module Grade Calculation
The module grade results of the assessment of the project work and the written exam. Details will be given during the lecture.

Workload

1. Time of presence lecture: 15 * 2 h = 30 h
2. Prepare/follow-up lecture: 15 * 1,5 h = 22,5 h
3. Creation product file, prepare and give the presentation: 37,5 h

Total: 90 h = 3 CR

Literature

- Lecture documents
- MDSAP Audit Standard (IMDRF)
- EU-regulation 2017/745 -Medical Device Regulation (MDR)
- FDA Quality System (QS) Regulation/Medical Device Current Good Manufacturing Practices (CGMP)

M 13.195 Module: Reinforcement Learning [M-INFO-105623]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Prof. Dr. Gerhard Neumann

Organisation: KIT Department of Informatics

Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-INFO-111255	Reinforcement Learning	6 CP	Lioutikov, Neumann

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- Students are able to understand the RL problem and challenges.
- Students can differentiate between different RL algorithm and understand their underlying theory
- Students will know the mathematical tools necessary to understand RL algorithms
- Students can implement RL algorithms for various tasks
- Students understand current research questions in RL

Content
Reinforcement Learning (RL) is a sub-field of machine learning in which an artificial agent has to interact with its environment and learn how to improve its behaviour by trial and error. For doing so, the agent is provided with an evaluative feedback signal, called reward, that he perceives for each action performed in its environment. RL is one of the hardest machine learning problems, as, in contrast to standard supervised learning, we do not know the targets (i.e. the optimal actions) for our inputs (i.e. the state of the environment) and we also need to consider the long-term effects of the agent's actions on the state of the environment. Due to recent successes, RL has gained a lot of popularity with applications in robotics, automation, health care, trading and finance, natural language processing, autonomous driving and computer games. This lecture will introduce the concepts and theory of RL and review current state of the art methods with a particular focus on RL applications in robotics. An exemplary list of topics is given below:

• Primer in Machine Learning and Deep Learning
• Supervised Learning of Behaviour
• Introduction in Reinforcement Learning
• Dynamic Programming
• Value Based Methods
• Policy Optimization and Trust Regions
• Episodic Reinforcement Learning and Skill Learning
• Bayesian Optimization
• Variational Inference, Max-Entropy RL and Versatility
• Model-based Reinforcement Learning
• Offline Reinforcement Learning
• Inverse Reinforcement Learning
• Hierarchical Reinforcement Learning
• Exploration and Artificial Curiosity
• Meta Reinforcement Learning

Workload
Approximately 180 hours, divided into:
• 45 hours of lecture attendance
• 15 hours of exercise attendance
• 90 hours of post-processing and working on exercise sheets
• 30 hours of exam preparation.

Recommendations

• Students should be familiar with the content of the "Foundations of Artificial Intelligence" lecture.
• Good Python knowledge is required.
• Good mathematical background knowledge is required.

13.196 Module: Reliability and Test Engineering [M-MACH-106050]

Responsible: Dr.-Ing. Thomas Gwosch
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-111840	Reliability and Test Engineering	5 CP	Gwosch

Assessment
The grade is composed of the evaluation of a final report following the practical part. The assessment criteria are as follows:

- Structure of the report
- Comprehensibility and comprehensibility
- Preparation of the tests
- Use of test and reliability methods
- Formulation and answering of test hypotheses
- Test evaluation, comprehensible results

Attendance and active participation in the lab is mandatory.

Prerequisites
keine

Competence Goal
The students:

- know the relevance of reliability and test engineering in engineering practice.
- know the methods of reliability and test engineering and the components and tools used.
- are able to carry out test planning, test execution and test interpretation for a given problem on a test bench by themselves.

Content
The students learn the methods of reliability and test engineering and the components used. Furthermore, they are able to independently carry out test planning, test execution and test interpretation for a given problem on a test bench.

The following contents are taught in the lecture:

- Relevance of reliability and test engineering in the industry.
- Overview of test equipment
- Test strategies and statistical test planning
- Testing with hypotheses
- Reliability models

The implementation of test planning, test execution and test interpretation on a demonstrator test bench is part of the practical session subsequent to the lecture (See also Event 2145351: Workshop for Reliability and Test Engineering).

Module Grade Calculation
The module grade is the grade of the examination performance of another type.

Additional Information
In case of questions pleas contact lrt@ipek.kit.edu

The number of participants is limited, an application is necessary. For details please check the lab's web page https://www.ipek.kit.edu/2976.php

Workload
150 h

Recommendations
We strongly recommend the attendance of the MSuP lectures. Students who have not (yet) attended are recommended to learn the contents in advance.

Teaching and Learning Methods
Materials/lecture notes are supplied via ILIAS.

Literature
O'Connor: Test Engineering

O'Connor: Practical Reliability Engineering

Birolini: Reliability Engineering

Bertsche: Zuverlässigkeit mechatronischer Systeme

VDI 4002: Zuverlässigkeitsingenieur

M 13.197 Module: Rheology of Polymers [M-CIWVT-104329]

Responsible: Prof. Dr. Norbert Willenbacher
Organisation: KIT Department of Chemical and Process Engineering
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-108884	Rheology of Polymers	4 CP	Willenbacher

Assessment
The examination is an oral examination with a duration of about 30 minutes (section 4 subsection 2 number 2 SPO).

The duration of the examination differs in the case of a specialized subject comprehensive examination and is approximately 15 minutes.

Prerequisites
None

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 30 h
- Homework: 70 h
- Exam Preparation: 20 h

M 13.198 Module: Robotics II - Humanoid Robotics [M-INFO-107123]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114152	Robotics II - Humanoid Robotics	3 CP	Asfour

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students have an overview of current research topics in autonomous learning robot systems using the example of humanoid robotics. They are able to classify and evaluate current developments in the field of cognitive humanoid robotics.

The students know the essential problems of humanoid robotics and are able to develop solutions on the basis of existing research.

Content
The lecture presents current work in the field of humanoid robotics that deals with the implementation of complex sensorimotor and cognitive abilities. In the individual topics different methods and algorithms, their advantages and disadvantages, as well as the current state of research are discussed.

The topics addressed are: Applications and real world examples of humanoid robots; biomechanical models of the human body, biologically inspired and data-driven methods of grasping, imitation learning and programming by demonstration; semantic representations of sensorimotor experience as well as cognitive software architectures of humanoid robots.

Workload
Lecture with 2 SWS, 3 CP.
3 LP corresponds to approx. 90 hours, thereof:
approx. 15 * 2h = 30 Std. Attendance time
approx. 15 * 2h = 30 Std. Self-study prior/after the lecture
approx. 30 Std. Preparation for the exam and exam itself

Recommendations
Having visited the lectures on Robotics I - Introduction to Robotics and Mechano-Informatics and Robotics is recommended.

M 13.199 Module: Scientific Group Project in Medical Ultrasound Imaging [M-ETIT-106775]

Responsible: Dr. Nicole Ruiter
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113613	Scientific Group Project in Medical Ultrasound Imaging	3 CP	Ruiter

Assessment
The examination takes place in form of an ungraded intermediate presentation and a graded final presentation and report.

Prerequisites
none

Competence Goal

- The students will be able to analyze, structure and formally describe problems in the field of small scientific projects for ultrasound imaging and tomography
- The students will be able to communicate in English technical language.
- The students are able to perform calculations and use the necessary tools for this in a methodologically appropriate way.
- The students are able to critically evaluate them.

Content
Scientists at KIT have developed the world's first 3D Ultrasound Tomography device. In this course small research projects are offered in this innovative field of research and neighboring fields. The projects will be carried out within a semester by a group of students (2 to 3 students). Students can select from a set of open topics. Projects will be assigned at the beginning of the course.

The research projects may cover one of several aspects of an ultrasound imaging system like image reconstruction, ultrasound simulation, imaging evaluation, (automated) image analysis and processing, system design considerations, etc.

Examples for projects: designing, building, characterizing, and evaluating an imaging phantom for speed of sound mode imaging. Testing and evaluating a new generation of GPUs for a specific ultrasound simulation task. Implementation and evaluation of methods and/or adaptions to the reconstruction process of ultrasound images.

Two introductory lectures will be held, and ongoing supervision will be provided.

An intermediate presentation and a final presentation of the student groups will be held. A short report (max. 5 pages) must be provided by the students at the end.

Module Grade Calculation
The module grade results of the assessment of the final presentation and the report. Details will be given during the lecture.

Workload

1. Attendance in lectures and presentations: 4*2 h = 8 h
2. Work on scientific project: 15*4 h = 60 h
3. Preparation of and attendance in presentations and final report:22 h

A total of 90 h = 3 CR

13.200 Module: Seminar Advanced Concepts for Flexible and Soft Optoelectronic Devices and Sensors [M-ETIT-106674]

Responsible: Prof. Dr. Gerardo Hernandez Sosa
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113427	Seminar Advanced Concepts for Flexible and Soft Optoelectronic Devices and Sensors	3 CP	Hernandez Sosa

Assessment
The examination consists of a written journal article and an oral presentation of the student's work, both given in English. The overall impression is rated.

Prerequisites
none

Competence Goal
At the end of the seminar, students will be able to independently familiarize themselves with new research topics, independently search and select relevant scientific literature and summarize the topic in the form of a concise journal-style article as well as an oral presentation. Through the critical evaluation and exposure to current scientific literature, the students will develop a deeper knowledge in the future directions in the research field of flexible and soft electronics. Furthermore, they will develop skills in scientific writing and communication in English language, which are key competences for their future academic and professional career.

Content
The seminar on "Seminar Advanced Concepts for Flexible and Soft Optoelectronic Devices and Sensors" is for students curious in the latest research developments on devices, materials and the physics of novel optoelectronic devices. Discussed topics include but are not limited to: solution processable and printed electronics, flexible and stretchable electronics, wereable sensors, soft robotics, printed optics, biodegradable & sustainable electronics, 3D electronics, etc.

The seminar addresses master students from electrical engineering, physics, mechanical engineering, material science, KSOP and related MSc programs. During the seminar, the students will get the opportunity to familiarize themselves with state-of-the-art research from a selection of topics under the guidance of a mentor and discuss the topic during a presentation in the seminar. The students must attend the seminar regularly, independently present the research topic in a 30-min scientific talk and submit a short scientific review paper (3-5 pages) based on the scientific literature the presentation was based on.

Prof. Dr. Gerardo Hernandez Sosa and Prof. Dr. Jasmin Aghassi-Hagmann will select the topics and guide the discussion.

Module Grade Calculation
The module grade results of the assessment of the written paper and the oral presentation. Details will be given during the lecture.

Additional Information
Attendance of at least 80% is compulsory during the seminar course. Compulsory attendance is necessary for actively contributing to the discussion of the topics presented by all students.

Workload
The workload includes (2 SWS):

- active participation in the preparation sessions and seminar lectures: 22,5 h
- preparation of the seminar presentation: 36 h
- preparation of the written journal article: 31,5 h

Total: 90 h = 3 LP

Recommendations
Basic knowledge in the field of conventional and/or organic (opto) electronic devices and sensors is helpful.

M 13.201 Module: Seminar Electrocatalysis [M-ETIT-105629]

Responsible: Prof. Dr.-Ing. Ulrike Krewer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each term	1 term	German	4	1

Mandatory			
T-ETIT-111256	Seminar Electrocatalysis	3 CP	Krewer

Prerequisites
none

M 13.202 Module: Seminar Embedded Systems [M-ETIT-100455]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Prof. Dr.-Ing. Eric Sax
Prof. Dr. Wilhelm Stork

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German	4	3

Mandatory			
T-ETIT-100753	Seminar Embedded Systems	4 CP	Becker, Sax, Stork

Assessment
Success is assessed in the form of a written paper, reviews and a presentation. The overall impression is assessed.

Prerequisites
none

Competence Goal
Seminar participants can independently familiarize themselves with a given technical topic, identify all relevant aspects and summarize the results. In this context, students can identify relevant literature in terms of the research question, assess the strengths and weaknesses of existing approaches and methods, and formally evaluate other works according to specified criteria. They can also suggest new aspects in line with the research question. They can present the results of their work concisely in the form of a short text (approx. 6-page paper, usually written in English) and an approx. 15-minute presentation in words and pictures (slides).

Content
In the "Embedded Systems" seminar, students work on a given topic from the field of information processing through literature and internet research under the guidance of research assistants and then present it to the other seminar participants in a short text (approx. 6-page paper, usually written in English) and a 15-minute presentation in words and pictures (slides). The students give each other feedback as part of a peer review and thus experience a part of the scientific publication process.

Module Grade Calculation
The grading is based on the elaboration, the mutual review and the presentation.

Workload
The workload includes:

1. Independent familiarization with a topic: 50h
2. Writing a scientific article: 40h
3. Preparing a peer review: 10h
4. Preparing and giving a presentation: 20h

Total: 120h = 4 LP

M 13.203 Module: Seminar New Components and Systems of Power Electronics [M-ETIT-100396]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German	4	2

Mandatory			
T-ETIT-100713	Seminar New Components and Systems of Power Electronics	4 CP	Hiller

Prerequisites
none

M 13.204 Module: Seminar on Applied Superconductivity [M-ETIT-105615]

Responsible: Prof. Dr. Tabea Arndt
Prof. Dr. Bernhard Holzapfel
Prof. Dr. Sebastian Kempf
Prof. Dr.-Ing. Mathias Noe

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-111243	Seminar on Applied Superconductivity	3 CP	Arndt, Holzapfel, Kempf, Noe

Assessment
Elaboration of a scientific topic and presentation of a talk on the topic within the seminar of about 30min.

Competence Goal
Students are to familiarize themselves with an unknown scientific topic in the field of applied superconductivity. They independently prepare a presentation on the topic they have chosen and are able to present it to the general audience. In this role, the students will learn to clearly and didactyly communicate scientific topics and to lead a scientific discussion. As audience members, students are also enabled to recognize strengths and weaknesses of a presentation and to give constructive feedback to the person giving the presentation.

Content
In the seminar, students choose a current topic from the fields of

- Superconducting materials
- Superconducting magnet technology
- Superconducting power supply systems
- Superconducting detectors and sensors
- Superconducting Quantum Bits and Quantum Computing

and present this topic in a lecture to the other seminar participants.

Module Grade Calculation
The module grade corresponds to the grade of the oral examination.

Workload
For the successful completion of the module, a workload of approx. 90h is required. This is composed as follows:

1.) Attendance time in the seminar: 12*1.5h = 18h

2.) Preparation and follow-up of the seminar: 12*3h = 36h

3.) Preparation and execution of the presentation with handouts: 36h

Recommendations
None

M 13.205 Module: Seminar Selected Topics in Communication [M-ETIT-100441]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German	4	1

Mandatory			
T-ETIT-100962	Seminar Selected Topics in Communications	4 CP	Jäkel

Prerequisites
none

M 13.206 Module: Seminar Sensors [M-ETIT-100380]

Responsible: Dr. Wolfgang Menesklou
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each term	1 term	German	4	1

Mandatory			
T-ETIT-100707	Seminar Sensors	3 CP	Menesklou

13.207 Module: Seminar: Assistive robotics and exoskeletons in medical applications [M-INFO-106400]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-INFO-112922	Seminar: Assistive robotics and exoskeletons in medical applications	3 CP	Mombaur

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal

- The students know the state of the art of exoskeletons and assistive robots and current medical applications.
- Students are able to independently research, understand, critically evaluate and summarize scientific literature on a given topic (usually in English).
- Students will be able to prepare and deliver a scientific presentation, taking into account the level of knowledge of the other seminar participants, and to answer detailed questions on the topic
- Students will be able to ask questions about scientific presentations of other students and make active contributions to scientific discussions
- Students will be able to use Latex to create a scientific text (in English) incorporating the sources they have read.

Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and successfully apply these guidelines in the preparation of their scientific work.

Content
This module provides an overview of the current state of the art and practical use of assitive robots and exoskeletons in medicine, as well as the potential of these technologies to improve patient care and the quality of life of people with and without physical impairments. Medical assistive robots are designed to perform a variety of healthcare tasks, such as assisting with surgeries or nursing care, reminding patients to take their medications, and monitoring patients' vital signs. Exoskeletons are designed to improve mobility and will be worn by people directly on their bodies to assist or completely replace their muscle strength. Some types of exoskeletons help people with mobility impairments to walk, stand and perform other physical activities to regain independence and participate in activities of daily living. Other types of exoskeletons are used by healthy people to prevent injuries in difficult working conditions. Mobility assistance robots for geriatric patients also exist in the form of robotic rollators designed to help their users to stand, walk, and navigate their surroundings in a safe and stable manner. Seminar topics cover the spectrum of different robot types and applications. Students can give their presentations in English or German as they prefer.

Additional Information
Max 10 Participants

Workload
Estimated effort for this module is 90 hours:
20h – In person events (kickoff meeting, indiidual preparatory meetings, seminar block)
20h – Literature rechearch
20h – Preparation of presentation
30h - Paper writing

Recommendations
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) is helpful

13.208 Module: Seminar: Digital Accessibility and Assistive Technologies [M-INFO-105884]

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-INFO-111832	Seminar: Digital Accessibility and Assistive Technologies	3 CP	Stiefelhagen

Content
Digital accessibility is a topic that affects us all. Accessing information digitally, from childhood to old age. Assistive technologies, such as smartphones, tablets, smartwatches, wearables in general have become a part of our everyday life. Exactly these things should be operable and usable by all people. Regardless of any barriers.

But what are the details behind this? What are the rights and foundations for this? What all has to be done to be "barrier-free"?

This can all be best illustrated by the example of "visual impairment".

According to the World Health Organization, there are approximately 285 million people with visual impairments worldwide, including approximately 39 million people who are blind. The partial or complete loss of vision significantly restricts blind and visually impaired people in their working and social lives. It is difficult for blind and visually impaired people to orient themselves and move around in public spaces without assistance. The reasons for this are problems in perceiving obstacles and landmarks as well as the resulting fear of accidents and orientation difficulties. Other problems in everyday life are: reading texts, recognizing banknotes, food, clothes or finding objects in the household.

For support, blind and visually impaired people can already rely on a number of technical aids. For example, digitized texts can be made accessible through speech output or Braille output devices. There are also various devices made specifically for the blind. The most important aid for improving mobility is by far the cane for the blind. In recent years, some electronic aids for obstacle detection or orientation support have also been developed, but these offer only very limited functionality at a relatively high price and are therefore rather rarely in use.

The seminar is intended to provide insight into topics of IT-based assistive technologies (AT) and, on the other hand, to prepare participants for writing conference articles on the topic. The selection of topics may span a wider range. Such as:

- Legal principles
- Existing assistive technology tools for different application areas
- AT for information access
- New steps of accessible software development
- New basics and techniques for accessible web design (websites and web applications)
- Accessible documents today and tomorrow
- Use of machine vision methods
- Feedback systems and their basics
- Insights into current research topics around the topic of digital accessibility

For the latest information, visit http://cvhci.anthropomatik.kit.edu/

13.209 Module: Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society [M-INFO-106651]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-113398	Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society	3 CP	Bruno

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students gain experience with literature research on a current research topic. They explore, understand and compare different approaches to a selected scientific problem. The students are able to write a summary of their literature research in the form of a scientific publication in English and give a scientific talk on it.

Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and successfully apply these guidelines in the preparation of their scientific work.

Content
The students choose a topic from the field of robotics (e.g. remote control, behavior-based robotics, human-robot interaction, the “uncanny valley,” natural language understanding, machine learning) and conduct a research on it that, building on literature findings, also includes and addresses the perspectives of society and the general media (as given by science fiction books, movies and games, as well as media and news outlets) and technology assessment (including social/societal expectations and needs, ethical implications, and risks/benefits analyses).
Students work under the guidance of a scientific supervisor. At the end of the semester, they present the results and write an elaboration in English in the form of a scientific publication.

Workload
Seminar with 2 SWS, 3 LP.
3 LP corresponds to approx. 90 hours, of which
approx. 45 hours of literature research
approx. 25 hrs. elaboration
approx. 10 hrs. preparation of presentation
approx. 10 hrs. compulsory attendance

Recommendations
Knowledge of the content of modules Robotics I - Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics is helpful.

M 13.210 Module: Seminar: Human-Robot Interaction [M-INFO-106498]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-INFO-113116	Seminar: Human-Robot Interaction	3 CP	Bruno

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students gain experience with literature research on a current research topic. They explore, understand and compare different approaches to a selected scientific problem. The students are able to write a summary of their literature research in the form of a scientific publication in English and give a scientific talk on it.

Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and successfully apply these guidelines in the preparation of their scientific work.

Content
The students choose a topic from the field of human-robot interaction, e.g. attention modelling, socially-aware navigation, social gestures generation or metrics for HRI experiments. They conduct a literature research on this topic under the guidance of a scientific supervisor. At the end of the semester, they present the results and write an elaboration in English in the form of a scientific publication.

Workload
Seminar with 2 SWS, 3 LP.
3 LP corresponds to approx. 90 hours, of which
approx. 45 hours of literature research
approx. 25 hrs. elaboration
approx. 10 hrs. preparation of presentation
approx. 10 hrs. compulsory attendance

Recommendations
Knowledge of the content of modules Robotics I - Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics is helpful.

13.211 Module: Sensors [M-ETIT-100378]

Responsible: Dr. Wolfgang Menesklou
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-101911	Sensors	3 CP	Menesklou

M 13.212 Module: Signal Processing in Communications [M-ETIT-100443]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	3

Mandatory			
T-ETIT-100747	Signal Processing in Communications	6 CP	Jäkel

Assessment
Success control takes place in the form of a written examination lasting 120 min.

Prerequisites
none

Competence Goal
The students are able to analyze and assess algorithms of signal processing used in communication systems and to consider aspects of implementation. They can use mathematical methods in the context of signal processing in communication systems for autonomously deriving and elaborating theoretical results, and check their viability by simulations.

Content
Topics already covered in the Bachelor system theory modules are deduced thoroughly and mathematical derivation and reasoning is provided.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload

1. Attendance to the lecture: 20 * 1,5 h = 30 h
2. Preparation and review: 20 * 3 h = 60 h
3. Attendance to the tutorial: 6 * 1,5 h = 9 h
4. Preparation and review: 6 * 3,5 h = 21 h
5. Preparation for the exam: 60 h

In total: 180 h = 6 LP

Recommendations
Basics knowledge of communication systems, as, e.g., provided in KIT's Bachelor courses, is supposed, Furthermore, working knowledge in the areas system theory and probability theory is assumed.

M 13.213 Module: Signal Processing Lab [M-ETIT-106633]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Laboratory/Practical Course)
Profiling Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113369	Signal Processing Lab	6 CP	Wahls

Assessment
Success is assessed in the form of a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal
After this module, students will have a sound basic knowledge of the main methods of signal processing as well as their areas of application, key parameters and the effects of parameter changes on the behavior of the methods. Students will be able to analyze given signal processing tasks in group work, develop solutions and document their results.

Content
The Digital Signal Processing practical course currently comprises eight experiments designed to familiarize students with the fundamentals of signal processing, in particular some selected measurement methods such as correlation measurement technology and modal analysis as well as Kalman filtering and the fundamentals of image processing. The focus of the experiments to be completed with various programs and devices is to teach students the practical aspects of modern signal processing.

Note: The lecturer reserves the right to include experiments other than those listed here in this practical course without prior notice.

Module Grade Calculation
The module grade is the grade of the written examination.

Additional Information
A prerequisite for admission to the examination is the submission of protocols of all experiments. The quality of the protocols will be assessed; they must be acceptable for admission to the examination.

Attendance is compulsory during all practical sessions, including the introductory session. Admission to the examination will not be granted for even one unexcused absence.

Workload
The workload results from attending the introductory event (1.5 h), 8 experimental sessions of 4 h each. In addition, the preparation of the experiments is estimated at 8x4 h and the writing of the protocols as well as the follow-up work at 8x4 h. Preparing for the exam and attending it takes about 60 hours. This results in a total workload of approx. 160 hours.

Recommendations
Knowledge of the contents of the modules "Signals and Systems", "Measurement Technology" and "Methods of Signal Processing" is strongly recommended.

M 13.214 Module: Signal Processing Methods [M-ETIT-106899]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113837	Signal Processing Methods	6 CP	Wahls

Assessment
Written exam, approx. 120 minutes.

Prerequisites
none

Competence Goal
Students can

- choose appropriate estimation methods based on theoretical properties and practical considerations
- determine estimators for specific problems
- can weight the pros and cons of data decomposition methods; apply them to given problems; interpret the results
- understand the advantages and limitations of the considered time-frequency analysis methods
- interpret time-frequency representations
- choose appropriate analysis and synthesis windows/wavelets
- determine time-frequency transforms of given signals

Content
This module introduces students to advanced signal processing methods that are widely employed in engineering. The three main topic areas are

1. Parameter estimation
2. Decomposition of data into components and modes
3. Time-frequency analysis

The following topics are treated:

· Best linear unbiased estimator
· Maximum likelihood estimation
· General Bayesian estimators
· Linear Bayesian estimators
· Principal component analysis
· Independent component analysis
· Dynamic and empirical mode decomposition
· Hilbert spaces and frames
· Short-time Fourier transform
· Wavelets
· Analytic signals
· Wigner-Ville-Distribution
· Huang-Hilbert transform

Illustrating examples from diverse application areas are discussed.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
The workload includes:

1. attendance in lectures and tutorials: 15*4 h = 60 h
2. preparation / follow-up: 15*4 h = 60 h
3. preparation of and attendance in examination: 60 h

A total of 180 h = 6 CR

Recommendations
Familiarity with signals and systems (in particular, Fourier transforms) and probability theory at the Bachelor level is assumed.

M 13.215 Module: Signal Processing with Nonlinear Fourier Transforms and Koopman Operators [M-ETIT-106675]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113428	Signal Processing with Nonlinear Fourier Transforms and Koopman Operators	6 CP	Wahls

Assessment
The examination in this module consists of programming assessments and a graded written examination of 120 minutes.

The programming assignments are either pass or fail. They must be passed during the lecture period for admission to the written examination.

Prerequisites
none

Competence Goal
Students

- understand the basic theory of linear operator on Hilbert spaces and can analyze simple operators analytically
- know the use cases for selected integrable partial differential equations (PDEs) and can apply them under non-ideal circumstances (small non-integrable terms)
- can determine the PDE corresponding to a given Lax-pair and check if the PDE is actually integrable (i.e. check if the Lax pair is “fake”)
- understand the theory of nonlinear Fourier analysis for selected PDEs and can compute nonlinear (inverse) Fourier transforms numerically and, in simple cases, analytically
- know and implement practical engineering applications of nonlinear Fourier transforms
- understand the theory of the Koopman operator including selected engineering applications
- compute Koopman spectra numerically using data-driven methods and use them in practical engineering applications

Content
This module introduces students to signal processing methods that rely on nonlinear Fourier transforms and Koopman operators. These methods allow us to transform large classes of nonlinear systems such that they essentially behave like linear systems. They can also be used to decompose signals driven by such systems into physically meaningful nonlinear wave components (for example, solitons).

While these methods originated in mathematical physics, there has been a growing interesting of exploiting their unique capabilities in engineering contexts. The goal of this module is to give engineering students a practical introduction to this area. It provides the necessary theoretical background, enables students to apply the methods in practice via computer assignments, and discusses recent research from the engineering literature.

The following topics will be discussed:

- Introduction to linear operators on Hilbert spaces
- Integrable model systems (Korteweg-de Vries equation, Nonlinear Schrödinger equation)
- Lax-integrable systems (representations of Lax pairs, fake Lax pairs, conserved quantities)
- Solution of integrable model systems using nonlinear Fourier transforms (inverse scattering method) and the unified transform method
- Physical interpretation of nonlinear Fourier spectra (in particular, solitons)
- Practical applications of nonlinear Fourier transforms
- Theoretical properties of Koopman operators
- Data-driven computation of Koopman operators (residual dynamic mode decomposition)
- Practical applications of Koopman operators

Module Grade Calculation
The module grade is the grade of the written exam.

Additional Information
Some tutorial sessions will be classically devoted to solving pen and paper problems, but in others students will be working on their practical computer assignments. For the latter, students have to bring their own laptops with Matlab installed. The solutions of the computer assignments must be submitted by the provided deadlines, which are typically one week after the corresponding tutorial has taken place.

Workload
The workload includes:

1. attendance in lectures and tutorials: 15*4 h = 60 h
2. preparation / follow-up: 30*3 h = 60 h
3. finishing programming assignments: 30 h
4. preparation of and attendance in examination: 30 h

A total of 180 h = 6 CR

Recommendations
Familiarity with signals and systems at the Bachelor level (Fourier and Laplace transforms, linear systems, etc.) is assumed.

M 13.216 Module: Simulation and Optimization in Robotics and Biomechanics [M-INFO-106504]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-INFO-113123	Simulation and Optimization in Robotics and Biomechanics	6 CP	Mombaur

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students
• can explain advanced principles of modeling, optimization and control of dynamic processes, in particular mechanical systems and can apply them
• can model, classify and analyze complex motions in robotics or biomechanics, and investigate specific properties such as stability.
• can apply nonlinear optimization and optimal control methods and can compare and evaluate different mathematical approaches.
• know how to use software tools based on C++ and Lua for modeling, simulation, optimization and visualization of humanoid and robotic systems
are capable of solving optimal control problems numerically and to evaluate the quality of the solution.

Content
The goal of this course is to give a practical introduction into simulation and optimization of motions in robotics and biomechanics. Simulation and optimization play an important role in generating and controlling motions in complex robotics systems and in predicting and analyzing motions of humans. Theory and methods will be covered, but the focus is on the use software tools for modeling, simulation, optimization and visualization of multibody systems. Topics covered include:
- Dynamic process modeling
- Transforming real world problems into mathematical models
- Modeling of complex robotics and biomechanics systems (e.g. humanoids), based on previous modeling knowledge
- Common template models for bipedal walking and running in robotics and biomechanics
- Simulation of mechanical / robotics systems (Integrators and Initial value problems)
- Boundary value problems
- Nonlinear optimization problems
- Optimal control problems
- Direct and indirect methods for optimal control problems, focus on direct methods, especially direct multiple shooting
- Stability of dynamical systems, stability in biomechanics and robotics

Additional Information
Limitation to 30 participants

Workload
Estimated effort for this module is 180 hours:
60h - Lecture and exercises (2+2 SWS)
80h - Independent work (repetition of lecture contents, preparation of assignments
40h - Exam preparation

13.217 Module: Single-Photon Detectors [M-ETIT-101971]

Responsible: Dr. Konstantin Ilin
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-108390	Single-Photon Detectors	4 CP	Ilin

Assessment
Type of Examination: Oral exam
Duration of Examination: approx. 20 minutes

Prerequisites
none

Competence Goal
After completing the module, students will get basic knowledges on various physical mechanisms underlying optical response of the currently available detectors with the ultimate sensitivity – the single-photon detectors (SPDs) – thereby will be able to explain their functionality in details. The grasp of these knowledges enables students to critically analyze advantages and limitations of different types of SPDs and to make a decision on development of the detection system for particular applications.

Content
The students will get an overview of the modern types of single-photon detectors already widely used in applications and currently developing as well. Basics of the response mechanisms of the detectors and particular areas of their application will be considered as well as the main directions of development and optimization of new types of SPDs and detection systems. In particular the following topics will be addressed:

- Applications of single-photon detectors (SPD)
- Detection system and light-matter interaction
- Basic characteristics of SPDs and experimental methods of their determination
- Photoelectric effect: photomultiplier tubes (PMT); microchannel plate (MCP)
- Semiconducting detectors: photoresistor, PIN photodiode, avalanche photodiode (APD), single-photon avalanche diode (SPAD), visible light photon counter (VLPC), quantum dot field effect transistor (QD-FET)
- Superconducting detectors: transition edge sensor (TES), superconducting tunnel junction (STJ), superconducting nanowire single-photon detector (SNSPD)
- Hybrid detection system

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload

1. Lecture presence time in winter semester– 18 h
2. Exercises presence time – 9 h
3. Pre- /Post-preparation on lectures/exercises- 36 h
4. Preparation to and examination – 57 h

M 13.218 Module: Software Engineering [M-ETIT-100450]

Responsible: Dr. Clemens Reichmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	4

Mandatory			
T-ETIT-108347	Software Engineering	3 CP	Reichmann

Prerequisites
none

M 13.219 Module: Sol-Gel Processes [M-CIWVT-104489]

Responsible: Dr.-Ing. Steffen Peter Müller
Organisation: KIT Department of Chemical and Process Engineering
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-108822	Sol-Gel Processes	4 CP	Müller

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

Competence Goal
Students are capable to describe and analyse the complete process from the startin gmaterial (sol) to the finished product (gel), like ceramics.

They are qualified to evaluate and estimate every single step of the entire process critically.

Content
Production of functional material via the sol-gel-process: hydrolyse and condensation, the gel-building process (gelation) and aging, deformation and rhelogy, drying-process, structure of aero- and xerogels, surface-chemistry and modyfication of the surface and finally sintering. Applications: powder, ceramics, glass, membranes and coatings.

Workload

- Attendance time (Lecture): 22,5 h
- Homework: 16 h
- Exam Preparation: 80 h

13.220 Module: Source Coding Techniques [M-ETIT-105273]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-ETIT-110673	Source Coding Techniques	3 CP	Schmalen

Assessment
Oral exam approx. 20 minutes.

Prerequisites
Knowledge of basic engineering mathematics including integral transformations and probability theory as well as basic knowledge of communications engineering.

Competence Goal
Students will be able to understand and apply the methods and tools of source coding. Students will learn a variety of tools for quantizing signals, transforming them into efficient storage and lossless compression methods. They continue to learn the theoretical limitations of source coding and can classify various practical methods based on the theoretical limits of their performance. With the help of numerical methods you can solve problems of source coding yourself.

Content
The course extends the topics covered in the lecture in Communication Technology I. The focus here is on methods that emerge when considering source coding. For this purpose, partially known techniques have to be extended, in some cases new methods have to be learned. Source coding is an indispensable tool in communications engineering, on the one hand to compactly represent and prepare multimedia signals for transmission and, on the other hand, to use storage capacity efficiently and economically. Source coding provides the direct link between the system user and the actual data transmission. The first part of the lecture deals with lossless source coding techniques, such as those used to reduce file size in popular zip format, but also more general lossless methods for the transmission of high quality signals. The second part is devoted to source coding of multimedia signals and, in particular, regards the source coding of audio and video signals. Different methods of quantization of multimedia signals are discussed and then shown how the quantized signals can be encoded in order to obtain as compact a representation as possible. In addition to predictive methods, transformation coding is also described. All of the methods are described in terms of their use in modern methods of source coding such as MP3, JPEG, H264. Many of the applications are illustrated with example implementations in software (python / MATLAB).

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
Attendance lecture: 15 * 2 h = 30 h

Preparation / Postprocessing Lecture: 15 * 2 h = 30 h

Exam preparation and presence: 30 h

Total: 90 h = 3 LP

Recommendations
Previous visit to the lecture "Telecommunications I", "Probability Theory" and "Signals and Systems" is recommended. Knowledge from the lectures "Applied Information Theory" is helpful, but not necessary.

M 13.221 Module: Student Innovation Lab [M-ETIT-105073]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Prof. Dr. Werner Nahm
Prof. Dr.-Ing. Eric Sax
Prof. Dr. Wilhelm Stork
Prof. Dr. Orestis Terzidis
Prof. Dr.-Ing. Thomas Zwick

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
15 CP	graded	Each term	2 terms	English	4	2

Mandatory			
T-ETIT-110291	Innovation Lab	9 CP	Hohmann, Nahm, Sax, Stork, Zwick
T-WIWI-102864	Entrepreneurship	3 CP	Terzidis
T-WIWI-110166	SIL Entrepreneurship Project	3 CP	Terzidis

Assessment
This module consists of an approx. 60-minute written exam on the contents of the Entrepreneurship lectures, as well as 5 other types of exams on the contents of the seminar Entrepreneurship and Innovation Lab in the form of term papers and presentations. All exams results are graded.

In addition, smaller, ungraded term papers are due during the course to monitor progress.

Prerequisites
none

Competence Goal
Personal competence

- Reflection faculty:
The students are able to analyze, evaluate and develop an alternative for action for certain elements of action in social interaction
- Decision-making ability:
The students are able to prepare a decision template in time and to provide the necessary arguments for alternative decisions and therefore are able to decide in time.
- Interdisciplinary teamwork
Students are able to detect their limits of competence in one domain and to adjust to a the non-specialist domain. The students are able to detect a lack in competence and to compensate this lack via competences of other team members. The students are able to communicate their domain-specific knowledge and develop a basic understanding of other domains.
- Value-based action:
The students are able to use selected psychological tools to determine their own values. They are able to match these values with team members and reflect if their offer fits these values.

Social competence

- Ability to cooperate:
The students are able to analyze and judge their cooperative behavior in a group.
- Communication competence:
The students are able to present their information in persuasive, focused and target group oriented way.
- Ability to deal with conflicts:
The students are able to detect conflicts in advance, analyze them and name solution concepts.

Innovation and entrepreneurship competence

- Agile product development:
The students are able to apply methods of agile product development e.g. Scrum.
- Methodical innovation retrieval:
The students are able to conduct processes for user- and technology-centered innovation to develop sustainable value propositions for certain target groups (e.g. Design Thinking (DT), Technology Application Selection (TAS)- process).
- Orientation on management of new technology-based firms (NTBF):
The students are able to name central concepts of intellectual property and legal structures. The students are able to name the most important tasks of entrepreneurial leadership. They are able to name the most common form of business modeling and to setup a business plan. The students know important approaches to establish an organization. The students are able to determine the ownership structure in an investment situation. The students are able to name marketing concepts and setup a business model.
- Generate investment readiness:
The students are able to setup rudimentary revenue and cost plan. Furthermore, they are able to establish a project plan for a company in order to derive an investment plan. The students are able to present their business proposal to investors and develop empathy for the investors.
- Competence to develop a business model:
The students are able to apply respective tools for business modeling e.g. Business Model Canvas. The students are able to develop and assess alternative business models.
- Risk handling:
The students are able to name basic risks w.r.t. requirements, technical limitations and profitability. The students are able to apply methods of customer interaction for evaluation of requirements and willingness to pay. The students are able to setup a rudimentary competitors analyze. The students are able to name and identify risks and present potential reactions.

Systemic technical competence

- Problem solution competence:
The students are able to analyze, assess and structurally solve a technical problem.
- Agile methodology of system development:
The students are able to name and apply different system development processes.
- Validation in volatile environment:
The students are able to conduct technical and economical validation under volatile constraints. For this, they are able to name the constraints and interpret the results of the validation.
- Functional decomposition:
The students are able to identify, interpret and derive functional requirements from complex customer needs.
- Architecture development:
The students are able to recognize coherences from the functional requirements and derive a suitable system architecture.

Content

This module strives to combine technical, social and personal competences from the technical and entrepreneurial domain. The objective is to prepare students as best as possible for entrepreneurial activity within or outside of an established organization. Our teaching methods are research-based with a practical orientation.

The lecture Entrepreneurship as the essential component offers the theoretical basis and provides insight in important theoretical concepts and empirical evidence. Currently released case studies and practical experiences of successful founders support the theoretical and empirical content. In order to run a company for the long term additional knowledge is important. That's why the lecture also teaches basic principles for opportunity recognition, business modeling, an introduction to entrepreneurial marketing and leadership. Customer-based design methods from the lean startup approach as well as methods of technology-centered innovation are presented. Future founders have to be able to develop and handle resources such as financial and human capital, infrastructure and intellectual property. Further aspects tackle the establishment of an organization and funding of the own project.

The knowledge taught in the lecture Entrepreneurship will be applied in an application-oriented seminar and the labs. Hence we use an action learning approach to extend the taught knowledge by practical skills and reflection capabilities. In an team of five, the students will experience their way from the ideation process to the final pitch in front of investors.

The students are able to choose between the following options concerning the labs:

- The Automation Innovation Lab offers drones as an innovation platform for cooperative swarm solutions.
- The Industry 4.0 Innovation Lab enables innovation in the context of the next industrial revolution via mobile robot platforms.
- In the Interconnected Intelligent Systems Lab innovations in the context of Assisted Living and Smart Housing are enabled by providing a rich assembly set of mobile robots, actuators and sensors.
- The Computer Vision for Health Lab offers a selection of state-of-the-art imaging devices and powerful computing hardware for innovative image-based applications for medicine and healthcare.

The module also presents methods of agile system development (Scrum) along with associated validation methods as well as methods for functional prototyping. Gate plans are used within the module to determine the progress of the project. Methods for single person work and teamwork are presented and applied. Additionally group-specific knowledge of the different roles of team members, solutions to conflict situations and interdisciplinary teams are presented.

Module Grade Calculation

The module grade consists of the written exam of the Lecture Entrepreneurship (40%), of the submissions and presentation of the Innovation Lab (40%) and of the submissions and presentation of the SIL Entrepreneurship Project (20%).

Additional Information

An application is required to participate in this module. Information about the application: www.kit-student-innovation-lab.de**.**

Workload

Lecture Entrepreneurship: 32h attendance time, 48h preparation and follow-up time, 10h preparation time for assessment

Seminar Entrepreneurship: 34h attendance time, 3h preparation and follow-up time, 53h preparation time for assessment.

Innovation Lab: 8h attendance time, 213h preparation and follow-up time, 49h preparation time for assessment.

This results in a total of 450 hours and a total of 15 LPs for both semesters (15*30/2 = 225).

Recommendations

It is recommended to attend the lecture Entrepreneurship at the same time as the seminar Entrepreneurship Project and the Innovation Lab in the winter semester.

Teaching and Learning Methods

Related courses:

Lecture Entrepreneurship
Seminar Entrepreneurship Project
Innovation Labs
Please note that the courses must be booked in parallel.

Related exams:

Written exams covering the content of lecture Entrepreneurship
Presentation of the Value Profile (seminar Entrepreneurship)
Submission of the Business Plan (seminar Entrepreneurship)
Submission of a Technical Report with requirements list and system architecture (Innovation Lab)
Submission of the reflection of the Gate Plans (Innovation Lab)
Presentation of the High-fidelity (Innovation Lab)

M 13.222 Module: Superconducting Magnet Technology [M-ETIT-106684]

Responsible: Prof. Dr. Tabea Arndt
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113440	Superconducting Magnet Technology	4 CP	Arndt

Assessment
The examination takes place in form of an oral exam (abt. 30 minutes).

Two timeslots (weeks) for examination dates will be announced (usually near end of lecture period & end of semester)

Prerequisites
none

Competence Goal

- The students have a solid knowledge of architecture and design aspects of applications in magnets, windings and coils in power engineering.
- For the most important magnet applications the students can apply the state of the art, choose between options and can reflect the main benefits.
- The students have a clear understanding of opportunities, benefits and limitations of superconducting windings and magnets.
- The students are able to perform the required design calculations and to solve fundamental design questions independently.

Content
As the materials become increasingly mature and powerful, using superconductivity in a variety of applications of electrical engineering is of rising interest and benefit, too. This module is focuses on Superconducting Magnet Technology:

Windings, coils and magnets may be used as a device by itself (providing high magnetic fields e.g. in MRI, NMR, accelerators, industry magnets, etc.) or as components for Power Systems.

This section will cover the following aspects:

- Unique selling points of superconducting windings.
- Basic approaches and tools to design superconducting windings.
- Discussion of winding architectures
- Criteria to design the appropriate operating temperatures, materials, conductors, cooling technology for the electromagnetic purpose.
- Limits and opportunities when preparing and operating superconducting windings.
- Measures for safe operation of superconducting magnets.
- High-Field Magnets
- Magnets for Fusion Technology
- 3D topologies (e.g. in dipole magnets or motors/ generators)
- New options potentially offered by widespread use of hydrogen.
- New winding topologies

In the exercises, selected magnets will be designed and calculated analytically and with some computational tools (e.g. dipole magnets and compact, cryogen free HTS-magnets)

The lecturer may change the details of the content without further notice. Materials will be offered on ILIAS.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload

1. attendance in lectures and exercises: 15*3 h = 45 h
2. preparation / follow-up: 15*3 h = 45 h
3. preparation of and attendance in examination: 30 h

A total of 120 h = 4 CR

Recommendations
Having knowledge in “Superconducting Materials” is beneficial, but not mandatory.

M 13.223 Module: Superconducting Materials [M-ETIT-105521]

Responsible: Prof. Dr. Bernhard Holzapfel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	2 terms	English	4	2

Mandatory			
T-ETIT-111096	Superconducting Materials	6 CP	Holzapfel

Assessment
The assessment of success takes place in the form of an oral examination lasting 40 minutes.

The oral examination includes the contents of Superconducting Materials Part I (offered every winter term) and Superconducting Materials Part II (offered every summer term).

Prerequisites
none

Competence Goal
The students have a good knowledge and can describe and compare the properties of different superconducting materials including those currently employed in energy and electronic applications (niobium-based superconductors, oxocuprates, MgB2) and also promising recently discovered ones (pnictides), including their synthesis methods.

Students have a thorough understanding of the synthesis variations of superconducting materials in bulk, thin film and wire form as well as the close relationship between microstructural properties of superconductors and their current carrying capabilities. They are able to select the appropriate superconducting materials for the different application scenarios of superconductors.

The students are able to talk about topic-related aspects in English using the technical terminology of the field of study.

Content
This lecture series gives an overview on the basic properties of the known different classes of superconducting materials as well as their synthesis routes in bulk, thin film and wire form. Special emphasis s given to the close interaction of micro- and nanoscale microstructural properties and the superconducting electrical transport properties, which are the key to all large scale applications in power and magnet technology.
The lecture series will cover basic properties of superconductors, superconducting elements, classical metallic superconducting alloys and compounds, high temperature superconductors, Fe-based superconductors and some other “exotic” superconductors, synthesis of superconducting films and wires, superconducting critical currents and pinning in type II superconductors as well an overview on the most prominent applications of superconductors in electronics, medicine and power application.
The obligatory practical work covers a few experiments regarding the synthesis and characterization of superconducting materials.
The lecturer reserves the right to alter the contents of the course without prior notification.
Course material will be available on ILIAS. Up-to-date information will be available via the ITEP- homepage prior to the beginning of the semester.

Module Grade Calculation
The module grade is the grade of the oral exam.

Additional Information
WS: Superconducting Materials Part I

SoSe: Superconducting Materials Part II

Workload
A workload of approx. 186h is required for the successful completion of the module. This is composed as follows:

- Attendance time in lectures: 28*1.5h = 42h
- Preparation and follow-up of lectures: 28*3h = 84h
- Preparation for the exam: 60h

Recommendations
Knowledge of the basic course “Superconductivity for Engineers” is required

13.224 Module: Superconducting Nanowire Detectors [M-ETIT-105609]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-111236	Superconducting Nanowire Detectors	4 CP	Kempf

Assessment
Oral Exam (20 min.)

Prerequisites
Module "M-ETIT-102332 - Thin films: technology, physics and applications" + Thin Films: Technology, Physics and Applications II must not be started.

Competence Goal
Students should be able to discuss interplay between growth conditions of thin films, physical and geometrical properties of nanostructure made of these films, and performance and suitable areas of application of detectors of radiation based on interaction of these nanostructures with electromagnetic power. The knowledge obtained by students should provide a theoretical basis for the most important steps in development of thin film nanoelectronic devices.

Content
Students will get practically oriented information about technology of thin films including different methods of deposition of thin films like magnetron sputtering, thermal evaporation, pulsed laser ablation, about basics of vacuum technology, and about mechanisms of growth of thin films of different materials at different conditions.

Patterning methods (photo- and e-beam lithography, reactive ion etching, ion milling, and lift-off techniques) suitable for nanometer scale features of electronic devices will be considered in details.

Experimental methods of characterization of material, geometrical, optical, physical, superconducting, electron and phonon properties of thin films, nanostructures made of these films, and devices based on these nanostructures will be discussed.

Consideration of technology and physics of thin film structures will be done on example of development of three types of fast and sensitive detectors of electro-magnetic radiation for applications in optical and THz spectral ranges: superconducting nanowire single-photon detector, hot-electron bolometer, and YBCO ps-fast detector of synchrotron emission. Dependence of detector's performance on their fabrication condition will be analyzed in frame of physical models which describe response mechanisms of the detectors to absorbed radiation.

Practical actualization of the knowledge is possible in frame of Praktikum Nanoelektronik (LVN 23669).

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
The workload in hours is broken down below:

1. Attendance time in lectures in the winter semester 15*3h = 45h
2. Preparation / follow-up of the same 15*3h = 45h
3. Exam preparation and attendance in the same 30h

Recommendations
Previous participation on Module "Physics, Technology and Applications of thin films " is recommanded.

M 13.225 Module: Superconductivity for Engineers [M-ETIT-105611]

Responsible: Prof. Dr. Bernhard Holzapfel
Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-111239	Superconductivity for Engineers	5 CP	Holzapfel, Kempf

Assessment
The assessment of success takes place in the form of a written examination lasting 120min. The grade corresponds to the result of the written examination.

Prerequisites
none

Competence Goal
Students know the physical fundamentals of superconductivity and can place various theoretical and practical aspects of superconductivity in the overall context. They understand the principles behind specific applications of superconductivity and are able to communicate with experts in the field.

Content
Superconductivity is one of the most fascinating and astonishing effects in solid state physics. It plays technologically an important role in many modern, scientific, medical and industrial applications. It establishes, for example, the basis of realizing high field electromagnets to be used in magnetic resonance imaging systems in healthcare or for guiding charged particle in modern particle accelerators such as the LHC. Moreover, it allows to build state-of-the-art energy systems as well as sensing devices such as magnetic field sensors or energy-dispersive single particle. In addition, it is conceivable that superconductivity will be utilized in near future for energy and traffic engineering applications, e.g. for dissipationless power transmission over large distances or high-speed trains connecting major cities.

Within this context, this module gives a comprehensive introduction in the basics of superconductivity paving the way for the discussion of state-of-the-art applications of superconductivity. In particular, the module will cover the following topics:

- Historical remarks
- Overview of superconducting materials and applications of superconductivity
- Reminder of normal metals: free electron gas, Drude and Sommerfeld model, electrical and thermal properties, band structure
- Phenomena of superconductivity: zero electrical dc resistance, Meissner Ochsenfeld effect
- Thermodynamics and thermal properties of superconductors
- Phenomenological theories of superconductors: Two-fluid model, London theory, Pippard theory, Ginzburg-Landau theory
- Microscopic theory of conventional superconductors
- Type-I and type-II superconductivity
- Magnetic properties of type-I and type-II superconductors
- Irreversible magnetic properties, Bean model
- AC losses
- Electrical and thermal stabilization
- Energy gap and quasiparticle tunneling
- Unconventional superconductors
- High-frequency electrodynamics of superconductors
- Macroscopic quantum effects
- Overview of applications of superconductivity

The tutorial is closely connected to the lecture and deepens important aspects from the field of superconductivity. Using exercises, important theories and effects as well as the realization of applications of superconductivity is discussed.

Module Grade Calculation
The module grade is the grade of the written examination.

Additional Information
Will be changed to 6 CR in winter term 25/26.

Workload
A workload of approx. 149h is required for the successful completion of the module. This is composed as follows:

- Attendance time in lectures and exercises: 12*1.5h + 6*1.5h = 27h
- Preparation and follow-up of lectures: 12*3h = 36h
- Preparation and follow-up of tutorials: 6*6h = 36h
- Preparation for the exam: 50h

Recommendations
None

13.226 Module: Supplementary Studies on Science, Technology and Society [M-FORUM-106753]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation: General Studies. Forum Science and Society (FORUM)

Part of: Additional Examinations

Credits	Grading	Recurrence	Duration	Language	Level	Version
16 CP	graded	Each term	3 terms	German	3	1

Election Notes

Students have to self-record the achievements obtained in the Supplementary Studies on Science, Technology and Society in their study plan. FORUM (formerly ZAK) records the achievements as "non-assigned" under "ÜQ/SQ-Leistungen". Further instructions on self-recording of achievements can be found in the FAQ at https://campus.studium.kit.edu/ and on the FORUM homepage at https://www.forum.kit.edu/english/. The title of the examination and the amount of credits override the modules placeholders.

If you want to use FORUM achievements for both your Interdisciplinary Qualifications and for the Supplementary Studies, please record them in the Interdisciplinary Qualifications first. You can then get in contact with the FORUM study services (stg@forum.kit.edu) to also record them in your Supplementary Studies.

In the Advanced Unit you can choose examinations from three subject areas: "About Knowledge and Science", "Science in Society" and "Science in Social Debates". It is advised to complete courses from each of the three subject areas in the Advanced Unit.

To self-record achievements in the Advanced Unit, you have to select a free placeholder partial examination first. The placeholders' title do *not* affect which achievements the placeholder can be used for!

Mandatory			
T-FORUM-113578	Lecture Series Supplementary Studies on Science, Technology and Society - Self Registration	2 CP	Mielke, Myglas
T-FORUM-113579	Basic Seminar Supplementary Studies on Science, Technology and Society - Self Registration	2 CP	Mielke, Myglas
Advanced Unit Supplementary Studies on Science, Technology and Society (Election: at least 12 credits)			
T-FORUM-113580	Elective Specialization Supplementary Studies on Science, Technology and Society / About Knowledge and Science - Self-Registration	3 CP	Mielke, Myglas
T-FORUM-113581	Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Society - Self-Registration	3 CP	Mielke, Myglas
T-FORUM-113582	Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Public Debates - Self Registration	3 CP	Mielke, Myglas
Mandatory			
T-FORUM-113587	Registration for Certificate Issuance - Supplementary Studies on Science, Technology and Society	0 CP	Mielke, Myglas

Assessment

The monitoring is explained in the respective partial achievement.

They are composed of:
- Protocols
- Reflection reports
- Presentations
- Preparation of a project work
- An individual term paper
- An oral examination
- A written exam

Upon successful completion of the supplementary studies, graduates receive a graded report and a certificate issued by the FORUM.

Prerequisites

The course is offered during the course of study and does not have to be completed within a defined period. Enrollment is required for all assessments of the modules in the supplementary studies.

Participation in the supplementary studies is regulated by § 3 of the statutes. KIT students register for the supplementary studies by selecting this module in the student portal and booking a performance themselves. Registration for courses, assessments, and exams is regulated by § 8 of the statutes and is usually possible shortly before the start of the semester.

The course catalog, module description (module manual), statutes (study regulations), and guidelines for creating the various written performance requirements can be downloaded from the FORUM homepage at https://www.forum.kit.edu/begleitstudium-wtg.php.

Registration and exam modalities

PLEASE NOTE:

Registration on the FORUM, i.e. additionally via the module selection in the student portal, enables students to receive up-to-date information about courses or study modalities. In addition, registering on the FORUM ensures that you have proof of the credits you have earned. As it is currently (as of winter semester 24-25) not yet possible to continue additional credits acquired in the Bachelor's programme electronically in the Master's programme, we strongly advise you to digitally secure the credits you have earned by archiving the Bachelor's transcript of records yourself and by registering on FORUM.

In the event that a transcript of records of the Bachelor's certificate is no longer available - we can only assign the achievements of registered students and thus take them into account when issuing the certificate.

Competence Goal

Graduates of the Supplementary Studies on Science, Technology, and Society gain a solid foundation in understanding the interplay between science, the public, business, and politics. They develop practical skills essential for careers in media, political consulting, or research management. The program prepares them to foster innovation, influence social processes, and engage in dialogue with political and societal entities. Participants are introduced to interdisciplinary perspectives, encompassing social sciences and humanities, to enhance their understanding of science, technology, and society. The teaching objectives of this supplementary degree program include equipping participants with both subject-specific knowledge and insights from epistemological, economic, social, cultural, and psychological perspectives on scientific knowledge and its application in various sectors. Students are trained to critically assess and balance the implications of their actions at the intersection of science and society. This training prepares them for roles as students, researchers, future decision-makers, and active members of society.

Through the program, participants learn to contextualize in-depth content within broader frameworks, independently analyze and evaluate selected course materials, and communicate their findings effectively in both written and oral formats. Graduates are adept at analyzing social issues and problem areas, reflecting on them critically from a socially responsible and sustainable standpoint.

Content

The Supplementary Studies on Science, Technology and Society can be started in the 1st semester of the enrolled degree programme and is not limited in time. The wide range of courses offered by FORUM makes it possible to complete the program usually within three semesters. The supplementary studies comprises 16 or more credit points (LP). It consists of **two modules: the Basic Module (4 LP) and the Advanced Module (12 LP).**

The **basic Module** comprises the compulsory courses ‘Lecture Series Supplementary Studies on Science, Technology and Society’ and a basic seminar with a total of 4 LP.

The **Advanced Module** comprises courses totalling 12 LP in the humanities and social sciences subject areas ‘On Knowledge and Science’, ‘Science in Society’ and ‘Science in Public Debates’. The allocation of courses to the accompanying study programme can be found on the homepage https://www.forum.kit.edu/wtg-aktuelland in the printed FORUM course catalogue.

The 3 thematic subject areas:

Subject area 1: About Knowledge and Science

This is about the internal perspective of science: students explore the creation of knowledge, distinguishing between scientific and non-scientific statements (e.g., beliefs, pseudo-scientific claims, ideological statements), and examining the prerequisites, goals, and methods of knowledge generation. They investigate how researchers address their own biases, analyze the structure of scientific explanatory and forecasting models in various disciplines, and learn about the mechanisms of scientific quality assurance.

After completing courses in the "Knowledge and Science" area, students can critically reflect on the ideals and realities of contemporary science. They will be able to address questions such as: How robust is scientific knowledge? What are the capabilities and limitations of predictive models? How effective is quality assurance in science, and how can it be improved? What types of questions can science answer, and what questions remain beyond its scope?

Subject area 2: Science in Society

This focuses on the interactions between science and different areas of society, such as how scientific knowledge influences social decision-making and how social demands impact scientific research. Students learn about the specific functional logics of various societal sectors and, based on this understanding, estimate where conflicts of goals and actions might arise in transfer processes—for example, between science and business, science and politics, or science and journalism. Typical questions in this subject area include: How and under what conditions does an innovation emerge from a scientific discovery? How does scientific policy advice work? How do business and politics influence science, and when is this problematic? According to which criteria do journalists incorporate scientific findings into media reporting? Where does hostility towards science originate, and how can social trust in science be strengthened?

After completing courses in the "Sciene in Society" area, students can understand and assess the goals and constraints of actors in different societal sectors. This equips them to adopt various perspectives of communication and action partners in transfer processes and to act competently at various social interfaces with research in their professional lives.

Subject area 3: Science in Public Debates

The courses in this subject area provide insights into current debates on major social issues such as sustainability, digitalization, artificial intelligence, gender equality, social justice, and educational opportunities. Public debates on complex challenges are often polarized, leading to oversimplifications, defamation, or ideological thinking. This can hinder effective social solution-finding processes and alienate people from the political process and from science. Debates about sustainable development are particularly affected, as they involve a wide range of scientific and technological knowledge in both problem diagnosis (e.g., loss of biodiversity, climate change, resource consumption) and solution development (e.g., nature conservation, CCS, circular economy).

By attending courses in "Science in Public Debates," students are trained in an application-oriented way to engage in factual debates—exchanging arguments, addressing their own prejudices, and handling contradictory information. They learn that factual debates can often be conducted more deeply and with more nuance than is often seen in public discourse. This training enables them to handle specific factual issues in their professional lives independently of their own biases and to be open to differentiated, fact-rich arguments.

Supplementary credits:

Additional LP (supplementary work) totalling a maximum of 12 LP can also be acquired from the complementary study programme (see statutes for the WTG complementary study programme § 7). § 4 and § 5 of the statutes remain unaffected by this. These supplementary credits are not included in the overall grade of the accompanying study programme. At the request of the participant, the supplementary work will be included in the certificate of the accompanying study programme and marked as such. Supplementary coursework is listed with the grades provided for in § 9.

Module Grade Calculation

The overall grade of the supplementary course is calculated as a credit-weighted average of the grades that were achieved in the advanced module.

Additional Information
Climate change, biodiversity crisis, antibiotic resistance, artificial intelligence, carbon capture and storage, and gene editing are just a few areas where science and technology can diagnose and address numerous social and global challenges. The extent to which scientific findings are considered in politics and society depends on various factors, such as public understanding and trust, perceived opportunities and risks, and ethical, social, or legal considerations.
To enable students to use their expertise as future decision-makers in solving social and global challenges, we aim to equip them with the skills to navigate the interfaces between science, business, and politics competently and reflectively. In the Supplementary Studies, they acquire foundational knowledge about the interactions between science, technology, and society.

They learn:
- How reliable scientific knowledge is produced,
- how social expectations and demands influence scientific research, and
- how scientific knowledge is adopted, discussed, and utilized by society.

The program integrates essential insights from psychology, philosophy, economics, social sciences, and cultural studies into these topics. After completing the supplementary studies programme, students can place the content of their specialized studies within a broader social context. This prepares them, as future decision-makers, to navigate competently and reflectively at the intersections between science and various sectors of society, such as politics, business, or journalism, and to contribute effectively to innovation processes, public debates, or political decision-making.

Workload
The workload is made up of the number of hours of the individual modules:

- Basic Module approx. 120 hours
- Advanced Module approx. 360 hours

> Total: approx. 480 hours

In the form of supplementary services, up to approximately 360 hours of work can be added.

Recommendations
It is recommended to complete the supplementary study program in three or more semesters, beginning with the lecture series on science, technology, and society in the summer semester. Alternatively, you can start with the basic seminar in the winter semester and then attend the lecture series in the summer semester.

Courses in the Advanced Module can be taken simultaneously. It is also advised to complete courses from each of the three subject areas in the advanced unit.

Teaching and Learning Methods
- Lectures
- Seminars/Project Seminars
- Workshops

M 13.227 Module: Surface Science, without Exercises [M-PHYS-106483]

Responsible: TT-Prof. Dr. Philip Willke
Prof. Dr. Wulf Wulfhekel
PD Dr. Khalil Zakeri-Lori

Organisation: KIT Department of Physics

Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-113099	Surface Science, without Exercises	8 CP	Willke, Wulfhekel, Zakeri-Lori

Assessment
Oral Exam. In the MSc Physics, this module is examined together with further modules attended as part of the major in physics. The total duration of the oral exam is approx. 60 minutes.

Prerequisites
none

Competence Goal
Students are introduced to the basic concepts of surface science, master the relevant theoretical concepts, and understand the concepts and measurement methods of surface science and their applications.

Content
In the lecture, physics at surfaces and interfaces as well as the physical chemistry at surfaces are discussed. Starting with the two-dimensional space group, the structure of surfaces is discussed as well as effects arising from symmetry breaking at surfaces and interfaces. Furthermore, layer growth and modification of layer growth using various techniques will be discussed. The main part of the lecture deals with the electronic structure of two-dimensional systems and nanostructures as well as the experimental techniques of surface science.

Workload
240 hours consisting of attendance time (60 hours), wrap-up of lecture incl. exam preparation (180 hours).

Recommendations
Basic knowledge of solid state physics, quantum mechanics, and thermodynamics is assumed.

Literature

- K. Oura, V.G. Lifshits, A.A. Saranin, A.V. Zotov, M. Katayama, Surface Science: An Introduction, Springer
- H. Ibach, Physics of Surfaces and Interfaces, Springer

M 13.228 Module: Sustainable Product Engineering: Sustainable Product Design - Long-term Business Success with Sustainably Developed Products [M-MACH-107189]

Responsible: Dr.-Ing. Karl-Friedrich Ziegahn
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-114033	Sustainable Product Engineering	4 CP	Ziegahn

Assessment
See partial performance

Prerequisites
None

Competence Goal
Students are able to ...

- name and describe key points of sustainable product development in an economic, social and ecological context, as well as sustainability goals and their significance in product development, interactions between technical products and their environment, the holistic approach and the equal importance of economic, social and ecological aspects as well as environmental performance characteristics.
- discuss life cycle-related product design using the example of complex vehicle components such as airbag systems and other current products.
- understand practical product stresses caused by environmental conditions using the example of technology-intensive components; robustness and service life of products as the basis for sustainable product development; development of skills for the application of environmental simulation in the development process of technical products.
- To develop key qualifications such as teamwork / project planning / self-organization / presentation using realistic projects.

Content
Understanding of sustainability goals and their importance in product development, the interactions between technical products and their environment, the holistic approach and the equal importance of economic, social and ecological aspects as well as environmental performance characteristics

Teaching life cycle-related product design skills using the example of complex vehicle components such as airbag systems and other current products

Understanding of practical product stresses caused by environmental conditions using the example of technology-intensive components; robustness and service life of products as the basis for sustainable product development; development of skills for the application of environmental simulation in the development process of technical products

Promotion of the development of key qualifications such as teamwork / project planning / self-organization / presentation based on realistic projects

The aim of the course is to convey the key points of sustainable product development in an economic, social and ecological context.

Module Grade Calculation
The module grade corresponds to the grade from the partial performance.

Additional Information
None

Workload
Attendance: 30h

Self-study: 90h

Recommendations
None

Teaching and Learning Methods
Lecture

Literature
None

Base For
None

M 13.229 Module: System Integration and Communication Structures in Industry 4.0 and IoT [M-ETIT-106026]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-112212	System Integration and Communication Structures in Industry 4.0 and IoT	3 CP	Becker

Prerequisites
none

13.230 Module: System Integration in Micro- and Nanotechnology [M-MACH-105315]

Responsible: apl. Prof. Dr. Ulrich Gengenbach
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105555	System Integration in Micro- and Nanotechnology	4 CP	Gengenbach

Assessment
A performance assessment is obligatory and can be oral, a written exam, or of another kind.

Prerequisites
None

Competence Goal
The students acquire basic knowledge of challenges and system integration technologies from mechanical engineering, precision engineering and electronics

Content

- Introduction to system integration (fundamentals)
- Brief introduction to MEMS processes
- Flexures
- Surfaces and plasma processes for surface treatment
- Adhesive bonding in engineering
- Mounting techniques in electronics
- Molded Interconnect devices (MID)
- Functional Printing
- Low temperature cofired ceramics in system integration
- 3D-Integration in semiconductor technology

Workload
The work load is about 120 hours, corresponding to 4 credit points.

Teaching and Learning Methods
Lecture

Literature

- Risse, Fertigungsverfahren der Mechatronik, Feinwerk- und Präzisionsgerätetechnik, Vieweg+Teubner Verlag, Wiesbaden, 2012
- Madou, Fundamentals of microfabrication and nanotechnology, CRC Press Boca Raton, 2012
- Habenicht, Kleben Grundlagen, Technologien, Anwendungen, Springer-Verlag Berlin Heidelberg, 2009
- J. Franke, Räumliche elektronische Baugruppen (3D-MID), Carl Hanser-Verlag München, 2013

13.231 Module: System Integration in Micro- and Nanotechnology 2 [M-MACH-105316]

Responsible: apl. Prof. Dr. Ulrich Gengenbach
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-110272	System Integration in Micro- and Nanotechnology 2	4 CP	Gengenbach

Assessment
A performance assessment is obligatory and can be oral, a written exam, or of another kind.

Prerequisites
None

Competence Goal
The students acquire knowledge of novel system integration technologies and their application in microoptic and microfluidic systems.

Content
Introduction to system integration (novel processes and applications)

Assembly of hybrid microsystems

Packaging processes

Applications:

- Micro process engineering
- Lab-on-chip systems
- Microoptical systems
- Silicon Photonics

Novel integration processes:

- Direct Laser Writing
- Self Assembly

Workload
The work load is about 120 hours, corresponding to 4 credit points.

Teaching and Learning Methods
Lecture

Literature

- N.-T. Nguyen, Fundamentals and Applications of Microfluidics, Artech House
- G. T. Reed, Silicon Photonics: An Introduction, Wiley

M 13.232 Module: System-on-Chip Laboratory [M-ETIT-100451]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Prof. Dr. Ivan Peric

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Laboratory/Practical Course)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100798	System-on-Chip Laboratory	6 CP	Becker, Peric

Assessment
Other types of examinations

Prerequisites
none

Competence Goal
Students can reproduce basic knowledge of digital and analog circuit design and hardware-related software programming. In practice, students are able to apply these methods in the following areas using a current system-on-chip architecture:

• Design of a system architecture for mixed-signal systems

• Simulation of the designed digital and analog circuits

• Debugging the implementations at the simulation and implementation level

• Verification of the overall system developed through test benches

In addition, they can apply the hardware / software code design approach and can evaluate implementation targets based on the given requirements (FPGA and ASIC).

Content
In the System-on-Chip Laboratory, a fully-fledged mixed-signal hardware architecture for audio playback based on a system-on-chip (SoC) is developed.

The system design includes the creation of necessary sub-components, their integration into an overall system, and the simulation and verification of the individual components and the overall system. A prototype is implemented and tested on an FPGA basis. The integration is then prepared for a possible ASIC production. Analog circuits are also considered and designed to build an audio amplifier.

Module Grade Calculation
The grade formation results from the combination of the processing of the exercise sheets, the evaluations during the internship and a final presentation including discussion of the results developed in the project.

Workload
1. Presence time in laboratory appointments: 15 * 4 = 60 hours
2. Preparation / post-processing: 15 * 4 = 60 hours
3. Demonstration and integration tests: 3 * 3 = 9 hours
4. Preparation of the final presentation: 15 hours

Recommendations

- Knowledge of Verilog Hardware Description Language, e.g. from Digital Circuit Design
- Knowledge in the design of analog circuits (amplifier circuits, stability considerations), e.g. from the Analog Circuit Design
- Knowledge of VHDL design, e.g. from Hardware Modeling and Simulation
- Knowledge of simulation of digital circuits, e.g. from Hardware Modeling and Simulation
- Knowledge of hardware design processes and algorithms, e.g. from Hardware Synthesis and Optimisation

M 13.233 Module: Systems and Software Engineering [M-ETIT-100537]

Responsible: Prof. Dr.-Ing. Eric Sax
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-100675	Systems and Software Engineering	5 CP	Sax

Assessment
Written exam, approximately 90 minutes.

Students are given the opportunity to earn a grade bonus through separate task assignments. If the grade of the written exam is between 4.0 and 1.3, the bonus improves the grade by a maximum of one grade level (0.3 or 0.4). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. Bonus points do not expire and remain valid for exams taken at a later date.

Prerequisites
none

Competence Goal
• Students are able to analyse and explain the functional principles and applications of embedded systems.

• Students are able to evaluate and apply maturity models as well as Software Development Life Cycle models including the waterfall model, V-model, prototyping model, agile models, and DevOps.

• Students are able to apply various creativity techniques to develop innovative solutions to problems. They will be able to derive and analyse requirements.

• Students are familiar with diagram formats software modelling languages; they can evaluate and create these based on problem descriptions of an application area. They will be able to create and evaluate functional, data-oriented, algorithmic, state-oriented, and object-oriented views.

• Students are able to understand and apply various aspects of the realization of embedded systems. They will be able to consider implementation alternatives: hardware, co-design and scheduling aspects.

• Students are familiar with the various testing phases in a project and can explain them. They can assess the reliability of a system and understand the concept of functional safety.

Content
The focus of the course is on processes and methods for the design of systems composed of electrical, electronic and electronically programmable systems that contain software, hardware and mechanical components. The desired competencies of the course include the knowledge and goal-oriented use of modeling techniques, design processes, description and representation tools as well as specification languages that correspond to the current state of the art.

Module Grade Calculation
The grade is determined by the written exam and the bonus points.

Additional Information
Will be changed to 6 CR in winter term 25/26.

Workload
For each Credit Point (CP), 30h of work is scheduled. The resulting 150h are distributed as follows:

- 15 weeks of 1.5h attendance in lecture and 2h preparation and follow-up per week = 52.5h
- 15 weeks of 1.5h attendance in each exercise and at least 2h preparation (includes processing of exercise sheets and the processing of tasks for the acquisition of bonus points) per week = 52.5h
- Preparation for the exam = 45h

Recommendations
Knowledge in Digital Technology and Information and Automation Technology (e.g. module M-ETIT-102102 and M-ETIT-106336)

M 13.234 Module: Systems Engineering for Automotive Electronics [M-ETIT-100462]

Responsible: Prof. Dr.-Ing. Jürgen Bortolazzi
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-100677	Systems Engineering for Automotive Electronics	4 CP	Bortolazzi

Prerequisites
none

M 13.235 Module: Team Project: Sensors and Electronics [M-ETIT-105465]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Prof. Dr.-Ing. Thomas Zwick

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	pass/fail	Each term	1 term	German	4	1

Mandatory			
T-ETIT-111007	Team Project: Sensors and Electronics	3 CP	Ulusoy, Zwick

Assessment
Final Design Report

Prerequisites
An application is required to participate in this module. Information about the application: https://www.ihe.kit.edu/VorlesungenWS_4850.php

Competence Goal

- Students independently expand their knowledge in a selected field of sensors and electronics beyond lecture contents
- Students will go through multiple phases from conceptual design to measurement and thereby gain practical experience
- Students are able to respect practical limits when applying theoretical knowledge
- Students can consider available measurement equipment in their design process
- Students are able to work in a team and organize a project independently and under their own responsibility

Content
Students will develop a system or a component in the field of sensors and electronics. The project's content has to go beyond the content of a single lecture or require the combination of multiple lectures. It has to be connected to general challenges or problems in research. On top of the theoretical aspects students will have to plan and execute their project's realization. Manufacturing tolerances/limits and available measurement equipment have to be respected. This module can be combined with an international student design competition.

Module Grade Calculation
No Grade. Only pass or fail.

Workload
A total of 90 hours (per Student) is estimated for the completion of this module.

1. Planning and conceptual design: 10h
2. Simulation & Design: 50h
3. Assembly, Verification, Measurement: 15h
4. Final report: 15h

Recommendations
Lectures at the Institute for Radio Frequency Engineering and Electronics (IHE)

M 13.236 Module: Technical Acoustic [M-ETIT-101835]

Responsible: Dr. Nicole Ruiter
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-104579	Technical Acoustic	3 CP	Ruiter

Assessment
Success control is carried out as part of an overall oral examination (approx. 20 minutes) of the selected courses, with which the minimum requirement for CP is met.

Prerequisites
none

Competence Goal
The students understand the basics of acoustics and their technical applications and can understand the basic technical implementation.

Content
The lecture deals with the basics of sound and sound propagation. In addition to sound generation, the measurement and analysis methods for sound, the perception of sound in humans and is also discussed. Selected applications and their technical implementation are presented.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload
The workload includes:

Attendance time in lectures (2 h 15 appointments each) = 30 h

Self-study (3 h 15 appointments each) = 45 h

Preparation / post-processing = 20 h

Total effort approx. 95 hours = 3 LP

13.237 Module: Technical Optics [M-ETIT-100538]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100804	Technical Optics	5 CP	Neumann

Prerequisites
none

13.238 Module: Technologies in Radiotherapy [M-ETIT-107292]

Responsible: Prof. Dr.-Ing. Maria Francesca Spadea
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	3	1

Mandatory			
T-ETIT-114338	Technologies in Radiotherapy	6 CP	Spadea

Assessment
The examination takes place within the framework of an oral overall examination where also the project developed during the course will be discussed (approx. 30 minutes).

Prerequisites
none

Competence Goal
Upon successful completion of this course, students will be able to:

- Understand the Fundamentals of Radiotherapy
- Explain the physical principles of photon and particle interactions in radiotherapy.
- Describe different types of radiation beams and accelerator technologies, including linear accelerators (linac), cyclotrons, and synchrotrons.
- Comprehend Radiobiological Principles
- Analyze the biological effects of radiation on tissues and the principles of radiobiology.
- Evaluate different fractionation schemes and their impact on treatment efficacy.
- Navigate the Radiotherapy Workflow
- Describe the full radiotherapy treatment process from imaging to patient setup.
- Understand intra- and inter-fraction motion management techniques to improve treatment accuracy.

Content

- This module is designed to provide students with the theoretical and practical aspects of treating/curing cancer with radiotherapy technologies
- This module gives an overview about current status of technologies for advanced radiotherapy treatments
- Furthermore, this module gives knowledge about image process for quantitative information extraction
- Table of contents
    - Introduction to the course and radiotherapy
    - Type of beams and accelerators: photon and particle interactions; linac, cyclotron and synchrotron
    - Radiobiology
    - Radiotherapy workflow
    - Algorithms for dose calculation and introduction to TPS
    - Excursion to radiotherapy facility
    - Fractionation schemes and patient set up
    - Project introduction and methodology (Joana/Lina)
    - Intra-fraction + Inter-fraction motion management
    - Adaptive Radiotherapy
    - Synthetic CT for MRI-guided, online adaptive RT
    - Advanced machines and other radiotherapy techniques
    - FLASH radiotherapy
    - Advanced particle therapy

Module Grade Calculation
The module grade is the grade of the oral exam.

Additional Information
The course is limited to a number of 20 participants due to capacity reasons. If necessary, a selection procedure will be carried out. Places will be allocated taking into account the students' study program (students of “Biomedical Engineering” program will be preferred, students from Mechatronic and Computer Science Program and interest in medical applications will be preferred) and academic progress. Details will be announced on the lecture website

Workload
The workload includes:

1. attendance in lectures and exercises: 15*4 h = 60 h
2. preparation / follow-up: 15*4 h = 60 h
3. preparation of and attendance in examination: 60 h

A total of 180 h = 6 CR

Recommendations

- Basic knowledge in the field of medical imaging;
- Knowledge of basic interaction of photon/particle interactions
- It is recommended to have access to a personal computer or desktop

M 13.239 Module: Test of Embedded Systems in Industrial Contexts [M-ETIT-100546]

Responsible: Prof. Dr.-Ing. Eric Sax
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100811	Test of Embedded Systems in Industrial Contexts	4 CP	Sax

Prerequisites
none

M 13.240 Module: Thermal-Fluid-Dynamics [M-MACH-107112]

Responsible: Dr. Sebastian Ruck
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-106372	Thermal-Fluid-Dynamics	4 CP	Ruck

Assessment
see individual course

Prerequisites
none

Competence Goal
The objectives of the lecture are the fundamentals of thermal-hydraulics for describing and modelling convective fluid flow as occurring in power engineering components. A major objective is the description of the convective heat transfer for external and internal flows. A key issue is the transfer of analytic models and empirical results into "state of the art" computational tools and their validation by advanced experimental methods. Within the scope of the course, the students learn (a) to develop differential equation for thermal-hydraulic problems and to describe the thermal flow field by means of dimensionless parameters, (b) to transfer a real problem to an experiment or computational model, (c) to develop analogies and correlations for heat transfer processes of forced convection, (d) to select adequate computational methods/models, (e) to evaluate and select experiments including measurement techniques with adequate instrumentation for thermal-hydraulic problems and (f) to know design option for an efficient and effective heat exchange.

Content

- Fundamentals of flows and heat transfer
- Dimensionless parameters of thermal fluid dynamics
- Velocity and temperature laws in boundary layers
- Convective heat transfer of external and internal flows
- Heat transfer analogies (Prandtl-, von Kárman, Martinelli,…)
- Methods for enhancing heat transfer
- Strategies and methods for investigation of thermal-hydraulics in R&D

The lecture provides an overview of momentum and energy transport as occurring in power engineering components and heat exchangers. On the basis of the conservation equations and the fundamentals of thermal-hydraulics, dimensionless parameters for forced and free convection are evolved. Flows close to walls play a crucial role for the convective heat transfer and for heat exchanger components. Thus, with scaling rules the laminar and turbulent thermal boundary layer equations are introduced. In the following, velocity and temperature laws of the wall as a basis for analogies and models of computational tools are discussed and the influence of roughness and surface design are shown. Concepts of state-of-the-art turbulence modelling and their applicability for different conditions or different heat transfer fluids (e.g. liquid metals, gas, oil) are described. Analogies and correlations for internal and external forced convection are developed by means of approximation concepts. Design options to enhance the efficiency and effectiveness of heat exchangers are discussed.

Module Grade Calculation
The grade correspondends to the grade of the oral examination.

Workload
120 hours, of which 30 hours anttendance and 90 hours self-study

M 13.241 Module: Ubiquitous Computing (24146) [M-INFO-107161]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-INFO-114188	Ubiquitous Computing	5 CP	Beigl

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The aim of the lecture is to impart knowledge of the fundamentals and advanced methods and techniques of ubiquitous computing. After completing the lecture, students will be able to
reproduce and discuss what they have learnt about existing ubiquitous computing systems.
evaluate the general knowledge of ubiquitous systems and transfer statements and laws to special cases.
evaluate and assess different methods for design processes and user studies and select suitable methods for the development of new solutions.
invent, plan, design and evaluate new ubiquitous systems for use in everyday or industrial process environments and assess the costs and technical implications.

Content
The lecture provides an overview of the history and teaches the concepts, theories and methods of ubiquitous information technology (ubiquitous computing). Based on the appliance concept, students then design their own appliances in the exercise, plan the construction and then develop them. The necessary technical and methodological basics such as hardware for ubiquitous systems, software for ubiquitous systems, principles of context recognition for ubiquitous systems, networking of ubiquitous systems and design of ubiquitous systems and in particular information appliances are discussed. Methods of design and testing for human-machine interaction and human-machine interfaces developed in ubiquitous computing are explained in detail. There is also an introduction to the economic aspects of a ubiquitous system.

In the practical part of the lecture, the understanding of ubiquitous systems is deepened through practical application of the knowledge base of the lecture. The students design and develop their own appliance and test it. The aim is to have gone through the steps towards a prototypical and possibly marketable appliance.

Workload
The total workload for this course unit is approximately 150 hours (5.0 credits).
Activity
Workload
Attendance time: Attendance of the lecture
15 x 90 min
22 h 30 min
Attendance time: Attendance of the exercise
15 x 45 min
11 h 15 min
Preparation / follow-up of the lecture and exercise
15 x 90 min
22 h 30 min
Developing a self-developed concept for an information appliance
33 h 45 min
Go through set of slides 2x
2 x 12 h
24 h 00 min
Prepare exam
36 h 00 min
TOTAL
150 h 00 min
Workload for the course unit "Ubiquitous Information Technologies

M 13.242 Module: Ultrasound Imaging [M-ETIT-100560]

Responsible: Dr. Nicole Ruiter
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)
Profiling Modules (Medical Technology and Clinical Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100822	Ultrasound Imaging	3 CP	Ruiter

Prerequisites
none

M 13.243 Module: Verified Numerical Methods [M-ETIT-104493]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-109184	Verified Numerical Methods	4 CP	Hohmann

M 13.244 Module: Wearable Robotic Technologies [M-INFO-107113]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: Elective Modules (Electives)
Profiling Modules (Engineering Modules)

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114145	Wearable Robotic Technologies	4 CP	Asfour, Beigl

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student has received fundamental knowledge about wearable robotic technologies and understands the requirements for the design, the interface to the human body and the control of wearable robots. He/she is able to describe methods for modelling the human neuromusculoskeletal system, the mechatronic design, fabrication and composition of interfaces to the human body. The student understands the symbiotic human–machine interaction as a core topic of Anthropomatics and has knowledge of state-of-the-art examples of exoskeletons, orthoses and prostheses.

Content
The lecture provides an overview of wearable robot technologies (exoskeletons, prostheses and ortheses) and their potentials. It starts with the basics of wearable robotics and introduces different approaches to the design of wearable robots and their related actuator and sensor technology. The lecture focuses on modeling the neuromusculoskeletal system of the human body, the interfaces of wearable robots to the human body and the physical and cognitive human-robot interaction for tightly-coupled hybrid human-robot systems. Examples of current research and various applications of lower, upper and full body exoskeletons as well as prostheses are presented.

Workload
Lecture with 2 SWS, 4 LP
4 LP corresponds to 120 hours, including
15 * 2 = 30 hours attendance time
15 * 3 = 45 self-study
45 hours preparation for the exam

Recommendations
Attendance of the lecture Mechano-Informatics in Robotics is recommended.

13.245 Module: Workshop Finite Element Method in Electromagnetics [M-ETIT-107147]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Modules (Electives)

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-114166	Workshop Finite Element Method in Electromagnetics	3 CP	Doppelbauer

Assessment
Success control takes place in the form of different types of examination consisting of a written assignment in the form of an written report.

Prerequisites
none

Competence Goal
In this course, students acquire basic knowledge about the application of the finite element method in electromagnetic analysis: mathematical principles, levels of abstraction, model creation and result analysis.

Content

- Introduction to the mathematical basics of the finite element method (FEM) of electromagnetics
- Presentation of the industry-standard software ANSYS Maxwell
- Construction of a model of a permanently excited synchronous machine
- Presentation and implementation of optimization strategies for the design of machines with regard to various parameters
- Introduction to results analysis

The module teaches students

- How to use industry-standard software from the field of electromagnetic FEM
- Solve basic practical tasks in the field of electromagnetic FEM
- Approaches to optimizing various parameters using the example of electrical machines
- Question and evaluate the results of a simulation or optimization

Module Grade Calculation
The module grade is the grade of the written paper.

Workload

1. Attendance time: 20h
2. Preparation and follow-up time: 10h
3. Project work: approx. 60h

   Total approx. 90 h, corresponds to 3 CP

Recommendations
Knowledge from the modules "Elektrische Maschinen und Stromrichter" and "Entwurf elektrischer Maschinen" is desired.

14 Courses

T 14.1 Course: Adaptive Optics [T-ETIT-107644]

Responsible: Dr. Szymon Gladysz
Prof. Dr. Ulrich Lemmer

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-103802 - Adaptive Optics

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2313724	Adaptive Optics	2 SWS	Lecture / 🗣	Gladysz

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Type of Examination: Oral examination

Duration of Examination: approx. 30 Minutes

Modality of Exam: The oral exam will be scheduled during the semester break.

The module grade is the grade of the oral exam.

Prerequisites
None.

Recommendations
Basic knowledge of statistics.

Workload
90 hours

T 14.2 Course: Advanced Artificial Intelligence [T-INFO-114220]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107198 - Advanced Artificial Intelligence

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	1

Events					
ST 2025	2400141	Advanced Artificial Intelligence	4 SWS	Lecture / 🗣	Niehues, Lioutikov

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites
None.

T 14.3 Course: Advanced Communications Engineering [T-ETIT-113676]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106815 - Advanced Communications Engineering

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	1

Assessment
The assessment takes place in the form of a written examination lasting 120 min.

The module grade is the grade of the written exam.

Prerequisites
none

T 14.4 Course: Advanced Molecular Cell Biology [T-CHEMBIO-105196]

Responsible: Dr. Franco Weth
Organisation: KIT Department of Chemistry and Biosciences
Part of: M-CHEMBIO-101904 - Advanced Molecular Cell Biology

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each winter term	2

Assessment
Examination: 120min (written) or approx. 45min (oral)

Prerequisites
none

Recommendations
Passed exam of the Adjustment Course in “Basic Molecular Cell Biology”.

Additional Information
Advanced textbook or review articles will be announced on a weekly basis. They have to be read by all participants. The contents will be discussed in the class sessions. Each class session is chaired by one participant and all participants have to contribute a sub-chapter / figure per session. For the problems class, exercise sheets will be handed out and participants have to be prepared to present their solutions.

Workload
150 hours

T 14.5 Course: Analog Circuit Design [T-ETIT-100973]

Responsible: Prof. Dr. Ivan Peric
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100466 - Analog Circuit Design

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2312664	Analog Circuit Design	2 SWS	Lecture / 🔀	Peric
WT 24/25	2312666	Tutorial for 2312664 Analog Circuit Design	1 SWS	Practice / 🔀	Peric

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 14.6 Course: Antennas and Beamforming [T-ETIT-113920]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106956 - Antennas and Beamforming

Type	Credits	Grading	Recurrence	Expansion	Version
Written examination	4 CP	graded	Each winter term	1 terms	1

Events					
WT 25/26	2308465	Antennas and Beamforming	2 SWS	Lecture / 🗣	Younis
WT 25/26	2308466	Tutorial for 2308465 Antennas and Beamforming	1 SWS	Practice / 🗣	Younis

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of a written examination lasting 120 minutes.
The module grade is the grade of the written exam.

Prerequisites
none

Recommendations
Knowledge of the basics of radio frequency technology and some basic knowledge on communication and radar systems is recommended.

T 14.7 Course: Appliance and Power Tool Design [T-MACH-105229]

Responsible: Prof. Dr.-Ing. Sven Matthiesen
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102705 - Appliance and Power Tool Design

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	4

Events					
ST 2025	2145164	Power Tool Design	2 SWS	Lecture / 🗣	Matthiesen

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
Approx. 30 min oral exam

The Appliance and Power Tool Design Project Work will be examined in conjunction with the concurrent lecture. To ensure that the impact on the overall grade is appropriate, the weighting of the exam is 12 credits, for MSc Mechanical Engineerring 2025.

Prerequisites
T-MACH-110767 - Appliance and Power Tool Design Project Work must be started.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-110767 - Appliance and Power Tool Design Project Work must have been started.

Recommendations
None

Additional Information
The participation in the lecture requires the participation in Appliance and Power Tool Design Project Work.
Due to organizational reasons, the number of participants is limited. In the beginning of August, a registration form will be available at the IPEK website. The selection itself is made by the course's responsible in personal interviews. The criterion for selection is the verified progress of studies. In the event of equal progress, the decision is made by lot.

The course is offered in German.

Workload
120 hours

T 14.8 Course: Appliance and Power Tool Design Project Work [T-MACH-110767]

Responsible: Prof. Dr.-Ing. Sven Matthiesen
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-102705 - Appliance and Power Tool Design

Type	Credits	Grading	Recurrence	Expansion	Version
Coursework	8 CP	pass/fail	Each summer term	1 terms	3

Events					
ST 2025	2145165	Power Tool Design Project Work	4 SWS	Project (P / 🗣	Matthiesen

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The Appliance and Power Tool Design Project Work will be examined in conjunction with the concurrent lecture.

Prerequisites
None

Recommendations
None

Additional Information
The participation in the project work requires the participation in “Appliance and power tool design”.
Due to organizational reasons, the number of participants is limited. In the beginning of August, a registration form will be available at the IPEK website. The selection itself is made by the course's responsible in personal interviews. The criterion for selection is the verified progress of studies. In the event of equal progress, the decision is made by lot.

The course is offered in German.

Workload
240 hours

T 14.9 Course: Applied Information Theory [T-ETIT-100748]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100444 - Applied Information Theory

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each winter term	1

Events					
WT 24/25	2310537	Applied Information Theory	3 SWS	Lecture /	Jäkel
WT 24/25	2310539	Tutorial for 2310537 Applied Information Theory	1 SWS	Practice /	Jäkel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The success control takes place in the form of an oral examination lasting 25 minutes. Before the examination, there is a preparation phase of 15 minutes in which preparatory tasks are solved.

Prerequisites
none

T 14.10 Course: Authentication and Encryption [T-INFO-110824]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: M-INFO-105338 - Authentication and Encryption

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2400045	Authentication and Encryption	2 SWS	Lecture / 🗣	Müller-Quade, Bayreuther

Legend: 🖥 Online, ⚭ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

T 14.11 Course: Automated Visual Inspection and Image Processing [T-INFO-101363]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: M-INFO-100826 - Automated Visual Inspection and Image Processing

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	2

Events					
WT 24/25	2424169	Automated Visual Inspection and Image Processing	4 SWS	Lecture / 🗣	Beyerer, Zander

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

14.12 Course: Basic Molecular Cell Biology [T-CHEMBIO-105199]

Responsible: Dr. Franco Weth
Organisation: KIT Department of Chemistry and Biosciences
Part of: M-CHEMBIO-101903 - Basic Molecular Cell Biology

Type	Credits	Grading	Recurrence	Version
Coursework	2 CP	pass/fail	Each summer term	2

Events					
ST 2025	7148	Basic Molecular Cell Biology KSOP	2 SWS	Lecture / 🗣	Weth

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The written exam over 120 Minutes is scheduled for the beginning of the break after the SS.
A resit exam is offered at the end of the break.

Prerequisites
none

Recommendations
Basic knowledge in General Chemistry

Workload
60 hours

14.13 Course: Basic Seminar Supplementary Studies on Science, Technology and Society - Self Registration [T-FORUM-113579]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation: General Studies. Forum Science and Society (FORUM)

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Recurrence	Expansion	Version
Coursework	2 CP	pass/fail	Each summer term	1 terms	1

Assessment
Study achievement in the form of a presentation or a term paper or project work in the selected course.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
It is recommended that the basic seminar be completed during the same semester as the lecture series "Science in Society". If it is not possible to attend the lecture series and the basic seminar in the same semester, the basic seminar can also be attended in the semesters before the lecture series.
However, attending courses in the advanced unit before attending the basic seminar should be avoided.

T 14.14 Course: Basics of Converter Control [T-ETIT-100717]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100400 - Basics of Converter Control

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each summer term	2

Events					
ST 2025	2306330	Basics of Converter Control	2 SWS	Lecture / 🗣	Liske

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Prerequisites
none

T 14.15 Course: Basics of Finite Elements [T-BGU-100047]

Responsible: Prof. Dr.-Ing. Peter Betsch
Organisation: KIT Department of Civil Engineering, Geo and Environmental Sciences
Part of: M-BGU-100052 - Basics of Finite Elements

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	5 CP	graded	Each term	1 terms	2

Events					
WT 24/25	6215901	Grundlagen Finite Elemente	2 SWS	Lecture / 🗣	Franke
WT 24/25	6215902	Übungen zu Grundlagen Finite Elemente	2 SWS	Practice / 🗣	Reiff

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
oral exam, appr. 30 min.

Prerequisites
none

Recommendations
none

Additional Information
none

Workload
150 hours

T 14.16 Course: Basics of Nanotechnology I [T-PHYS-102529]

Responsible: apl. Prof. Dr. Gernot Goll
Organisation: KIT Department of Physics
Part of: M-PHYS-102097 - Basics of Nanotechnology I

Type	Credits	Grading	Version
Oral examination	4 CP	graded	1

Events					
WT 24/25	4021041	Basics of Nanotechnology I	2 SWS	Lecture / 🗣	Goll

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.17 Course: Basics of Nanotechnology II [T-PHYS-102531]

Responsible: apl. Prof. Dr. Gernot Goll
Organisation: KIT Department of Physics
Part of: M-PHYS-102100 - Basics of Nanotechnology II

Type	Credits	Grading	Version
Oral examination	4 CP	graded	1

Events					
ST 2025	4021151	Basics of Nanotechnology II	2 SWS	Lecture / 🗣	Goll

Legend: 🖥 Online, ⚃ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.18 Course: Basics of Technical Logistics II [T-MACH-109920]

Responsible: Prof. Dr.-Ing. Kai Furmans
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105302 - Basics of Technical Logistics II

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	2

Events					
WT 24/25	2117098	Basics of Technical Logistics II	3 SWS	Lecture / Practice (/ 🗣	Mittwollen

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
The assessment consists of a written exam (60 min.) according to § 4 paragraph 2 Nr. 1 of the examination regulation.

Prerequisites
none

Recommendations
Knowledge of the basics of technical mechanics and out of "Basic of Technical Logstics I" (T-MACH-109919) preconditioned.

Workload
150 hours

T 14.19 Course: Batteries and Fuel Cells Laboratory [T-ETIT-100708]

Responsible: Dr.-Ing. Andre Weber
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100381 - Batteries and Fuel Cells Laboratory

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each winter term	1

Events					
WT 24/25	2304235	Batteries and Fuel Cells Laboratory	4 SWS	Practical course / 🗣	Weber
WT 25/26	2304235	Batteries and Fuel Cells Laboratory	4 SWS	Practical course / 🗣	Weber

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 14.20 Course: Batteries, Fuel Cells, and Electrolysis [T-ETIT-113986]

Responsible: Prof. Dr.-Ing. Ulrike Krewer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107005 - Batteries, Fuel Cells, and Electrolysis

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	1

Events					
WT 25/26	2304240	Batteries, Fuel Cells and Electrolysis	2 SWS	Lecture /	Krewer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Success control takes place in the form of a written examination lasting 120 minutes.

The module grade is the grade of the written examination.

Prerequisites
The following partial achievements must not have started:

- T-ETIT-100983 - Batterien und Brennstoffzellen
- T-ETIT-114097 - Batterien, Brennstoffzellen und ihre Systeme

T 14.21 Course: Biologically Inspired Robots [T-MACH-113856]

Responsible: Prof. Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-106903 - Biologically Inspired Robots

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	3 CP	graded	Each summer term	1 terms	1

Events					
ST 2025	2122330	Biologically Inspired Robots	2 SWS	Lecture / 🗣	Rönnau

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
Success is assessed in the form of an oral examination (approx. 15-20 minutes)

Prerequisites
none

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-INFO-101351 - Biologically Inspired Robots must not have been started.

Recommendations
It is recommended to listen to the course "Robotics I" beforehand .

Additional Information
none

Workload
90 hours

T 14.22 Course: Biomechanics: Design in Nature and Inspired by Nature [T-MACH-105651]

Responsible: Prof. Dr. Claus Mattheck
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107181 - Biomechanics: Design in Nature and Inspired by Nature

Type	Credits	Grading	Recurrence	Version
Coursework	4 CP	pass/fail	Each winter term	2

Assessment
Colloquium, ungraded.

Additional Information
The number of participants is limited. Prior registration through ILIAS is necessary, In case of too many registrations, a selection (in accordance with SPO) will take place.

Before the registration in SP 26 (ME) or SP 01 (MSMT) the participation at the seminar must be confirmed.

Workload
120 hours

T 14.23 Course: Biomedical Engineering for Engineers - Fundamentals of Project Management in Medical Engineering [T-MACH-112817]

Responsible: Dr. Ralf Ahrens
Prof. Dr. Andreas Guber
Dr. Taleieh Rajabi

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106461 - Biomedical Engineering for Engineers - Fundamentals of Project Management in Medical Engineering

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	4 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2141104	Biomedical Engineering for Engineers - Fundamentals of Project Management in Medical Engineering	2 SWS	Lecture / 🖥	Rajabi, Guber, Ahrens

Legend: 🖥 Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Assessment
oral exam (approx. 20 Min)

Prerequisites
none

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-111069 - BioMEMS - Microfludic Chipsystems V must not have been started.

Workload
120 hours

T 14.24 Course: BioMEMS - Microfludic Chipsystems V [T-MACH-111069]

Responsible: Prof. Dr. Andreas Guber
Dr. Taleieh Rajabi

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105484 - BioMEMS - Microfludic Chipsystems V

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	4 CP	graded	Each winter term	1 terms	2

Assessment
oral exam (appr. 20 Min.)

Prerequisites
none

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-112817 - Biomedical Engineering for Engineers - Fundamentals of Project Management in Medical Engineering must not have been started.

Workload
120 hours

T 14.25 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I [T-MACH-100966]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100489 - BioMEMS - Microsystems Technologies for Life Sciences and Medicine I

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	2

Events					
WT 24/25	2141864	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I	2 SWS	Lecture / 🗣	Guber, Ahrens

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written exam (75 Min.)

Prerequisites
none

Workload
120 hours

T 14.26 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II [T-MACH-100967]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100490 - BioMEMS - Microsystems Technologies for Life Sciences and Medicine II

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	2

Events					
ST 2025	2142883	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II	2 SWS	Lecture / 🗣	Guber, Ahrens

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written exam (75 Min.)

Prerequisites
none

Workload
120 hours

T 14.27 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III [T-MACH-100968]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100491 - BioMEMS - Microsystems Technologies for Life Sciences and Medicine III

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	2

Events					
ST 2025	2142879	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III	2 SWS	Lecture / 🗣	Guber, Ahrens

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written exam (75 Min.)

Prerequisites
none

Workload
120 hours

T 14.28 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV [T-MACH-106877]

Responsible: Dr. Ralf Ahrens
Prof. Dr. Andreas Guber

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105483 - BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2141102	BioMEMS IV - Microsystems technology for Life Sciences and Medicine	2 SWS	Lecture / 🗣	Guber, Ahrens, Länge
ST 2025	2142893	BioMEMS IV - Microsystems technology for Life Sciences and Medicine	2 SWS	/ ✕	Ahrens, Länge, Doll
WT 25/26	2141102	BioMEMS IV - Microsystems technology for Life Sciences and Medicine	2 SWS	Lecture / 🗣	Guber, Ahrens, Länge

Legend: 🖥 Online, ⯐ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Oral examination (45 Min.)

Prerequisites
none

Workload
120 hours

T 14.29 Course: Business Innovation in Optics and Photonics [T-ETIT-104572]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-101834 - Business Innovation in Optics and Photonics

Type	Credits	Grading	Recurrence	Version
Examination of another type	4 CP	graded	Each winter term	1

Events					
WT 24/25	2305742	Business Innovation in Optics and Photonics	2 SWS	Lecture / 🗣	Riedel, Nahm
WT 24/25	2305743	Erxercise for 2305742 Business Innovation in Optics and Photonics	1 SWS	Practice / 🗣	Riedel, Nahm

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Type of Examination: examination of another type

Duration of Examination: 4 group presentations à 20 minutes (approx.)

Modality of Exam: The exam consists of four group presentations. 2nd day: Technology Presentation. 3rd day: Development plan presentation. 4th day: Business Canvas presentation. Final presentation at Zeiss visit: Business pitch

Prerequisites
Good knowledge in optics & photonics.

T 14.30 Course: CAE-Workshop [T-MACH-105212]

Responsible: Prof. Dr.-Ing. Tobias Düser
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102684 - CAE-Workshop

Type	Credits	Grading	Recurrence	Version
Examination of another type	4 CP	graded	Each term	2

Events					
WT 24/25	2147175	CAE-Workshop	3 SWS	Block / 🗣	Düser
ST 2025	2147175	CAE-Workshop	3 SWS	Block / 🗣	Düser
WT 25/26	2147175	CAE-Workshop	3 SWS	Block / 🗣	Düser

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
Written test (with practical part on the computer), duration 60 min.

Prerequisites
None

Additional Information
Consistent attendance on the workshop days is required for successful participation in the exam. The number of participants is limited. Selection will be made by drawing lots after the end of the registration period.

The course is offered in German.

Workload
120 hours

T 14.31 Course: Channel Coding: Algebraic Methods for Communications and Storage [T-ETIT-111244]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105616 - Channel Coding: Algebraic Methods for Communications and Storage

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	3 CP	graded	Each summer term	1 terms	1

Events					
ST 2025	2310546	Channel Coding: Algebraic Methods for Communications and Storage	2 SWS	Lecture / 🧩	Schmalen

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The exam is held as an oral exam of 20 Min according to 4 Abs. 2 Nr. 1 SPO Bachelor/Master Elektrotechnik und Informationstechnik. Grade of the module corresponds to the grade of the oral exam.

Prerequisites
none

Recommendations
Previous attendance of the lectures "Communication Engineering I" and "Probability Theory" is recommended.

T 14.32 Course: Channel Coding: Graph-Based Codes [T-ETIT-111245]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105617 - Channel Coding: Graph-Based Codes

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	6 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2310520	Channel Coding: Graph-Based Codes	3 SWS	Lecture /	Schmalen
WT 24/25	2310521	Exercise for 2310520 Channel Coding: Graph-Based Codes	1 SWS	Practice /	Schmalen
WT 25/26	2310520	Channel Coding: Graph-Based Codes	3 SWS	Lecture /	Schmalen
WT 25/26	2310521	Exercise for 2310520 Channel Coding: Graph-Based Codes	1 SWS	Practice /	Schmalen

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The success control takes place in the form of an oral examination lasting 25 minutes. Before the examination, there is a preparation phase of 30 minutes in which preparatory tasks are solved.

Prerequisites
none

Recommendations
Previous attendance of the lectures "Communication Engineering I" and "Theory of Probability" is recommended. Knowledge from the lectures "Applied Information Theory" and "Verfahren der Kanalcodierung" is helpful.

14.33 Course: Communication Systems and Protocols [T-ETIT-101938]

Responsible: Dr.-Ing. Jens Becker
Prof. Dr.-Ing. Jürgen Becker

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-100539 - Communication Systems and Protocols

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each summer term	1

Events					
ST 2025	2311616	Communication Systems and Protocols	2 SWS	Lecture / 🗣	Becker, Becker
ST 2025	2311618	Tutorial for 2311616 Communication Systems and Protocols	1 SWS	Practice / 🗣	Stammler

Legend: 🖥 Online, ✣ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.34 Course: Communications Engineering Laboratory [T-ETIT-114159]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107136 - Communications Engineering Laboratory

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2310517	Communication Engineering Laboratory	4 SWS	Practical course / 🗘	Schmalen, Jäkel, Edelmann
ST 2025	2310517	Communications Engineering Laboratory	4 SWS	Practical course / 🗘	Schmalen, Jäkel, Edelmann
WT 25/26	2310517	Communications Engineering Laboratory	4 SWS	Practical course / 🗘	Schmalen, Jäkel, Edelmann

Legend: 🖥 Online, 🗘 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination consists of the participation in the experiments and an oral examination. The overall impression is rated.

The module grade results of the participation in the experiments and an oral examination. Details will be given during the lecture.

Prerequisites
none

Recommendations
Previous attendance of the lectures "Signals and Systems" and "Communications Engineering I".

T 14.35 Course: Components of Power Systems [T-ETIT-113445]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106689 - Components of Power Systems

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2307397	Components of Power Systems	2 SWS	Lecture / 🗣	Kaptue Kamga

Legend: 🖥 Online, ⚃ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of an oral examination lasting approx. 20 minutes.
The module grade is the grade of the oral exam.

Prerequisites
none

T 14.36 Course: Computational Imaging [T-INFO-112573]

Responsible: Johannes Meyer
Organisation: KIT Department of Informatics
Part of: M-INFO-106190 - Computational Imaging

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each winter term	1

Events					
WT 24/25	2400173	Computational Imaging	3 SWS	Lecture / Practice (/ 🗣	Meyer, Beyerer
WT 25/26	2400173	Computational Imaging	3 SWS	Lecture / Practice (/ 🗣	Meyer, Beyerer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
The assessment takes the form of a written examination, usually lasting 60 minutes in accordance with Section 4 (2) No. 1 SPO.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take place
- in the form of an oral examination in accordance with Section 4 (2) No. 2 SPO or
- in the form of a written examination in accordance with Section 4 (2) No. 1 SPO.

Prerequisites
None.

T 14.37 Course: Computational Intelligence [T-MACH-105314]

Responsible: Stefan Meisenbacher
apl. Prof. Dr. Ralf Mikut
apl. Prof. Dr. Markus Reischl

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105296 - Computational Intelligence

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2105016	Computational Intelligence	2 SWS	Lecture /	Mikut, Reischl, Meisenbacher

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Written exam (Duration: 1h)

Prerequisites
none

Workload
120 hours

T 14.38 Course: Control of Linear Multivariable Systems [T-ETIT-100666]

Responsible: Dr.-Ing. Mathias Kluwe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100374 - Control of Linear Multivariable Systems

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	1

Events					
WT 24/25	2303177	Control of Linear Multivariable Systems	3 SWS	Lecture / 🗣	Kluwe
WT 24/25	2303179	Control of Linear Multivariable Systems (Tutorial to 2303177)	1 SWS	Practice / 🗣	Fehn

Legend: 🖥 Online, ❁ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is checked as part of a written overall test (120 minutes) of the course.

Prerequisites
none

Recommendations
For a deeper understanding, basic knowledge of system dynamics and control technology is absolutely necessary, as taught in the ETIT Bachelor module "System Dynamics and Control Technology" M-ETIT-102181.

T 14.39 Course: Control of Power-Electronic Systems [T-ETIT-111897]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105915 - Control of Power-Electronic Systems

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	2

Events					
ST 2025	2306337	Control of Power-Electronic Systems	3 SWS	Lecture / 🗣	Liske, Göhner
ST 2025	2306338	Tutorial for 2306337 Control of Power-Electronic Systems	1 SWS	Practice / 🧩	Liske, Göhner

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 14.40 Course: Current Topics on BioMEMS [T-MACH-102176]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105485 - Current Topics on BioMEMS

Type	Credits	Grading	Recurrence	Version
Examination of another type	4 CP	graded	Each term	2

Events					
WT 24/25	2143873	Actual topics of BioMEMS	2 SWS	Seminar / 🧩	Guber, Ahrens
ST 2025	2143873	Actual topics of BioMEMS	2 SWS	Seminar / 🧩	Guber, Ahrens

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
active participation and own presentation (30 Min.)

Prerequisites
none

Workload
120 hours

T 14.41 Course: Cyber-Physical Modeling [T-ETIT-113908]

Responsible: Prof. Dr.-Ing. Mike Barth
Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106953 - Cyber-Physical Modeling

Type	Credits	Grading	Version
Written examination	6 CP	graded	1

Events					
ST 2025	2303310	Cyber Physical Modeling	3 SWS	Lecture / 🗣	Hohmann, Barth
ST 2025	2303311	Tutorial to 2303310 Cyber Physical Modeling	1 SWS	Practice / 🗣	Hohmann, Barth, Thömmes, Schicketanz

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in the form of a written examination lasting 90 min.
The module grade is the grade of the written exam.

Prerequisites
none

T 14.42 Course: Data Analytics for Engineers [T-MACH-105694]

Responsible: Stefan Meisenbacher
apl. Prof. Dr. Ralf Mikut
apl. Prof. Dr. Markus Reischl

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105307 - Data Analytics for Engineers

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each summer term	2

Events					
ST 2025	2106014	Data Analytics for Engineers	3 SWS	Lecture / Practice (/	Mikut, Reischl

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Written exam (Duration: 1h)

Prerequisites
none

Workload
150 hours

T 14.43 Course: Data Science [T-INFO-113124]

Responsible: Prof. Dr.-Ing. Klemens Böhm
Organisation: KIT Department of Informatics
Part of: M-INFO-106505 - Data Science

Type	Credits	Grading	Recurrence	Version
Oral examination	8 CP	graded	Each winter term	2

Events					
WT 24/25	24114	Data Science 1	3 SWS	Lecture / 🗣	Böhm, Kalinke

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment takes the form of an oral examination (usually lasting 20 minutes) in accordance with Section 4 (2) No. 2 SPO.

Depending on the number of participants, it will be announced six weeks before the examination (§ 6 Para. 3 SPO) whether the assessment will take place

- in the form of an oral examination in accordance with § 4 Para. 2 No. 2 SPO **or**
- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO

will take place.

Prerequisites
None.

Recommendations
Database knowledge, e.g. from the **database systems** lecture **,** is required.

Additional Information
Exams are currently not taking place !!!

14.44 Course: Deep Learning for Computer Vision I: Basics [T-INFO-111491]

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: M-INFO-105753 - Deep Learning for Computer Vision I: Basics

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each summer term	2

Events					
ST 2025	2400007	Deep Learning for Computer Vision I: Basics	2 SWS	Lecture / 🗣	Stiefelhagen, Reiß, Peng

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Prerequisites
None.

Recommendations
Basic knowledge of pattern recognition as taught in the module Cognitive Systems, is expected.

Additional Information
The course is partially given in German and English.

T 14.45 Course: Deep Learning for Computer Vision II: Advanced Topics [T-INFO-111494]

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: M-INFO-105755 - Deep Learning for Computer Vision II: Advanced Topics

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each winter term	2

Events					
WT 24/25	2400258	Deep Learning for Computer Vision II: Advanced Topics	2 SWS	Lecture / 🗣	Stiefelhagen, Reiß, Peng
WT 25/26	2400258	Deep Learning for Computer Vision II: Advanced Topics	2 SWS	Lecture / 🗣	Stiefelhagen, Reiß, Peng

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 14.46 Course: Design of Electrical Machines [T-ETIT-100785]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100515 - Design of Electrical Machines

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each winter term	2

Events					
WT 24/25	2306324	Design of Electrical Machines	2 SWS	Lecture / 🧩	Doppelbauer
WT 24/25	2306325	Tutorial for 2306324 Design of Electrical Machines	1 SWS	Practice / 🧩	Doppelbauer

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

Recommendations
Modul: Elektrische Maschinen und Stromrichter

T 14.47 Course: Detectors for Applications in Space and Astronomy [T-ETIT-100761]

Responsible: Prof. Theo Scherer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100541 - Detectores for Applications in Space and Astronomy

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2312678	Detectores for Applications in Space and Astronomy	2 SWS	Lecture	Scherer

Prerequisites
none

14.48 Course: Development Lab Medical Measurement Technology [T-ETIT-113626]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106779 - Medical Measurement Technology Lab

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	1

Assessment
The examination of the Development Lab takes place in form of other types of examinations. It consists of 6 graded protocols to the 6 experiments.
The grade for the Development Lab is the average grade of the 6 protocols.

The module grade is the grade for the Development Lab.

Prerequisites
Students may only take part in the Development Lab if they have successfully completed the Preparatory Lecture and the Preparatory Lab.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-ETIT-113758 - Preparatory Lab Medical Measurement Technology must have been passed.
2. The course T-ETIT-113721 - Preparatory Lecture Medical Measurement Technology must have been passed.

T 14.49 Course: Digital Beam-Forming for Imaging Radar [T-ETIT-110940]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105415 - Digital Beam-Forming for Imaging Radar

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2308450	Digital Beam-Forming for Imaging Radar	2 SWS	Lecture / 🗣	Younis
WT 24/25	2308451	Tutorial for 2308450 Digital Beam-Forming for Imaging Radar	1 SWS	Practice / 🗣	Younis
WT 25/26	2308450	Digital Beam-Forming for Imaging Radar	2 SWS	Lecture / ✕	Younis

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written Exam approx. 120 Min.

Prerequisites
The basic principles will be repeated in the lecture. The following lectures are helpful for a comprehensive understanding: Radar System Engineering (engl.), Antennen und Mehrantennensysteme, Spaceborne Radar Remote Sensing (engl.), Modern Radio System Engineering (engl.)

Recommendations
Basics of signal processing and radar techniques are useful.

T 14.50 Course: Digital Circuit Design [T-ETIT-100974]

Responsible: Prof. Dr. Ivan Peric
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100473 - Digital Circuit Design

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2312683	Digital Circuit Design	2 SWS	Lecture / 🧩	Peric
ST 2025	2312685	Practical Excercise to 2312683 Digital Circuit Design	1 SWS	Practice / 🧩	Peric

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

14.51 Course: Digital Hardware Design Laboratory [T-ETIT-104571]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-102266 - Digital Hardware Design Laboratory

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	1

Events					
ST 2025	2311645	Digital Hardware Design Laboratory	4 SWS	Practical course / 🗣	Becker

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Control of success is carried out in an oral examination as well as during the laboratory exercises in form of laboratory reports and/or oral interrogations.

Prerequisites
none

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module M-ETIT-102264 - Digital Hardware Design Laboratory must not have been started.

Recommendations
Previous knowledge in design and design automation for electronic systems (e.g. from the lectures SAE, No. 23606, HSO, No. 23619 or HMS, No. 23608) is recommended.

Additional Information
The module ETIT-102264 („Praktikum Entwurf digitaler Systeme“) must not have been started or completed.

14.52 Course: Digital Hardware Design Laboratory [T-ETIT-104570]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-102264 - Digital Hardware Design Laboratory

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	1

Events					
ST 2025	2311637	Laboratory in Design Automation	4 SWS	Practical course / 🗣	Becker

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Prerequisites
none

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module M-ETIT-102266 - Digital Hardware Design Laboratory must not have been started.

T 14.53 Course: Digital Real Time Simulations for Energy Technologies [T-ETIT-113449]

Responsible: Prof. Dr.-Ing. Giovanni De Carne
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106690 - Digital Real Time Simulations for Energy Technologies

Type	Credits	Grading	Version
Examination of another type	3 CP	graded	1

Events					
ST 2025	2314013	Digital Real Time Simulations for Energy Technologies	2 SWS	Lecture / 🗣	De Carne

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of other types of examination. It consists of an assessment from an exercise on HiL and an oral overall examination (approx. 15 minutes) explaining the exercise results. The overall impression is evaluated.
The module grade results of the assessment of an exercise and the oral exam. Details will be given during the lecture.

Prerequisites
none

T 14.54 Course: Digital Signal Processing in Optical Communications – with Practical Exercises [T-ETIT-106852]

Responsible: Prof. Dr.-Ing. Sebastian Randel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103450 - Digital Signal Processing in Optical Communications – with Practical Exercises

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	2

Events					
ST 2025	2309472	Digital Signal Processing in Optical Communications	2 SWS	Lecture / 🗣	Randel
ST 2025	2309473	Digital Signal Processing in Optical Communications (Practical Exercises)	2 SWS	Practice / 🗣	Randel

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The exercise sheets and the oral questionnaire are used to rate other types of examinations. The overall impression is assessed. Duration about 20 minutes.

Prerequisites
Basic knowledge of optical communication systems. Proven, for example, by completing one of the modules "Optical Networks and Systems-ONS", "Optoelectronic Components -OC, or" Optical Transmitters and Receivers - OTR.

Recommendations
Knowledge of the basics of optical communication technology and digital signal processing is helpful.

Workload
170 hours

T 14.55 Course: Digital Twin Engineering [T-ETIT-112224]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106040 - Digital Twin Engineering

Type	Credits	Grading	Recurrence	Version
Examination of another type	4 CP	graded	Each winter term	1

Events					
WT 24/25	2301486	Digital Twin Engineering	2 SWS	Lecture / 🗣	Barth, Witucki
WT 25/26	2301486	Digital Twin Engineering	2 SWS	Lecture / 🗣	Barth, Witucki

Legend: 🖥 Online, ⚃ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of other types of examination. It consists of a model library developed in the course of a semester-long project in the modeling language Modelica and a presentation of the library lasting 25 minutes. The quality of the model library is evaluated within the framework of the criteria: documentation, formal correctness, functionality, usability, HMI and modeling level of detail. The presentation is evaluated as an additional aspects. The overall impression is evaluated.

The assessment of the developed model library and the presentation of the library will be included in the module grade. More details will be given at the beginning of the course.

Prerequisites
none

T 14.56 Course: Digitalization from Production to the Customer in the Optical Industry [T-MACH-110176]

Responsible: Dr.-Ing. Marc Wawerla
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105341 - Digitalization from Production to the Customer in the Optical Industry

Type	Credits	Grading	Recurrence	Version
Examination of another type	4 CP	graded	Each winter term	5

Events					
WT 24/25	2149702	Digitalization from Product Concept to Production	2 SWS	Lecture / 🗣	Wawerla

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Alternative test achievement (graded):
- Written processing of a case study (weighting 50%) and
- Presentation of the results (ca. 10 min.) followed by a colloquium (ca. 30 min.), (weighting 50%)

Prerequisites
none

Additional Information
For organisational reasons, the number of participants for the course is limited. As a result, a selection process will take place. Further information for application can be found via: https://www.wbk.kit.edu/english/education.php.

Workload
120 hours

14.57 Course: Distributed Discrete Event Systems [T-ETIT-100960]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100361 - Distributed Discrete Event Systems

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2302106	Distributed Discrete Event Systems	2 SWS	Lecture / 🧩	Heizmann, Hoffmann
ST 2025	2302108	Practice to Distributed Discrete Event Systems	1 SWS	Practice / 🗣	Hoffmann

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.58 Course: Dosimetry of Ionising Radiation [T-ETIT-104505]

Responsible: PD Dr. Bastian Breustedt
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-101847 - Dosimetry of Ionising Radiation

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each winter term	2

Events					
WT 24/25	2305294	Dosimetry of Ionising Radiation	2 SWS	Lecture / 🗣	Breustedt
WT 25/26	2305294	Dosimetry of Ionising Radiation	2 SWS	Lecture / 🗣	Breustedt

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success control is carried out as part of an overall written examination (2 h).

Prerequisites
none

T 14.59 Course: Drive System Engineering B: Stationary Machinery [T-MACH-114000]

Responsible: Sascha Ott
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107190 - Drive System Engineering B: Stationary Machinery

Type	Credits	Grading	Recurrence	Expansion	Version
Written examination	4 CP	graded	Each winter term	1 terms	2

Assessment
written examination: 90 min duration

Prerequisites
Mutual exclusion with T-MACH-113981 (combined course/ exam) and T-MACH-105216 (German variant)

Recommendations
None

Additional Information
None

Workload
120 hours

T 14.60 Course: Educational Development for Student Teachers - Basic Level [T-ETIT-100797]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Version
Coursework	2 CP	pass/fail	Each term	1

Events					
WT 24/25	2411802	Tutorenschulung „Start in die Lehre“ (PEBA)		Others (sons	Heß

Assessment
Success monitoring consists of participation in attendance modules (attendance requirement of 80%) and submission of a written reflection portfolio.

Attendance is required both to perform the work as a team on-site and to provide practical techniques and skills that cannot be learned in pure self-study.

Prerequisites
Part-time work as a tutor at KIT during program participation.

14.61 Course: Elective Specialization Supplementary Studies on Science, Technology and Society / About Knowledge and Science - Self-Registration [T-FORUM-113580]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation: General Studies. Forum Science and Society (FORUM)

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each term	1

Assessment
Another type of examination assessment under § 5, section 3 involves a presentation, term paper, or project work within the chosen course.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
The contents of the basic module are helpful. The basic module should be completed or attended in parallel, but not after the advanced module.
The reading recommendations for primary and specialist literature are determined individually by the respective lecturers according to the subject area and course.

Additional Information
This placeholder can be used for any achievement in the Advanced Unit of the Supplementary Studies.

In the Advanced Module, students can choose their own individual focus, e.g. sustainable development, data literacy, etc. The focus should be discussed with the module coordinator at the FORUM.

T 14.62 Course: Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Public Debates - Self Registration [T-FORUM-113582]

Responsible:	Dr. Christine Mielke Christine Myglas
Organisation:	General Studies. Forum Science and Society (FORUM)
Part of:	M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each term	1

Assessment
Another type of examination assessment under § 5, section 3 involves a presentation, term paper, or project work within the chosen course.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
The contents of the basic module are helpful. The basic module should be completed or attended in parallel, but not after the advanced module.
The reading recommendations for primary and specialist literature are determined individually by the respective lecturers according to the subject area and course.

Additional Information
This placeholder can be used for any achievement in the Advanced Unit of the Supplementary Studies.

T 14.63 Course: Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Society - Self-Registration [T-FORUM-113581]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation: General Studies. Forum Science and Society (FORUM)

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each term	1

Assessment
Another type of examination assessment under § 5, section 3 involves a presentation, term paper, or project work within the chosen course.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
The contents of the basic module are helpful. The basic module should be completed or attended in parallel, but not after the advanced module.
The reading recommendations for primary and specialist literature are determined individually by the respective lecturers according to the subject area and course.

Additional Information
This placeholder can be used for any achievement in the Advanced Unit of the Supplementary Studies.

T 14.64 Course: Electric Drives and Power Electronics Lab [T-ETIT-114162]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107138 - Electric Drives and Power Electronics Lab

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	1

Events					
ST 2025	2306331	Lab Course Electrical Drives and Power Electronics	4 SWS	Practical course / 🗣	Brodatzki, Hiller

Legend: 🖥 Online, ✿ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success control takes place in the form of other types of examination. It consists of one oral examination per experiment. The overall impression is assessed.

The assessments of the oral examinations are included in the module grade. Further details will be provided at the beginning of the course.

Prerequisites
none

T 14.65 Course: Electrical Energy Systems Lab [T-ETIT-114160]

Responsible: Dr.-Ing. Rainer Badent
Prof. Dr. Martin Doppelbauer
Prof. Dr.-Ing. Thomas Leibfried

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-107137 - Electrical Energy Systems Lab

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each winter term	1

Events					
WT 24/25	2307398	Lab Course Electrical Power Engineering	4 SWS	Practical course / 🗣	Badent, Brodatzki, N.N.

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success control takes place in the form of other types of examinations consisting of written and oral questions on the content of the experiments. The overall impression is assessed.
The questions on the individual experiments are included in the module grade. Further details will be provided at the beginning of the course.

Prerequisites
none

Recommendations
Participation in the courses Elektrische Maschinen and Stromrichter and Elektroenergiesysteme (bachelor courses)

Additional Information
Joint event of the IEH and the ETI.

T 14.66 Course: Electrocatalysis [T-ETIT-111831]

Responsible: Dr. Philipp Röse
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105883 - Electrocatalysis

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each summer term	2

Events					
ST 2025	2304300	Electrocatalysis	3 SWS	Lecture / 🗣	Röse
ST 2025	2304301	Exercise to 2304300 Electrocatalysis	1 SWS	Practice / 🗣	Röse

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

T 14.67 Course: Electromagnetics and Numerical Calculation of Fields [T-ETIT-100640]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100386 - Electromagnetics and Numerical Calculation of Fields

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2308263	Electromagnetics and Numerical Calculation of Fields	2 SWS	Lecture / 🗣	Pauli
WT 24/25	2308265	Exercise for 2308263 Electromagnetics and Numerical Calculation of Fields	1 SWS	Practice / 🗣	Pauli, Giroto de Oliveira

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success control is carried out in the form of a written test of 120 minutes.

Prerequisites
none

Recommendations
Fundamentals of electromagnetic field theory.

T 14.68 Course: Electronic Circuits for Light Sources and Laser [T-ETIT-100783]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100511 - Electronic Circuits for Light Sources and Laser

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2313746	Electronic Circuits for Light Sources and Laser	2 SWS	Lecture / 🗣	Kling

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.69 Course: Electronics and EMC [T-ETIT-100723]

Responsible: Dr. Martin Sack
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100410 - Electronics and EMC

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2307378	Electronics and EMC	2 SWS	Lecture / 🗣	Sack

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 14.70 Course: Engineer's Field of Work [T-MACH-105721]

Responsible: Prof. Dr. Martin Doppelbauer
Prof. Dr.-Ing. Marcus Geimer

Organisation: KIT Department of Mechanical Engineering

Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Version
Coursework (written)	2 CP	pass/fail	Each summer term	2

Events					
ST 2025	2114917	Engineer's Field of Work	2 SWS	Lecture / 🗣	Doppelbauer, Geimer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written test

Duration: 60 minutes

result: passed / not passed

No tools or reference materials may be used during the exam.

Prerequisites
none

Additional Information
The course is offered in German.

Workload
60 hours

T 14.71 Course: Entrepreneurship [T-WIWI-102864]

Responsible: Prof. Dr. Orestis Terzidis
Organisation: KIT Department of Economics and Management
Part of: M-ETIT-105073 - Student Innovation Lab

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each term	1

Events					
WT 24/25	2545001	Entrepreneurship	2 SWS	Lecture / 🧩	Terzidis, Dang
ST 2025	2545001	Entrepreneurship	2 SWS	Lecture / 🧩	Terzidis, Dang

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment consists of a written exam (60 minutes) (following §4(2), 1 of the examination regulation).

Students are offered the opportunity to earn a grade bonus through separate assignments. If the grade of the written exam is between 4.0 and 1.3, the bonus improves the grade by a maximum of one grade level (0.3 or 0.4). The exact criteria for awarding a bonus will be announced at the beginning of the lecture.

Prerequisites
None

Recommendations
None

T 14.72 Course: Ethics of Technology - ARs ReflecTIonis [T-ETIT-111923]

Responsible: Dr. phil. Michael Kühler
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Expansion	Version
Coursework	2 CP	pass/fail	Each term	1 terms	1

Events					
WT 24/25	9003013	ARS REFLECTIONIS. Thinking and Acting Responsibly in Engineering, Science, and Innovation		Block / Online	Does, Krüger
ST 2025	9003011	ARS REFLECTIONIS. Thinking and Acting Responsibly in Engineering, Science, and Innovation		Block / Blended	Does, Krüger, Derpmann
WT 25/26	9003013	ARS REFLECTIONIS. Thinking and Acting Responsibly in Engineering, Science, and Innovation		Block / Online	Does, Krüger

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Prerequisites
none

T 14.73 Course: Exercises for Materials Characterization [T-MACH-107685]

Responsible: Dr.-Ing. Jens Gibmeier
Prof. Dr. Reinhard Schneider

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103714 - Materials Characterization

Type	Credits	Grading	Recurrence	Version
Coursework	2 CP	pass/fail	Each summer term	4

Events					
ST 2025	2174586	Materials Characterization	2 SWS	Lecture / 🗣	Gibmeier, Peterlechner
ST 2025	2174988	Tutorials and lab courses for "materials characterization"	1 SWS	Practice / 🗣	Gibmeier, Peterlechner

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Regular attendance

Prerequisites
T-MACH-110945 – Exercises for Materials Characterization has not been started

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-110945 - Exercises for Materials Characterization must not have been started.

Additional Information
The course is offered in German.

Workload
60 hours

T 14.74 Course: Exercises for Materials Characterization [T-MACH-110945]

Responsible: Dr.-Ing. Jens Gibmeier
Prof. Dr. Reinhard Schneider
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-103714 - Materials Characterization

Type	Credits	Grading	Recurrence	Version
Coursework	2 CP	pass/fail	Each winter term	1

Events					
WT 24/25	2173432	Tutorials and Lab Courses for "Materials Characterization"	1 SWS	Practice / 🗣	Gibmeier, Peterlechner

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Regular attendance

Prerequisites
T-MACH-107685 – Übungen zu Werkstoffanalytik has not been started

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-107685 - Exercises for Materials Characterization must not have been started.

Additional Information
The course is offered in English.

Workload
60 hours

T 14.75 Course: Exercises for Microstructure-Property-Relationships [T-MACH-110930]

Responsible: Dr. Patric Gruber
Prof. Dr. Christoph Kirchlechner

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103713 - Properties

Type	Credits	Grading	Recurrence	Version
Coursework	2 CP	pass/fail	Each winter term	1

Events					
WT 24/25	2177021	Exercises in Microstructure-Property-Relationships	1 SWS	Practice / 🗣	Kirchlechner, Wagner, Gruber
WT 25/26	2177021	Exercises in Microstructure-Property-Relationships	1 SWS	Practice / 🗣	Kirchlechner, Wagner, Gruber

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Successful participation in a final colloquium

Prerequisites
T-MACH-107683 – Übungen zu Gefüge-Eigenschafts-Beziehungen has not been started

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-107683 - Exercises for Microstructure-Property-Relationships must not have been started.

Additional Information
Die Lehrveranstaltung wird in englischer Sprache angeboten.

Workload
60 hours

T 14.76 Course: Exercises for Microstructure-Property-Relationships [T-MACH-107683]

Responsible: Dr. Patric Gruber
Prof. Dr. Christoph Kirchlechner
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-103713 - Properties

Type	Credits	Grading	Recurrence	Version
Coursework	2 CP	pass/fail	Each summer term	3

Events					
ST 2025	2178125	Exercices in Microstructure-Property-Relationships	1 SWS	Practice / 🗣	Kirchlechner, Wagner, Gruber

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Successful participation in a final colloquium

Prerequisites
T-MACH-110930 – Exercises for Microstructure-Properties-Relationships has not been started

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-110930 - Exercises for Microstructure-Property-Relationships must not have been started.

Additional Information
The course is offered in German.

Workload
60 hours

T 14.77 Course: Explainable Artificial Intelligence [T-INFO-112774]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Organisation: KIT Department of Informatics
Part of: M-INFO-106302 - Explainable Artificial Intelligence

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2400128	Explainable Artificial Intelligence	2 SWS	Lecture / 🗣	Lioutikov

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

A bonus can be acquired through successful participation in the exercise as a success control of a different kind (§4(2), 3 SPO 2008) or study performance (§4(3) SPO 2015). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4). The bonus is only valid for the main and post exams of the semester in which it was earned. After that, the grade bonus expires.

Prerequisites
None.

Recommendations
• Experience in Machine Learning is recommended, e.g. through prior coursework.
◦ The Computer Science Department offers several great lectures e.g., “Maschinelles Lernen - Grundlagen und Algorithmen” and “Deep Learning ”
• A good mathematical background will be beneficial
• Python / PyTorch experience could be beneficial when we discuss practical examples/implementations.

T 14.78 Course: Fabrication and Characterisation of Optoelectronic Devices [T-ETIT-103613]

Responsible: Prof. Dr. Bryce Sydney Richards
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-101919 - Fabrication and Characterisation of Optoelectronic Devices

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2313760	Fabrication and Characterization of Optoelectronic Devices	2 SWS	Lecture / 🗣	Paetzold

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.79 Course: Fabrication Processes in Microsystem Technology [T-MACH-102166]

Responsible: Dr. Klaus Bade
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105478 - Fabrication Processes in Microsystem Technology

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each term	1

Events					
WT 24/25	2143882	Fabrication Processes in Microsystem Technology	2 SWS	Lecture /	Bade
ST 2025	2143882	Fabrication Processes in Microsystem Technology	2 SWS	Lecture /	Bade

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Oral examination, 20 minutes

Prerequisites
none

Workload
120 hours

14.80 Course: Field Propagation and Coherence [T-ETIT-100976]

Responsible: Prof.Dr.Dr.h.c. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100566 - Field Propagation and Coherence

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2309466	Field Propagation and Coherence	2 SWS	Lecture / 🗣	Freude
WT 24/25	2309467	Tutorial for 2309466 Field Propagation and Coherence	1 SWS	Practice / 🗣	Freude, N.N.

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.81 Course: Fundamentals on Plasma Technology [T-ETIT-100770]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100483 - Fundamentals on Plasma Technology

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2313734	Fundamentals on Plasma Technology	2 SWS	Lecture / 🗣	Kling

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.82 Course: Hardware Modeling and Simulation [T-ETIT-100672]

Responsible: Dr.-Ing. Jens Becker
Prof. Dr.-Ing. Jürgen Becker

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-100449 - Hardware Modeling and Simulation

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	2

Events					
WT 24/25	2311608	Hardware Modeling and Simulation	2 SWS	Lecture / 🗣	Becker, Becker
WT 24/25	2311610	Tutorial for 2311608 Hardware Modeling and Simulation	1 SWS	Practice / 🗣	Unger

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Achievement is examined in the form of a written examination lasting 120 minutes.

Prerequisites
none

T 14.83 Course: Hardware Synthesis and Optimization [T-ETIT-113922]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106963 - Hardware Synthesis and Optimization

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each summer term	1

Events					
ST 2025	2311619	Hardware Synthesis and Optimization	3 SWS	Lecture / 🗣	Becker
ST 2025	2311621	Tutorial for 2311619 Hardware Synthesis and Optimization	1 SWS	Practice / 🗣	Schmidt

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place within the framework of an oral overall examination (approx. 30 minutes).
The module grade is the grade of the oral exam.

Prerequisites
none

T 14.84 Course: Hardware/Software Co-Design [T-ETIT-100671]

Responsible: Dr.-Ing. Tanja Harbaum
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100453 - Hardware/Software Co-Design

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2311620	Hardware/Software Co-Design	2 SWS	Lecture / 🗣	Harbaum, Becker
WT 24/25	2311623	Tutorial for 2311620 Hardware/ Software Co-Design	1 SWS	Practice / 🗣	Gutermann

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

T 14.85 Course: High-Power Microwave Technology [T-ETIT-100791]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100521 - High-Power Microwave Technology

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2308435	High-Power Microwave Technology	2 SWS	Lecture / 🗣	Jelonnek, Marek
WT 25/26	2308435	High-Power Microwave Technology	2 SWS	Lecture / 🗣	Jelonnek, Marek

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.86 Course: Homework 'Basics of Finite Elements' [T-BGU-109908]

Responsible: Prof. Dr.-Ing. Peter Betsch
Organisation: KIT Department of Civil Engineering, Geo and Environmental Sciences
Part of: M-BGU-100052 - Basics of Finite Elements

Type	Credits	Grading	Recurrence	Expansion	Version
Coursework	1 CP	pass/fail	Each winter term	1 terms	1

Events					
WT 24/25	6215901	Grundlagen Finite Elemente	2 SWS	Lecture / 🗣	Franke
WT 24/25	6215902	Übungen zu Grundlagen Finite Elemente	2 SWS	Practice / 🗣	Reiff

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
processing of three exercise sheets

Prerequisites
none

Recommendations
none

Additional Information
none

Workload
30 hours

T 14.87 Course: HRI and Social Robotics [T-INFO-113396]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: M-INFO-106650 - HRI and Social Robotics

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2400159	HRI and Social Robotics	4 SWS	Lecture / Practice (/	Bruno, Maure

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Prerequisites
None.

Recommendations
Knowledge of the content of modules Robotics I - Introduction to Robotics is helpful.

T 14.88 Course: HRI and Social Robotics - Pass [T-INFO-113397]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: M-INFO-106650 - HRI and Social Robotics

Type	Credits	Grading	Recurrence	Version
Examination of another type	2 CP	graded	Each summer term	1

Events					
ST 2025	2400159	HRI and Social Robotics	4 SWS	Lecture / Practice (/ 🗣	Bruno, Maure

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Students must regularly submit exercise sheets. The number of exercise sheets and the scale for passing will be announced at the beginning of the course. The assessment can only be repeated once.

Recommendations
Knowledge of the content of modules Robotics I - Introduction to Robotics is helpful.

T 14.89 Course: Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy [T-INFO-101262]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Hon.-Prof. Dr. Uwe Spetzger

Organisation: KIT Department of Informatics

Part of: M-INFO-100725 - Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each term	2

Events					
WT 24/25	2424139	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	2 SWS	Lecture / 🗣	Spetzger
ST 2025	24678	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	2 SWS	Lecture / 🗣	Spetzger
WT 25/26	2424139	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	2 SWS	Lecture / 🗣	Spetzger

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

14.90 Course: Human-Machine-Interaction [T-INFO-101266]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-100729 - Human Computer Interaction

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	3

Events					
ST 2025	24659	Human-Computer-Interaction	2 SWS	Lecture /	Beigl, Lee

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites
Participation in the exercise is compulsory and the contents of the exercise are relevant for the examination.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-INFO-106257 - Human-Machine-Interaction Pass must have been passed.

T 14.91 Course: Human-Machine-Interaction in Anthropomatics: Basics [T-INFO-101361]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Dr.-Ing. Florian van de Camp

Organisation: KIT Department of Informatics

Part of: M-INFO-100824 - Human-Machine-Interaction in Anthropomatics: Basics

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each winter term	4

Events					
WT 24/25	2424100	Human-Machine-Interaction in Anthropomatics: Basics	2 SWS	Lecture /	van de Camp

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

T 14.92 Course: Human-Machine-Interaction Pass [T-INFO-106257]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-100729 - Human Computer Interaction

Type	Credits	Grading	Recurrence	Version
Coursework	0 CP	pass/fail	Each summer term	1

Events					
ST 2025	2400095	Human-Computer-Interaction	1 SWS	Practice /	Beigl, Lee
ST 2025	24659	Human-Computer-Interaction	2 SWS	Lecture /	Beigl, Lee

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Exercise sheets must be handed in regularly to pass the course. The specific details will be announced in the lecture.

Prerequisites
None.

Additional Information
Participation in the exercise is compulsory and the contents of the exercise are relevant for the examination.

T 14.93 Course: Humanoid Robotics Laboratory [T-INFO-111590]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-105792 - Humanoid Robotics Laboratory

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each winter term	3

Events					
WT 24/25	2424890	Humanoid Robotics Laboratory	4 SWS	Practical course / 🗣	Asfour, Meixner, Dreher

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Recommendations

- Very good programming skills in at least one high-level programming language are strongly recommended.
- Attendance of the lectures Robotics 1, Robotics 2, Robotics 3, as well as the robotics practical course are recommended.
- Project-specific recommendations (knowledge of C++, Python, ...) will be announced in the individual project descriptions

Additional Information

- Internship dates are always by arrangement with the supervising staff member.
- An extension work of the topic as a master thesis is possible in principle.
- The number of participants in this practical course is generally **limited** and varies with the number of available research projects at the institute.

T 14.94 Course: Humanoid Robots - Locomotion and Whole-Body Control [T-INFO-113395]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106649 - Humanoid Robots - Locomotion and Whole-Body Control

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
ST 2025	2400135	Humanoid Robots – Locomotion and Whole-Body Control	4 SWS	Lecture / 🗣	Mombaur, Große Sundrup

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Assessment
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

The grade of the course is given based on the performance in in an individual programming project on the topic of humanoid robots, which consists of the definition and solution of the project itself as well as a subsequent oral presentation in a block event and the submission of a written report. Project work starts in the exercise slots during the second half of the term and ends during the lecture free time.

As a prerequisite for the enrollment in the project, the students must regularly and successfully participate in the exercises and present their results for the exercise sheets during the first part of the term, according to the modalities announced at the beginning of the course.
Both components can be completed in the same group of two students. Withdrawal is possible until 2 weeks after enrollment in the project.
Active participation in the class is expected from all students and is a necessary requirement for the course.

Prerequisites

- Completion of module Robotics 1 or corresponding knowledge required.
- Programing skills

Recommendations
Attendance of the lectures Robotics I - Introduction to Robotics and Mechano-Informatics in Robotics is required.

Additional Information
Limitation to 30 participants

T 14.95 Course: Humanoid Robots - Locomotion and Whole-Body Control -Pass [T-INFO-114282]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106649 - Humanoid Robots - Locomotion and Whole-Body Control

Type	Credits	Grading	Recurrence	Version
Coursework (oral)	0 CP	pass/fail	Each term	1

Events					
ST 2025	2400135	Humanoid Robots – Locomotion and Whole-Body Control	4 SWS	Lecture / 🗣	Mombaur, Große Sundrup

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO).

The grade of the course is given based on the performance in in an individual programming project on the topic of humanoid robots, which consists of the definition and solution of the project itself as well as a subsequent oral presentation in a block event and the submission of a written report. Project work starts in the exercise slots during the second half of the term and ends during the lecture free time.

As a prerequisite for the enrollment in the project, the students must regularly and successfully participate in the exercises and present their results for the exercise sheets during the first part of the term, according to the modalities announced at the beginning of the course.
Both components can be completed in the same group of two students. Withdrawal is possible until 2 weeks after enrollment in the project.
Active participation in the class is expected from all students and is a necessary requirement for the course.

Prerequisites

- Completion of module Robotics 1 or corresponding knowledge required.
- Programing skills

Recommendations
Attendance of the lectures Robotics I - Introduction to Robotics and Mechano-Informatics in Robotics is required.

Additional Information
Limitation to 30 participants

T 14.96 Course: Imaging Techniques in Light Microscopy [T-CHEMBIO-105197]

Responsible: Prof. Dr. Martin Bastmeyer
Organisation: KIT Department of Chemistry and Biosciences
Part of: M-CHEMBIO-101905 - Imaging Techniques in Light Microscopy

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each winter term	3

Assessment
Written exam over 120 minutes (depending on the number of participants oral exam over approx.45 min).

Depending on the number of participants, a written exam (120 min) or an oral exam (approx.45 min) is accomplished. The exact modality of the exam will be announced at the beginning of the semester. The written exam is scheduled for the beginning of the break after the WS. A resit exam is offered at the end of the break.

Prerequisites
none

Recommendations
Attendance to the lecture. Basic knowledge in physics and biology.

Workload
90 hours

T 14.97 Course: Industrial Business Administration [T-WIWI-100796]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Version
Coursework (written)	3 CP	pass/fail	Each winter term	1

Events					
WT 24/25	2581040	Industrial Business Administration	2 SWS	Lecture / 🗣	Fichtner

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of this course is a ungraded written examination (60 min).

Prerequisites
None

T 14.98 Course: Industrial Circuitry [T-ETIT-100716]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100399 - Industrial Circuitry

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2306327	Industrial Circuitry	2 SWS	Lecture / 🧩	Liske

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

14.99 Course: Information Fusion [T-ETIT-106499]

Responsible: Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103264 - Information Fusion

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2302139	Information Fusion	2 SWS	Lecture /	Heizmann
WT 24/25	2302141	Erxercize for 2302139 Information Fusion	1 SWS	Practice /	Heizmann, Bihler

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Prerequisites
none

T 14.100 Course: Information Technology in Industrial Automation Systems [T-ETIT-100698]

Responsible: Dr.-Ing. Peter-Axel Bort
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100367 - Information Technology in Industrial Automation Systems

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2302144	Information Technology in Industrial Automation Systems	2 SWS	Lecture / 🗣	Bort

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

14.101 Course: Innovation Lab [T-ETIT-110291]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Prof. Dr. Werner Nahm
Prof. Dr.-Ing. Eric Sax
Prof. Dr. Wilhelm Stork
Prof. Dr.-Ing. Thomas Zwick

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105073 - Student Innovation Lab

Type	Credits	Grading	Recurrence	Expansion	Version
Examination of another type	9 CP	graded	Each term	2 terms	1

Events					
WT 24/25	2303192	Innovation Lab	2 SWS	Project (P / 🗣	Hohmann, Zwick, Sax, Stork, Nahm, Schmalen, Rost
ST 2025	2303192	Innovation Lab	2 SWS	Project (P / 🗣	Hohmann, Zwick, Sax, Stork, Terzidis
WT 25/26	2303192	Innovation Lab	2 SWS	Project (P / 🗣	Hohmann, Zwick, Sax, Stork, Nahm, Schmalen, Rost

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
see module description

T 14.102 Course: Integrated Intelligent Sensors [T-ETIT-100961]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100457 - Integrated Intelligent Sensors

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2311630	Integrated Intelligent Sensors	2 SWS	Lecture / 🗣	Stork

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

14.103 Course: Integrated Systems and Circuits [T-ETIT-100972]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100474 - Integrated Systems and Circuits

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	2

Events					
ST 2025	2312688	Integrated Systems and Circuits	2 SWS	Lecture / 🗣	Ilin
ST 2025	2312690	Tutorial for 2312688 Integrated Systems and Circuits	1 SWS	Practice / 🗣	Wünsch

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.104 Course: Intellectual Property Rights and Strategies in Industrial Companies [T-MACH-105442]

Responsible: Dipl.-Ing. Frank Zacharias
Organisation: KIT Department of Mechanical Engineering

Part of: M-ETIT-105803 - Interdisciplinary Qualifications
M-MACH-105419 - Intellectual Property Rights and Strategies in Industrial Companies

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each term	1

Events					
WT 24/25	2147161	Intellectual Property Rights and Strategies in Industrial Companies	2 SWS	Block /	Zacharias
ST 2025	2147160	Patents and Patentstrategies in innovative companies	2 SWS	/	Zacharias
WT 25/26	2147161	Intellectual Property Rights and Strategies in Industrial Companies	2 SWS	Block /	Zacharias

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
oral exam (ca. 20 min)

Prerequisites
none

Recommendations
None

Additional Information
The course is offered in German.

Workload
120 hours

T 14.105 Course: Introduction to Bionics [T-MACH-111807]

Responsible: apl. Prof. Dr. Hendrik Hölscher
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106525 - Introduction to Bionics

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	3

Events					
ST 2025	2142151	Introduction to Biomimetics	2 SWS	Lecture / 🗣	Hölscher, Greiner

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written exam (duration: 60 minutes)

Prerequisites
none

Additional Information
Brick T-MACH-102172 may not be started

T 14.106 Course: Introduction to Microsystem Technology I [T-MACH-114100]

Responsible: Dr. Vlad Badilita
Prof. Dr. Jan Gerrit Korvink

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102691 - Introduction to Microsystem Technology I

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2141861	Introduction to Microsystem Technology I	2 SWS	Lecture / 🗣	Korvink, Badilita

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written examination (60 min)

Prerequisites
T-MACH-114035 and T-MACH-105182 must not have started

Workload
120 hours

T 14.107 Course: Introduction to Microsystem Technology II [T-MACH-105183]

Responsible: Dr. Vlad Badilita
Prof. Dr. Jan Gerrit Korvink

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102706 - Introduction to Microsystem Technology II

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	3

Events					
ST 2025	2142874	Introduction to Microsystem Technology II	2 SWS	Lecture / 🗣	Korvink, Badilita

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written examination (60 min)

Prerequisites
T-MACH-114035 and T-MACH-114101 must not have started

Workload
120 hours

T 14.108 Course: Introduction to Nanotechnology [T-MACH-111814]

Responsible: apl. Prof. Dr. Hendrik Hölscher

Organisation: KIT Department of Mechanical Engineering
KIT Department of Economics and Management

Part of: M-MACH-107207 - Introduction to Nanotechnology

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	2

Events					
ST 2025	2142152	Introduction to Nanotechnology	2 SWS	Lecture / 🗣	Hölscher

Legend: 🖥 Online, ♻ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
written exam 90 min

Prerequisites
none

Additional Information
Brick T-MACH-111814 may not be started

Workload
120 hours

T 14.109 Course: Introduction to the Finite Element Method [T-MACH-105320]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Dr.-Ing. Tom-Alexander Langhoff

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106209 - Introduction to the Finite Element Method

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each summer term	4

Events					
ST 2025	2162282	Introduction to the Finite Element Method	2 SWS	Lecture / 🗣	Langhoff, Böhlke

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written exam (90 min)

prerequisites: passing the corresponding "Tutorial to Introduction to the Finite element method" (T-MACH-110330)

Prerequisites
Passing the "Tutorial to Introduction to the Finite element method" (T-MACH-110330) is a prerequisite for taking part in the exam.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-110330 - Tutorial Introduction to the Finite Element Method must have been passed.

Additional Information
Knowledge of the contents of the courses "Continuum Mechanics of Solids and Fluids" and "Mathematical Methods of Continuum Mechanics" as well as the corresponding tutorials are expected

Due to capacity reasons it is possible that not all students of this course can be admitted to the computer tutorials. Students of the bachelor's degree program in mechanical engineering who have chosen the Major Field Continuum Mechanics (SP-Nr 13) will be admitted to the computer tutorials in any case.
If additional places are available in the computer tutorials for this course, these will be allocated according to the BSc average grade.

Workload
90 hours

T 14.110 Course: Introduction to the Scientific Method (Seminar, Englisch) [T-ETIT-111317]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Expansion	Version
Coursework	1 CP	pass/fail	Each term	1 terms	1

Events					
WT 24/25	2305746	Introduction to the Scientific Method	1 SWS	Seminar / 🗣	Nahm
ST 2025	2305745	Introduction to the Scientific Method	1 SWS	Seminar / 🗣	Nahm

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The sucess control takes place in the form of a study achievement. The exam consists of the preparation and the presentation of a seminar paper.

Prerequisites
none

Additional Information
Detailled information on contents, competence goals, and work load at:
M-ETIT-105665 – Introduction to the Scientific Method (Seminar)

T 14.111 Course: Introduction to the Scientific Method (Seminar, German) [T-ETIT-111316]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Expansion	Version
Coursework	1 CP	pass/fail	Each term	1 terms	1

Events					
WT 24/25	2305504	Einführung in die wissenschaftliche Methode	1 SWS	Seminar / 🗣	Nahm
ST 2025	2305744	Einführung in die wissenschaftliche Methode	1 SWS	Seminar / 🗣	Nahm

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.112 Course: IT/OT-Security Seminar [T-ETIT-113648]

Responsible: Prof. Dr.-Ing. Mike Barth
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106789 - IT/OT-Security Seminar

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	4 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2303201	IT/OT-Security Seminar	2 SWS	Seminar / 🧩	Barth, Madsen
WT 25/26	2303201	IT/OT-Security Seminar	2 SWS	Seminar / 🧩	Barth, Madsen

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in the form of an oral examination.

The module grade is the grade of the oral exam.

Prerequisites
none

14.113 Course: Lab Computer-Aided Methods for Measurement and Control [T-MACH-105341]

Responsible: Jonas Merkert
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105291 - Lab Computer-Aided Methods for Measurement and Control

Type	Credits	Grading	Recurrence	Version
Coursework	4 CP	pass/fail	Each winter term	1

Events					
WT 24/25	2137306	Lab Computer-aided methods for measurement and control	3 SWS	Practical course / 🗣	Stiller

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Colloquia

Prerequisites
none

Workload
120 hours

14.114 Course: Lab Course on Nanoelectronics [T-ETIT-100757]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100468 - Lab Course on Nanoelectronics

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2312669	Laboratory Nanoelectronics	4 SWS	Practical course / 🗣	Kempf, weitere Mitarbeitende
ST 2025	2312669	Laboratory Nanoelectronics	4 SWS	Practical course / 🗣	Kempf, Mitarbeiter*innen
WT 25/26	2312669	Laboratory Nanoelectronics	4 SWS	Practical course / 🗣	Kempf, weitere Mitarbeitende

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.115 Course: Lab Course on Noise Thermometry [T-ETIT-112714]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106263 - Lab Course on Noise Thermometry

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2312682	Lab Course on Noise Thermometry	4 SWS	Practical course / 🗣	Kempf, weitere Mitarbeitende
ST 2025	2312682	Lab Course on Noise Thermometry	4 SWS	Practical course / 🗣	Kempf, Mitarbeiter*innen
WT 25/26	2312682	Lab Course on Noise Thermometry	4 SWS	Practical course / 🗣	Kempf, weitere Mitarbeitende

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of other types of examination. It is based on the evaluation of a written report (approx. 10-20 pages) which introduces the topic, discusses the execution of the lab course and the scientific results and finally puts the results into the overall context.

Prerequisites
none

T 14.116 Course: Lab course on superconducting materials [T-ETIT-111242]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105614 - Lab course on superconducting materials

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2312650	Praktikum Supraleitende Materialien	4 SWS	Practical course / 🗣	Holzapfel
ST 2025	2312695	Lab Course on Superconducting Materials	4 SWS	Colloquium (K / 🗣	Holzapfel, Hänisch

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The control of success takes place in form of the evaluation of a written report (approx. 10-20 pages) which introduces the topic, discusses the execution of the lab course and the scientific results puts the results into the overall context.

Prerequisites
none

T 14.117 Course: Lab Course Printed Flexible Electronics [T-ETIT-113075]

Responsible: Prof. Dr. Gerardo Hernandez Sosa
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106464 - Lab Course Printed Flexible Electronics

Type	Credits	Grading	Recurrence	Version
Coursework	6 CP	pass/fail	Each term	2

Events					
WT 24/25	2313765	Lab Course Printed Flexible Electronics	4 SWS	Practical course / 🗣	Hernandez Sosa
ST 2025	2313765	Lab Course Printed Flexible Electronics	4 SWS	Practical course / 🗣	Hernandez Sosa

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination consists of a written journal article and an oral presentation of the student's work, both given in English. The overall impression is rated.

The module is passed with successful assessment of the written paper and the oral presentation. Details will be given during the lecture. The module is ungraded.

Prerequisites
The M-ETIT-100475 Modul: Plastic Electronics / Polymerelektronik should be started.

Additional Information
- The lab is limited to a number of 6 participants due to capacity reasons. If necessary, a selection procedure will be carried out. Places will be allocated taking into account the students' academic progress. Details will be announced on the lecture website.
- The Lab course will take place in the clean room Facilities of InnovationLab in Heidelberg. Speyerer str. 4, 69115 Heidelberg where the research laboratories of Prof. Hernandez-Sosa are located.
- The 4 th experiment will take place at KIT Campus North, Institute of Nanotechnology, in the research unit and laboratories of Prof. Jasmin Aghassi-Hagmann

Attendance of at least 80% is compulsory during the seminar course. Compulsory attendance is necessary for actively contributing to the discussion of the topics presented by all students.

T 14.118 Course: Lab Course Robotic Winding Technology for Superconducting Wires [T-ETIT-114158]

Responsible: Prof. Dr. Tabea Arndt
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107135 - Lab Course Robotic Winding Technology for Superconducting Wires

Type	Credits	Grading	Recurrence	Expansion	Version
Examination of another type	6 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2314012	Robotic Winding Technology for Superconducting Wires	4 SWS	Practical course / 🗣	Arndt
WT 25/26	2314012	Lab Course Robotic Winding Technology for Superconducting Wires	4 SWS	Practical course / 🗣	Arndt

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed by evaluating a written final report (approx. 10-20 pages in length), in which an introduction to the topic, the execution of the experiment, the scientific results and a classification of the results in the overall context should be summarized.

Prerequisites
none

T 14.119 Course: Laboratory FPGA Based Circuit Design [T-ETIT-100759]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100470 - Laboratory FPGA Based Circuit Design

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2312674	Laboratory FPGA Based Circuit Design	4 SWS	Practical course / 🗣	Wünsch, Kempf
ST 2025	2312674	Laboratory FPGA Based Circuit Design	4 SWS	Practical course / 🗣	Kempf, Wünsch
WT 25/26	2312674	Laboratory FPGA Based Circuit Design	4 SWS	Practical course / 🗣	Kempf, weitere Mitarbeitende

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.120 Course: Laboratory in Software Engineering [T-ETIT-100681]

Responsible: Prof. Dr.-Ing. Eric Sax
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100460 - Laboratory in Software Engineering

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	2

Events					
ST 2025	2311640	Laboratory in Software Engineering	4 SWS	Practical course / 🗣	Sax

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.121 Course: Laboratory Information Systems in Power Engineering [T-ETIT-114183]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107159 - Laboratory Information Systems in Power Engineering

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	1

Events					
ST 2025	2307388	Praktikum: Informationssysteme in der elektrischen Energietechnik	4 SWS	Practical course / 🗣	Leibfried, und Mitarbeiter

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success control takes place in the form of other types of examination and is assessed in form of 3 experiments.

The module grade results of the assessment of the 3 experiments.

- 20 points are awarded for each experiment (max. 10 for preparation and max. 10 for performance).
- This results in a total of 60 points.
- At least 27 points must be achieved in order to pass the module.

Prerequisites
none

T 14.122 Course: Laboratory Lighting Technology [T-ETIT-104726]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-102356 - Laboratory Lighting Technology

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2313715	Laboratory Lighting Technology	4 SWS	Practical course / 🗣	Neumann, Trampert
ST 2025	2313715	Laboratory Lighting Technology	4 SWS	Practical course / 🗣	Trampert, Neumann
WT 25/26	2313715	Laboratory Lighting Technology	4 SWS	Practical course / 🗣	Neumann, Trampert

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.123 Course: Laboratory Mechatronic Measurement Systems [T-ETIT-106854]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103448 - Laboratory Mechatronic Measurement Systems

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	1

Events					
WT 24/25	2302123	Laboratory Mechatronic Measurement Systems	4 SWS	Practical course / 🗣	Heizmann, Steffens

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The success control is carried out in the form of a written test of 120 minutes. If there are fewer than 20 candidates, an oral exam of around 20 minutes can alternatively take place. The module grade is the grade of the written or oral exam.

Prerequisites
none

Recommendations
Knowledge from the lectures "Metrology" or "Metrology in Mechatronics" and "Manufacturing Metrology" as well as basic knowledge of programming (e.g. in Matlab, C / C ++) are helpful.

Additional Information
Annotations

The submission of the protocols of all experiments is required for admission to the examination. The quality of the protocols is assessed; for the admission to the exam, the quality must be acceptable.

Attendance of all laboratory dates including the introductory event is required. Already in the event of a single unexcused absence, admission to the examination will not be granted.

T 14.124 Course: Laboratory Modern Software Tools in Power Engineering [T-ETIT-110898]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105402 - Laboratory Modern Software Tools in Power Engineering

Type	Credits	Grading	Recurrence	Expansion	Version
Examination of another type	6 CP	graded	Each summer term	1 terms	1

Events					
ST 2025	2307355	Laboratory Modern Software Tools in Power Engineering	4 SWS	Practical course / 🗣	Leibfried

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
The control of success is carried out in the form of a total of 3 grades of the experiments (1 grade per experiment) in accordance with § 4 Paragraph 2 No. 3 SPO-Master2015-016, 2018

Recommendations
Basic knowledge from the lectures High Voltage Engineering, Calculation of Electrical Grids and Electric Power Transmission and Grid Control. PC knowledge and English skills.

T 14.125 Course: Laboratory Nanotechnology [T-ETIT-100765]

Responsible: Prof. Dr. Ulrich Lemmer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100478 - Laboratory Nanotechnology

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2313714	Laboratory Nanotechnology	4 SWS	Practical course / 🗣	Lemmer, Trampert
ST 2025	2313714	Laboratory Nanotechnology	4 SWS	Practical course / 🗣	Trampert, Lemmer
WT 25/26	2313714	Laboratory Nanotechnology	4 SWS	Practical course / 🗣	Lemmer, Trampert

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.126 Course: Laboratory Optoelectronics [T-ETIT-100764]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100477 - Laboratory Optoelectronics

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2313712	Laboratory Optoelectronics	4 SWS	Practical course / 🗣	Kling, Trampert
ST 2025	2313712	Laboratory Optoelectronics	4 SWS	Practical course / 🗣	Trampert, Kling

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.127 Course: Laser Metrology [T-ETIT-100643]

Responsible: Prof. Dr. Marc Eichhorn
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100434 - Laser Metrology

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2303200	Laser Metrology	2 SWS	Lecture / 🗣	Eichhorn

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The exam will be taken as an oral examination (about 20 minutes). The individual appointments for examination are offered at two previously determined dates.

Prerequisites
none

14.128 Course: Laser Physics [T-ETIT-100741]

Responsible: Prof. Dr. Marc Eichhorn
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100435 - Laser Physics

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2301480	Laserphysics	2 SWS	Lecture / Blended	Eichhorn
WT 24/25	2301481	Exercise for 2301480 Laserphysics	1 SWS	Practice / Blended	Eichhorn
WT 25/26	2301480	Laserphysics	2 SWS	Lecture / On-Site	Eichhorn
WT 25/26	2301481	Exercise for 2301480 Laserphysics	1 SWS	Practice / On-Site	Eichhorn

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The exam will be taken as an oral examination (about 20 minutes). The individual appointments for examination are offered at two previously determined dates.

Prerequisites
none

T 14.129 Course: Lecture Series Supplementary Studies on Science, Technology and Society - Self Registration [T-FORUM-113578]

Responsible:	Dr. Christine Mielke Christine Myglas
Organisation:	General Studies. Forum Science and Society (FORUM)
Part of:	M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Recurrence	Expansion	Version
Coursework	2 CP	pass/fail	Each summer term	1 terms	1

Assessment
Active participation, learning protocols, if applicable.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
It is recommended that you complete the lecture series "Science in Society" before attending events in the advanced module and in parallel with attending the basic seminar.
If it is not possible to attend the lecture series and the basic seminar in the same semester, the lecture series can also be attended after attending the basic seminar.
However, attending events in the advanced module before attending the lecture series should be avoided.

Additional Information
The basic module consists of the lecture series "Science in Society" and the basic seminar. The lecture series is only offered during the summer semester.
The basic seminar can be attended in the summer or winter semester.

14.130 Course: Light and Display Engineering [T-ETIT-100644]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100512 - Light and Display Engineering

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2313747	Light and Display Engineering	2 SWS	Lecture / ✕	Kling
WT 24/25	2313749	Übungen zu 2313747 Light and Display Engineering	1 SWS	Practice / ✕	Kling

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Prerequisites
none

T 14.131 Course: Lighting Design - Theory and Applications [T-ETIT-100997]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100577 - Lighting Design - Theory and Applications

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2313751	Lighting Design - Theory and Applications	2 SWS	Seminar / ✕	Kling

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Prerequisites
none

T 14.132 Course: Lighting Engineering [T-ETIT-100772]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100485 - Lighting Engineering

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2313739	Lighting Engineering	2 SWS	Lecture / 🗣	Neumann
WT 24/25	2313741	Lighting Engineering (Tutorial to 2313739)	1 SWS	Practice	Neumann

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.133 Course: Machine Learning - Foundations and Algorithms [T-INFO-111558]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-105778 - Machine Learning - Foundations and Algorithms

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	2

Events					
ST 2025	2400018	Machine Learning – Foundations and Algorithms	4 SWS	Lecture / Practice (/ 🗣	Neumann

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
The success control takes place in the form of a written exam, usually 90 minutes in length, according to § 4 Abs. 2 Nr. 1 SPO.

A bonus can be acquired through successful participation in the exercise as a success control of a different kind (§4(2), 3 SPO 2008) or study performance (§4(3) SPO 2015). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4). The bonus is only valid for the main and post exams of the semester in which it was earned. After that, the grade bonus expires.

Prerequisites
None.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-WIWI-106340 - Machine Learning 1 - Basic Methods must not have been started.

Recommendations
- Attendance of the lecture “Foundations of Artificial Intelligence” (“Grundlagen der Künstlichen Intelligence”)
- Knowledge in python
- Mathematics-heavy lecture. The basics will be reviewed, but mathematical proficiency is helpful

T 14.134 Course: Machine Learning 1 - Basic Methods [T-WIWI-106340]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105003 - Machine Learning 1

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each winter term	4

Events					
WT 24/25	2511500	Machine Learning 1 - Fundamental Methods	2 SWS	Lecture / 🗣	Zöllner
WT 24/25	2511501	Exercises to Machine Learning 1 - Fundamental Methods	1 SWS	Practice / 🗣	Zöllner, Polley, Fechner, Daaboul

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Depending on further pandemic developments, the exam will be offered either as an open-book exam, or as a written exam (60 min):

The exam takes place every semester and can be repeated at every regular examination date.

A grade bonus can be earned by successfully completing practice exercises. If the grade of the written exam is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

Prerequisites
None.

Workload
150 hours

T 14.135 Course: Machine Learning 2 – Advanced Methods [T-WIWI-106341]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105006 - Machine Learning 2

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each summer term	4

Events					
ST 2025	2511502	Machine Learning 2 - Advanced Methods	2 SWS	Lecture / 🗣	Zöllner, Fechner, Polley, Stegmaier
ST 2025	2511503	Exercises for Machine Learning 2 - Advanced Methods	1 SWS	Practice / 🗣	Zöllner, Fechner, Polley, Stegmaier

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Depending on further pandemic developments, the exam will be offered either as an open-book exam, or as a written exam (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

Prerequisites
None.

Workload
150 hours

T 14.136 Course: Machine Learning and Optimization in Communications [T-ETIT-110123]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-104988 - Machine Learning and Optimization in Communications

Type	Credits	Grading	Recurrence	Expansion	Version
Written examination	4 CP	graded	Each summer term	1 terms	3

Events					
ST 2025	2310560	Machine Learning and Optimization in Communications	2 SWS	Lecture / Blended	Schmalen
ST 2025	2310561	Practice to 2310560 Machine Learning and Optimization in Communications	1 SWS	Practice / Blended	Schmalen

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Written examination of 120 minutes.

Prerequisites
Knowledge of basic engineering mathematics including integral transformations and probability theory as well as basic knowledge of communications engineering.

Recommendations
Previous visit to the lecture "Telecommunications I" and "Probability Theory" is recommended. Knowledge from the lectures "Applied Information Theory" and "Measurement Engineering" are helpful.

T 14.137 Course: Machine Vision [T-MACH-105223]

Responsible: Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101923 - Machine Vision

Type	Credits	Grading	Recurrence	Version
Written examination	8 CP	graded	Each winter term	2

Events					
WT 24/25	2137308	Machine Vision	4 SWS	Lecture / Practice (/	Lauer, Merkert

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Type of Examination: written exam

Duration of Examination: 60 minutes

Prerequisites
None

Workload
240 hours

T 14.138 Course: Master's Thesis [T-ETIT-114436]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107356 - Master's Thesis

Type	Credits	Grading	Recurrence	Version
Final Thesis	30 CP	graded	Each term	1

Assessment
The Master's Thesis module has 30 credits. It consists of the Master's Thesis and a presentation. The presentation must be carried out within the processing time in accordance with SPO Section §14(4).

Prerequisites
SPO Section §14 Master's Thesis module (1) A prerequisite for admission to the Master's Thesis module is that the student has successfully completed module examinations totaling 75 credits.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. You need to have earned at least 75 credits in your course of studies.

Final Thesis
This course represents a final thesis. The following periods have been supplied:

Submission deadline	6 months
Maximum extension period	3 months
Correction period	8 weeks

This thesis requires confirmation by the examination office.

T 14.139 Course: Materials Characterization [T-MACH-107684]

Responsible: Dr.-Ing. Jens Gibmeier
Prof. Dr. Reinhard Schneider
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-103714 - Materials Characterization

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	4

Events					
ST 2025	2174586	Materials Characterization	2 SWS	Lecture / 🗣	Gibmeier, Peterlechner

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Assessment
Oral exam, about 25 minutes

Prerequisites
Successful participation in Übungen zu Werkstoffanalytik is the condition for the admittance to the oral exam in Werkstoffanalytik.

T-MACH-110945 – Exercises for Materials Characterization has not been started.

T-MACH-110946 – Materials Characterization has not been started.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-107685 - Exercises for Materials Characterization must have been passed.
2. The course T-MACH-110945 - Exercises for Materials Characterization must not have been started.
3. The course T-MACH-110946 - Materials Characterization must not have been started.

Additional Information
The course is offered in German.

Workload
120 hours

14.140 Course: Materials Characterization [T-MACH-110946]

Responsible: Dr.-Ing. Jens Gibmeier
Prof. Dr. Reinhard Schneider

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103714 - Materials Characterization

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2173431	Materials Characterization	2 SWS	Lecture / 🗣	Gibmeier, Peterlechner

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Oral exam, about 25 minutes

Prerequisites
Successful participation in Exercises for Materials Characterization is the condition for the admittance to the oral exam in Materials Characterization.

T-MACH-107685 – Übungen zu Werkstoffanalytik has not been started.

T-MACH-107684 – Werkstoffanalytik has not been started.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-110945 - Exercises for Materials Characterization must have been passed.
2. The course T-MACH-107685 - Exercises for Materials Characterization must not have been started.
3. The course T-MACH-107684 - Materials Characterization must not have been started.

Additional Information
The course is offered in English.

Workload
120 hours

T 14.141 Course: Mathematical Methods in Continuum Mechanics [T-MACH-110375]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106210 - Mathematical Methods in Continuum Mechanics

Type	Credits	Grading	Recurrence	Expansion	Version
Written examination	4 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2161254	Mathematical Methods in Continuum Mechanics	2 SWS	Lecture / 🗣	Böhlke

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written exam (90 min). Additives as announced.

Prerequisites
Passing the Tutorial to Mathematical Methods of Continuum Mechanics (T-MACH-110376)

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-110376 - Tutorial Mathematical Methods in Continuum Mechanics must have been passed.

Workload
120 hours

T 14.142 Course: Measurement Technology [T-ETIT-112147]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105982 - Measurement Technology

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each winter term	1

Events					
WT 24/25	2302117	Measurement Technology	2 SWS	Lecture /	Heizmann
WT 24/25	2302118	Exercise for 2302117 Measurement Technology	1 SWS	Practice /	Heizmann, Schmerbeck

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The examination takes place in form of a written examination lasting 120 minutes. The module grade is the grade of the written examination.

Prerequisites
T-ETIT-101937 – Messtechnik (German version) must not have started.

T 14.143 Course: Medical Image Processing for Guidance and Navigation [T-ETIT-113425]

Responsible: Prof. Dr.-Ing. Maria Francesca Spadea
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106672 - Medical Image Processing for Guidance and Navigation

Type	Credits	Grading	Recurrence	Version
Oral examination	9 CP	graded	Each winter term	2

Events					
WT 24/25	2305297	Medical Image Processing for Guidance and Navigation	6 SWS	Lecture / Practice (/ 🗣	Spadea, Raggio, Riggio, Arndt, Hopp
ST 2025	2305297	Medical Image Processing for Guidance and Navigation	4 SWS	Lecture / Practice (/ ✕	Spadea, Raggio, Riggio

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place within the framework of an oral overall examination of approx. 30 minutes about the lecture including a presentation and discussion of the project developed during the course. The overall impression is rated.

The module grade is the grade of the oral exam.

A bonus can be earned for submitting homework that will be provided during the lecture time.

The exact criteria for awarding a bonus will be announced at the beginning of the lecture period. If the grade in the oral exam is between 4.0 and 1.3, the bonus improves the grade by 0.3 or 0.4.

Bonus points do not expire and are retained for any examinations taken at a later date.

Prerequisites
none

T 14.144 Course: Methods and Processes of PGE - Product Generation Engineering [T-MACH-109192]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Norbert Burkardt

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102718 - Product Development – Methods of Product Engineering

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	1

Events					
ST 2025	2146176	Methods and Processes of PGE – Product Generation Engineering	4 SWS	Lecture / 🗣	Albers, Düser

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Assessment
Written exam (processing time: 120 min + 10 min reading time)

Auxiliaries:

- Calculator
- German dictionary (books only)

Prerequisites
None

Additional Information
This lecture is the basis for the main subject Integrated Product Development, which is offered as a specialisation.

The course is offered in German.

Workload
180 hours

T 14.145 Course: Microscale Fluid Mechanics [T-MACH-113144]

Responsible: Dr.-Ing. Philipp Marthaler
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-106539 - Microscale Fluid Mechanics

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
ST 2025	2153451	Microscale Fluid Mechanics	2 SWS	Lecture / 🗣	Marthaler

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Oral exam, duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Prerequisites
none

Workload
120 hours

T 14.146 Course: Microstructure-Property-Relationships [T-MACH-107604]

Responsible: Dr. Patric Gruber
Prof. Dr. Christoph Kirchlechner

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103713 - Properties

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	4

Events					
ST 2025	2178124	Microstructure-Property-Relationships	3 SWS	Lecture / 🗣	Kirchlechner, Gruber

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Oral examination (about 30 min)

Prerequisites
The successful participation in Übungen zu Gefüge-Eigenschafts-Beziehungen is the condition for the admittance to the oral exam in Gefüge-Eigenschafts-Beziehungen.

T-MACH-110930 - Exercises for Microstructure-Properties-Relationships has not been started.

T-MACH-110931 - Microstructure-Properties-Relationships has not been started.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-107683 - Exercises for Microstructure-Property-Relationships must have been passed.
2. The course T-MACH-110930 - Exercises for Microstructure-Property-Relationships must not have been started.
3. The course T-MACH-110931 - Microstructure-Property-Relationships must not have been started.

Additional Information
The course is offered in German.

Workload
120 hours

T 14.147 Course: Microstructure-Property-Relationships [T-MACH-110931]

Responsible: Dr. Patric Gruber
Prof. Dr. Christoph Kirchlechner

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103713 - Properties

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	2

Events					
WT 24/25	2177020	Microstructure-Property-Relationships	3 SWS	Lecture / Blended	Kirchlechner, Avadanii, Bansal, Vrellou, Gruber

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Oral examination (about 30 min)

Prerequisites
The successful participation in Exercises for Microstructure-Properties-Relationships is the condition for the admittance to the oral exam in Microstructure-Properties-Relationships.

T-MACH-107683 - Übungen zu Gefüge-Eigenschafts-Beziehungen has not been started.

T-MACH-107604 - Gefüge-Eigenschafts-Beziehungen has not been started.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-MACH-110930 - Exercises for Microstructure-Property-Relationships must have been passed.
2. The course T-MACH-107683 - Exercises for Microstructure-Property-Relationships must not have been started.
3. The course T-MACH-107604 - Microstructure-Property-Relationships must not have been started.

Additional Information
The course is offered in English.

Workload
120 hours

T 14.148 Course: Microsystem Technology [T-ETIT-100752]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100454 - Microsystem Technology

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2311625	Microsystem Technology	2 SWS	Lecture /	Stork

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

14.149 Course: Microwave Engineering Lab [T-ETIT-113938]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106973 - Microwave Engineering Lab

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2308415	Microwave Engineering Lab	4 SWS	Practical course / 🗣	Pauli
ST 2025	2308415	Microwave Engineering Lab	4 SWS	Practical course / 🗣	Pauli
WT 25/26	2308415	Microwave Engineering Lab	4 SWS	Practical course / 🗣	Pauli

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
In preparation for the laboratory experiments, each laboratory group must work together on a number of tasks as homework before the experiment and submit a single copy to the supervisor immediately before the start of the experiment. The tasks for the experiment itself are completed and recorded during the experiment. The protocol should be handed in to the supervisor immediately after the experiment. Before each experiment is carried out, there is a written or oral examination (approx. 20 minutes, no aids) on the content of the experiment.

The grade for the experiments is made up of the preparation, the protocol and the written or oral assessment of the learning objectives for each experiment. The final grade for the entire laboratory results from the overall impression of the performance. Students who appear unprepared for the respective experiment may not take part in the experiment. The experiment must be repeated at another time.

Prerequisites
none

Recommendations
Knowledge of microwave measurement technology and RF components and systems is helpful.

T 14.150 Course: Microwave Module Design [T-ETIT-111375]

Responsible: Dr. Thomas Geist
Prof. Dr.-Ing. Thomas Zwick

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105701 - Microwave Module Design

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	3 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2308426	Entwurf von Mikrowellenmodulen	2 SWS	Lecture / 🗣	Geist

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The success control is carried out as part of an oral overall examination (approx. 20 minutes) of the selected courses, which is in total meet the minimum requirement for LP.

Prerequisites
none

Recommendations
Knowledge of the basics of radio frequency technology and communications technology is helpful.

T 14.151 Course: Miniaturized passive microwave circuits [T-ETIT-108389]

Responsible: Dr.-Ing. Stefan Wünsch
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-101968 - Miniaturized Passive Microwave Circuits

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	2

Prerequisites
none

T 14.152 Course: Mixed-Signal IC Design [T-ETIT-111845]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105893 - Mixed-Signal IC Design

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2308443	Mixed-Signal IC Design	2 SWS	Lecture / 🗣	Caselle

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
The success criteria will be determined by an oral examination (30 min.)

T 14.153 Course: MMIC Design Laboratory [T-ETIT-111006]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105464 - MMIC Design Laboratory

Type	Credits	Grading	Recurrence	Expansion	Version
Examination of another type	6 CP	graded	Each term	1 terms	1

Events					
WT 24/25	2308438	MMIC Design Laboratory	4 SWS	Practical course /	Ulusoy
ST 2025	2308423	MMIC Design Laboratory	4 SWS	Practical course /	Ulusoy, Balaban
WT 25/26	2308438	MMIC Design Laboratory	4 SWS	Practical course /	Ulusoy

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The written report and the oral presentation are used to mark the course. The overall impression is assessed.

T 14.154 Course: Mobile Communications [T-ETIT-112127]

Responsible: Prof. Dr.-Ing. Peter Rost
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105971 - Mobile Communications

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2310523	Mobile Communications	2 SWS	Lecture /	Rost
WT 24/25	2310524	Tutorial for 2310523 Mobile Communications	1 SWS	Practice /	Rost
WT 25/26	2310523	Mobile Communications	2 SWS	Lecture /	Rost
WT 25/26	2310524	Exercises for 2310523 Mobile Communications	1 SWS	Practice /	Rost

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The success control takes place in the form of an oral examination lasting 25 minutes. Before the examination, there is a preparation phase of 15 minutes in which preparatory tasks are solved.

Prerequisites
none

T 14.155 Course: Mobile Communications II [T-ETIT-112679]

Responsible: Prof. Dr.-Ing. Peter Rost
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106244 - Mobile Communications II

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	3 CP	graded	Each summer term	1 terms	1

Events					
ST 2025	2310514	Mobile Communications II	2 SWS	Lecture /	Rost

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The success control takes place in the form of an oral examination lasting 25 minutes. Before the examination, there is a preparation phase of 15 minutes in which preparatory tasks are solved.

Prerequisites
none

14.156 Course: Mobile Communications Workshop [T-ETIT-113063]

Responsible: Prof. Dr.-Ing. Peter Rost
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106456 - Mobile Communications Workshop

Type	Credits	Grading	Recurrence	Version
Examination of another type	4 CP	graded	Each term	1

Events					
WT 24/25	2310513	Mobile Communications Workshop	2 SWS	Practical course / 🗣	Rost
ST 2025	2310522	Mobile Communications Workshop	2 SWS	Practical course / 🗣	Rost
WT 25/26	2310513	Mobile Communications Workshop	2 SWS	Practical course / 🗣	Rost

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The success controll takes place in the form of other types of examination. The exam consists of report covering the individual experiments. The reports are evaluated as a whole. *The grade of the module corresponds to the grade given for all reports (no individual grades for each report are given).*

Prerequisites
none

T 14.157 Course: Modeling Physiological Systems [T-ETIT-113630]

Responsible: Dr.-Ing. Axel Loewe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106782 - Modeling Physiological Systems

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	1

Assessment
The examination takes place in form of a written examination lasting 90 min. The submission of the workshop tasks before the exam is mandatory.

The module grade is the grade of the written exam.

Prerequisites
none

T 14.158 Course: Modelling and Simulation of Electrochemical Systems [T-ETIT-100781]

Responsible: Dr.-Ing. Andre Weber
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100508 - Modelling and Simulation of Electrochemical Systems

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2304217	Modellbildung elektrochemischer Systeme	2 SWS	Lecture / 🗣	Weber

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.159 Course: Modern Radio Systems Engineering [T-ETIT-100735]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100427 - Modern Radio Systems Engineering

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each term	2

Events					
ST 2025	2308430	Modern Radio Systems Engineering	3 SWS	Lecture / 🗣	Zwick, Pauli
ST 2025	2308431	Tutorial to 2308430 Modern Radio Systems Engineering	1 SWS	Practice / 🗣	Bhutani
WT 25/26	2308430	Modern Radio Systems Engineering	3 SWS	Lecture / 🗣	Zwick
WT 25/26	2308431	Tutorial to 2308430 Modern Radio Systems Engineering	1 SWS	Practice / 🗣	Bhutani

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The success control takes place in the form of an oral examination of approx. 20 minutes. The module grade is the grade of the oral examination.

Prerequisites
none

T 14.160 Course: Modern VLSI Technologies [T-ETIT-113864]

Responsible: Prof. Dr. Jasmin Aghassi-Hagmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106921 - Modern VLSI Technologies

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each summer term	1

Events					
ST 2025	2308441	Modern VLSI Technologies	2 SWS	Lecture / 🗣	Aghassi-Hagmann
ST 2025	2308442	Tutorial Modern VLSI Technologies	2 SWS	Practice / 🗣	Cadilha Marques

Legend: 🖥 Online, ✿ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success control takes place in form of an oral examination with a duration of approx. 20 minutes. Exercises have to be sucessfully completed before the exam is taken. Further details will be provided at the beginning of the course.
The module grade is the grade of the oral exam.

T 14.161 Course: Nano- and Quantum Electronics [T-ETIT-111232]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105604 - Nano- and Quantum Electronics

Type	Credits	Grading	Recurrence	Expansion	Version
Written examination	6 CP	graded	Each summer term	1 terms	1

Events					
ST 2025	2312668	Nano- and Quantum Electronics	3 SWS	Lecture / 🗣	Kempf
ST 2025	2312670	Tutorial for 2312668 Nano- and Quantum Electronics	1 SWS	Practice / 🗣	Wünsch

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of success takes place in the form of a written examination lasting 120min. The grade corresponds to the result of the written examination.

Prerequisites
none

Recommendations
Successful completion of the modules "Superconductivity for Engineers" and „Einführung in die Quantentheorie für Elektrotechniker“ is recommended.

T 14.162 Course: Navigation and Localization Techniques [T-ETIT-111829]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105881 - Navigation and Localization Techniques

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2308440	Navigation and Localization Techniques	2 SWS	Lecture / 🗣	Sand

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The success control is carried out as part of an oral overall examination (approx. 20 minutes) of the selected courses, which in total meet the minimum requirement for LP.

T 14.163 Course: Nonlinear Control Systems [T-ETIT-100980]

Responsible: Dr.-Ing. Mathias Kluwe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100371 - Nonlinear Control Systems

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2303173	Nichtlineare Regelungssysteme	2 SWS	Lecture / 🗣	Kluwe

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.164 Course: Nonlinear Optics [T-ETIT-101906]

Responsible: Prof. Dr.-Ing. Christian Koos
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100430 - Nonlinear Optics

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each summer term	2

Events					
ST 2025	2309468	Nonlinear Optics	2 SWS	Lecture / 🗣	Koos
ST 2025	2309469	Nonlinear Optics (Tutorial)	2 SWS	Practice / 🗣	Koos

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.165 Course: Novel Actuators and Sensors [T-MACH-102152]

Responsible: Prof. Dr. Manfred Kohl
Dr. Martin Sommer

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105292 - Novel Actuators and Sensors

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	4

Events					
WT 24/25	2141865	Novel actuators and sensors	2 SWS	Lecture / 🗣	Kohl, Sommer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written exam, 60 minutes

Prerequisites
T-MACH-114036 must not be started

Workload
120 hours

14.166 Course: Numerical Fluid Mechanics [T-MACH-105338]

Responsible: Prof. Dr.-Ing. Bettina Frohnapfel
Dr.-Ing. Davide Gatti

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107036 - Numerical Fluid Mechanics

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	4

Events					
WT 24/25	2153441	Numerical Fluid Mechanics	4 SWS	Lecture / Practice (/	Gatti
WT 25/26	2153441	Numerical Fluid Mechanics	4 SWS	Lecture / Practice (/	Gatti

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
oral exam - 30 minutes

Prerequisites
none

Workload
120 hours

14.167 Course: Numerical Methods - Exam [T-MATH-111700]

Responsible: apl. Prof. Dr. Peer Kunstmann
TT-Prof. Dr. Xian Liao
Prof. Dr. Wolfgang Reichel

Organisation: KIT Department of Mathematics

Part of: M-MATH-105831 - Numerical Methods
M-MATH-106972 - Numerical Methods with Programming Practice

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each summer term	1

Events					
ST 2025	0180300	Numerical Methods (Electrical Engineering, Meteorology, Remote Sensing, Geoinformatics)	2 SWS	Lecture	Tolksdorf
ST 2025	0180400	Tutorial for 0180300	1 SWS	Practice	Tolksdorf

Assessment
Success control takes the form of a written examination (120 minutes).

Prerequisites
none

T 14.168 Course: Numerical Methods - Workshop [T-MATH-113937]

Responsible: apl. Prof. Dr. Peer Kunstmann
TT-Prof. Dr. Xian Liao
Prof. Dr. Wolfgang Reichel

Organisation: KIT Department of Mathematics

Part of: M-MATH-106972 - Numerical Methods with Programming Practice

Type	Credits	Grading	Recurrence	Version
Coursework	1 CP	pass/fail	Each summer term	1

Assessment
Successful participation in the workshop is confirmed by signing the attendance sheet provided at each practice session.

Prerequisites
None

T 14.169 Course: Numerical Methods for Partial Differential Equations [T-ETIT-104595]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-102311 - Numerical Methods for Partial Differential Equations

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	2

Events					
ST 2025	2303600	Numerical Methods for Partial Differential Equations	2 SWS	Lecture / 🗣	Nagato-Plum
ST 2025	2303601	Practice to 2303180 Numerical Methods for Partial Differential Equations	1 SWS	Practice / 🗣	Nagato-Plum

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.170 Course: Operations Research in Health Care Management [T-WIWI-102884]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106853 - Operations Research in Health Care Management

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each term	4

Events					
WT 24/25	2550495	Operations Research in Health Care Management	2 SWS	Lecture / 🗣	Graß
WT 24/25	2550496	Übungen zu OR im Health Care Management	1 SWS	Practice	Graß
ST 2025	2550495	Operations Research in Health Care Management	2 SWS	Lecture / 🖥	Graß
ST 2025	2550496	Übungen zu OR im Health Care Management	1 SWS	Practice / 🖥	Graß

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
Success is assessed in English in the form of a 60-minute written examination (in accordance with §4(2), 1 SPO).

The examination is offered every semester.

Prerequisites
None

Recommendations
Basic knowledge as co nveyed in the module "Introduction to Operations Research" is assumed.

Additional Information
Lectures and examinations are held in English.

Workload
150 hours

T 14.171 Course: Optical Design Lab [T-ETIT-100756]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100464 - Optical Design Lab

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each summer term	2

Events					
ST 2025	2311647	Optical Design Lab	4 SWS	Practical course / 🗣	Stork

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.172 Course: Optical Engineering and Machine Vision [T-ETIT-113941]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106974 - Optical Engineering and Machine Vision

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	1

Assessment
The examination takes place in form of a written examination lasting 90 minutes.

The module grade is the grade of the written examination.

Prerequisites
none

14.173 Course: Optical Networks and Systems [T-ETIT-106506]

Responsible: Prof. Dr.-Ing. Sebastian Randel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103270 - Optical Networks and Systems

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	2

Events					
WT 24/25	2309470	Optical Networks and Systems	2 SWS	Lecture / 🗣	Randel
WT 24/25	2309471	Tutorial for 2309470 Optical Networks and Systems	1 SWS	Practice / 🗣	Randel, N.N.

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.174 Course: Optical Systems in Medicine and Life Science [T-ETIT-106462]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103252 - Optical Systems in Medicine and Life Science

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each summer term	3

Events					
WT 24/25	2305292	Optical Systems in Medicine and Life Science	2 SWS	Lecture / ✕	Hoffmann, Nahm
ST 2025	2305292	Optical Systems in Medicine and Life Science	2 SWS	Lecture / 🧩	Hoffmann, Nahm

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written exam (60 minutes)

Prerequisites
Only one out of the two modules "M-ETIT-100552 - Optische Systeme für Medizintechnik und Life Sciences" and "M-ETIT-103252 - Optical Systems in Medicine and Life Science" is allowed.

Recommendations
Good understanding of optics and optoelectronics.

Additional Information
Language English

T 14.175 Course: Optical Transmitters and Receivers [T-ETIT-100639]

Responsible: Prof.Dr.Dr.h.c. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100436 - Optical Transmitters and Receivers

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each winter term	2

Events					
WT 24/25	2309460	Optical Transmitters and Receivers	2 SWS	Lecture / 🗣	Freude
WT 24/25	2309461	Tutorial for 2309460 Optical Transmitters and Receivers	2 SWS	Practice / 🗣	Freude, N.N.

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.176 Course: Optics and Vision in Biology [T-CHEMBIO-105198]

Responsible: Prof. Dr. Martin Bastmeyer
Organisation: KIT Department of Chemistry and Biosciences
Part of: M-CHEMBIO-101906 - Optics and Vision in Biology

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	2

Assessment
Type of Examination: Written exam

Duration of Examination: 120 Minutes

Modality of Exam: The written exam is scheduled for the break after the WS. A resit exam will be offered, when needed.

Prerequisites
none

Recommendations
Passed exam of the Adjustment Course in "Basic Molecular Cell Biology" AdjC-BMCB.

Attendance to the lecture.

Additional Information
Prerequisite for exam participation: Passed exam of the Adjustment Course in “Basic Molecular Cell Biology”.
Anmerkungen engl.

Workload
120 hours

14.177 Course: Optimal Control and Estimation [T-ETIT-104594]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-102310 - Optimal Control and Estimation

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2303162	Optimal Control and Estimation	2 SWS	Lecture / 🗣	Kluwe

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.178 Course: Optimization of Dynamic Systems [T-ETIT-100685]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100531 - Optimization of Dynamic Systems

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each winter term	1

Events					
WT 24/25	2303183	Optimization of Dynamic Systems	2 SWS	Lecture /	Hohmann
WT 24/25	2303185	Optimization of Dynamic Systems (Tutorial to 2303183)	1 SWS	Practice /	Hess
WT 24/25	2303851	Accompanying group tutorial for 2303183 Optimization of Dynamic Systems	1 SWS	Tutorial (/	Hess

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The assessment consists of a written exam (120 min) taking place in the recess period.

Prerequisites
none

T 14.179 Course: Optoelectronic Components [T-ETIT-101907]

Responsible: Prof. Dr.-Ing. Sebastian Randel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100509 - Optoelectronic Components

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2309486	Optoelectronic Components	2 SWS	Lecture / 🧩	Randel
ST 2025	2309487	Optoelectronic Components (Tutorial)	1 SWS	Practice / 🧩	Randel

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.180 Course: Optoelectronic Measurement Engineering [T-ETIT-100771]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100484 - Optoelectronic Measurement Engineering

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2313736	Optoelectronic Measurement Engineering	2 SWS	Lecture / 🗣	Trampert

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

14.181 Course: Organ Support Systems [T-MACH-105228]

Responsible: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102702 - Organ Support Systems

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2106008	Organ support systems	2 SWS	Lecture / 🗣	Pylatiuk

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
Written examination (Duration: 45min)

Prerequisites
none

Workload
120 hours

T 14.182 Course: Packaging and Interconnects for Power Electronic Systems [T-ETIT-104518]

Responsible: Dr. Thomas Blank
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-102200 - Packaging and Interconnects for Power Electronic Systems

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2306349	Packaging and Interconnects for Power Electronic Systems	2 SWS	Lecture / 🗣	Blank

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.183 Course: Pattern Recognition [T-INFO-101362]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Tim Zander

Organisation: KIT Department of Informatics

Part of: M-INFO-100825 - Pattern Recognition

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	2

Events					
ST 2025	24675	Pattern Recognition	4 SWS	Lecture / Practice (/	Beyerer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

14.184 Course: Photometry and Radiometry [T-ETIT-100789]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100519 - Photometry and Radiometry

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2313727	Photometry and Radiometry	2 SWS	Lecture / 🗣	Trampert
WT 25/26	2313727	Photometry and Radiometry	2 SWS	Lecture / 🗣	Trampert

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.185 Course: Photonic Integrated Circuit Design and Applications [T-ETIT-111896]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105914 - Photonic Integrated Circuit Design and Applications

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	1

Events					
ST 2025	2309478	Photonic Integrated Circuit Design and Applications	2 SWS	Lecture /	Koos, Freude, Randel
ST 2025	2309479	Photonic Integrated Circuit Design and Applications (Practical Exercise)	2 SWS	Practical course /	Koos, Freude, Randel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment

- Part 1 – Solutions of problem sets: We will grade your solutions of the various problem sets and design projects. To this end, please upload your solution via the online teaching platform of your respective institution (see above) before the respective deadline. Please merge all pages into a single pdf file, and please use a scanner. Smartphone made snapshots are often illegible, and in this case your solutions cannot not be evaluated. In case there are any technical difficulties with the platforms, you may also submit your solutions by e-mail to picda@ipq.kit.edu before the respective deadline.
- Part 2 - Presentation of one pre-assigned problem set: At the beginning of the term, design projects will be pre-assigned to groups of participants. Each of these groups will explain their approach and results to lecturers and peer students in a short presentation (approx. 15 min), followed by approx. 10 min of public discussion with peer students and professors, and an individual private interview of each group member (approx. 10 min per person).

The overall impression is rated.

Prerequisites
none

T 14.186 Course: Photonics and Communications Lab [T-ETIT-109173]

Responsible: Prof. Dr.-Ing. Christian Koos
Prof. Dr.-Ing. Sebastian Randel

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-104485 - Photonics and Communications Lab

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	1

Events					
ST 2025	2309490	Photonics and Communications Lab	4 SWS	Practical course / 🗣	Koos, Freude, Randel, Kuzmin

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 14.187 Course: Physical Basics of Laser Technology [T-MACH-102102]

Responsible: Dr.-Ing. Johannes Schneider
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107064 - Physical Basics of Laser Technology

Type	Credits	Grading	Recurrence	Version
Oral examination	5 CP	graded	Each winter term	5

Events					
WT 24/25	2181612	Physical basics of laser technology	3 SWS	Lecture / Practice (/ 🗣	Schneider
WT 25/26	2181612	Physical basics of laser technology	3 SWS	Lecture / Practice (/ 🗣	Schneider

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
oral examination (ca. 25-30 min)

no tools or reference materials

Prerequisites
It is not possible, to combine this brick with brick Laser Material Processing [T-MACH-112763], brick Laser Application in Automotive Engineering [T-MACH-105164] and brick Physical Basics of Laser Technology [T-MACH-109084].

Recommendations
Basic knowledge of physics, chemistry and material science

Workload
150 hours

T 14.188 Course: Physics, Technology and Applications of Thin Films [T-ETIT-111237]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105608 - Physics, Technology and Applications of Thin Films

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	4 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2312710	Physics, Technology and Application of Thin Films	2 SWS	Lecture / 🗣	Ilin
WT 24/25	2312711	Exercise for 2312710 Physics, Technology and Application of Thin Films	1 SWS	Practice / 🗣	Ilin
WT 25/26	2312710	Physics, Technology and Application of Thin Films	2 SWS	Lecture / 🗣	Ilin
WT 25/26	2312711	Exercise for 2312710 Physics, Technology and Application of Thin Films	1 SWS	Practice / 🗣	Ilin

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The success control takes place within the framework of an oral overall examination of approx. 20 minutes.

T 14.189 Course: Plasma Sources [T-ETIT-100768]

Responsible: Prof. Dr. Wolfgang Heering
Dr.-Ing. Rainer Kling

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-100481 - Plasma Sources

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2313729	Plasma Sources	3 SWS	Lecture / ✕	Kling

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Prerequisites
none

T 14.190 Course: Plastic Electronics / Polymerelectronics [T-ETIT-100763]

Responsible: Prof. Dr. Ulrich Lemmer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100475 - Plastic Electronics / Polymerelectronics

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2313709	Polymerelectronics/ Plastic Electronics	2 SWS	Lecture / 🧩	Hernandez Sosa

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Assessment
The control of success takes place within the framework of an oral overall examination (approx. 30 minutes).

Prerequisites
none

Recommendations
Knowledge of semiconductor devices

Additional Information
Lecture and examination are held in German or English, as required.

T 14.191 Course: Polymers in MEMS B: Physics, Microstructuring and Applications [T-MACH-102191]

Responsible: Dr.-Ing. Matthias Worgull
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107035 - Polymers in MEMS B: Physics, Microstructuring and Applications

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2141854	Polymers in MEMS B: Physics, Microstructuring and Applications	2 SWS	Lecture / 🧩	Worgull

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Oral examination

Prerequisites
none

Workload
120 hours

T 14.192 Course: Polymers in MEMS C: Biopolymers and Bioplastics [T-MACH-102200]

Responsible: Dr.-Ing. Matthias Worgull
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107085 - Polymers in MEMS C: Biopolymers and Bioplastics

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2142855	Polymers in MEMS C - Biopolymers and Bioplastics	2 SWS	/	Worgull

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Oral examination

Prerequisites
none

Workload
120 hours

T 14.193 Course: Power Electronics [T-ETIT-109360]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-104567 - Power Electronics

Type	Credits	Grading	Recurrence	Expansion	Version
Written examination	6 CP	graded	Each summer term	1 terms	6

Events					
ST 2025	2300004	Ausweich- und Praktikumstermin für ETI-Vorlesungen	2 SWS	Practical course /	Hiller, Thönelt
ST 2025	2306323	Power Electronics	2 SWS	Lecture /	Hiller
ST 2025	2306324	Tutorial for 2306385 Power Electronics	2 SWS	Practice /	Hiller, Thönelt

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

Prerequisites
none

T 14.194 Course: Practical Aspects of Electrical Drives [T-ETIT-100711]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100394 - Practical Aspects of Electrical Drives

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	2

Events					
WT 24/25	2306311	Practical Aspects of Electrical Drives	2 SWS	Lecture / ✕	Brodatzki, Doppelbauer
WT 24/25	2306313	Übungen zu 2306311 Praxis elektrischer Antriebe	1 SWS	Practice / ✕	Doppelbauer
ST 2025	2306311	Practical Aspects of Electrical Drives	2 SWS	Lecture / ✕	Doppelbauer
ST 2025	2306313	Übungen zu 2306311 Praxis elektrischer Antriebe	1 SWS	Practice / ✕	Doppelbauer

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Prerequisites
none

Additional Information
Shift from SoSe to WiSe, does not take place in WiSe24/25 and SoSe25.

T 14.195 Course: Practical Course: Biologically Inspired Robots [T-INFO-111039]

Responsible: Prof. Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Informatics
Part of: M-INFO-105495 - Practical Course: Biologically Inspired Robots

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each winter term	1

T 14.196 Course: Practical Course: Human-Centred Robotics [T-INFO-113393]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106646 - Practical Course: Human-Centred Robotics

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each term	1

Events					
WT 24/25	2400193	Practical Course: Human-Centred Robotics Projects	4 SWS	Practical course / 🗣	Mombaur
ST 2025	2400149	Practical course: Human-Centred Robotics	4 SWS	Practical course / 🗣	Mombaur, Lee

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

This includes the preparation of a project report (ca. 10 pages and an oral presentation with slides and hardware demonstration (30 Min + 15 min questions). Students may withdraw from the examination during the first two weeks after the topic has been communicated.

Prerequisites
Programming skills are required.

Recommendations
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) are very helpful.

Additional Information
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week.

T 14.197 Course: Practical Course: Machine Learning and Intelligent Systems [T-INFO-112104]

Responsible: Michael Fennel
Prof. Dr.-Ing. Uwe Hanebeck

Organisation: KIT Department of Informatics

Part of: M-INFO-105958 - Practical Course: Machine Learning and Intelligent Systems

Type	Credits	Grading	Recurrence	Version
Examination of another type	8 CP	graded	Each term	1

Events					
ST 2025	24871	Practical Course Machine Learning and Intelligent Systems	4 SWS	Practical course / 🗣	Hanebeck, Prossel

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 14.198 Course: Practical Course: Movement and Technology [T-INFO-113394]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106648 - Practical Course: Movement and Technology

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	2

Events					
ST 2025	2400151	Practical Course: Movement and Technology	4 SWS	Practical course / 🗣	Mombaur, Lau

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

This includes the preparation of a project report (ca. 10 pages and an oral presentation of the project topics and results with slides. Students may withdraw from the examination during the first two weeks after the topic has been communicated.

Prerequisites
Programming skills are required.

Recommendations
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) are very helpful.

Programming skills.

Additional Information
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week.

T 14.199 Course: Practical Machine Learning [T-ETIT-113426]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106673 - Practical Machine Learning

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each summer term	2

Events					
ST 2025	2302200	Practical Machine Learning	4 SWS	Lecture / Practice (/ 🗣	Gardi

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Assessment
Success is assessed by the submission of the scientific essay and the presentation of the team project lasting approx. 30 minutes.

The module grade results from the team project accompanying the semester and the presentation of the team project. The overall impression is assessed. Further details will be provided at the beginning of the course.

Prerequisites
none

T 14.200 Course: Practical Seminar: Health Care Management (with Case Studies) [T-WIWI-102716]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106852 - Practical Seminar: Health Care Management (with Case Studies)

Type	Credits	Grading	Recurrence	Version
Examination of another type	5 CP	graded	Each term	3

Events					
WT 24/25	2500008	Practical seminar: Health Care Management	3 SWS	Others (sons / 🗣	Nickel, Mitarbeiter
ST 2025	2550498	Practical seminar: Health Care Management	3 SWS	Seminar / ⚙	Nickel, Mitarbeiter

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of this module is an examination of another type and consists of the following components:

- a case study to be worked on,
- a seminar paper and
- a final oral examination.

The overall grade results from the weighted evaluation of the case study, the seminar paper and the presentation. The exact weighting of these individual components for the grade will be announced at the beginning of the course.

Prerequisites
None.

Recommendations
Basic knowledge as conveyed in the module *Introduction toOperations Research* is assumed.

Additional Information
The lecture is offered every term.

The planned lectures and courses for the next three years are announced online.

Workload
150 hours

T 14.201 Course: Practical Tools for Control Engineers [T-ETIT-113628]

Responsible: Dr.-Ing. Balint Varga
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106780 - Practical Tools for Control Engineers

Type	Credits	Grading	Recurrence	Expansion	Version
Examination of another type	4 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2303210	Practical Tools for Control Engineers	2 SWS	Lecture / 🗣	Varga

Legend: 🖥 Online, ❋ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of other types of examination. It consists of an oral overall examination in the amount of 25 minutes and a homework programming task. The examination includes questions from the lecture slides and the presentation of the homework assignment. The homework must be submitted two weeks before of the oral exam. The overall impression is evaluated.

Prerequisites
none

Recommendations
The contents of the modules “Optimization of Dynamic Systems (ODS)” and “Regelung linearer Mehrgrößensysteme (RLM)” are helpful for the lecture.

Workload
120 hours

T 14.202 Course: Practical Training in Basics of Microsystem Technology [T-MACH-102164]

Responsible: Dr. Arndt Last
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105479 - Practical Training in Basics of Microsystem Technology

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each term	2

Events					
WT 24/25	2143875	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last
WT 24/25	2143877	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last
ST 2025	2143875	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last
WT 25/26	2143875	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last
WT 25/26	2143877	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written examination lasting 60 minutes.

Prerequisites
none

T 14.203 Course: Preparatory Lab Medical Measurement Technology [T-ETIT-113758]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106779 - Medical Measurement Technology Lab

Type	Credits	Grading	Recurrence	Version
Coursework	1 CP	pass/fail	Each winter term	2

Assessment
The examination of the Preparatory Lab takes place in form of other types of examinations. It consists of an ungraded practical test.

Prerequisites
none

T 14.204 Course: Preparatory Lecture Medical Measurement Technology [T-ETIT-113721]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106779 - Medical Measurement Technology Lab

Type	Credits	Grading	Recurrence	Version
Coursework	2 CP	pass/fail	Each winter term	2

Assessment
The examination of the Preparatory Lecture takes place in form of other types of examinations. It consists of an ungraded written test.

Prerequisites
none

14.205 Course: Principles of Medicine for Engineers [T-MACH-105235]

Responsible: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102720 - Principles of Medicine for Engineers

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2105992	Principles of Medicine for Engineers	2 SWS	Lecture / 🗣	Pylatiuk

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written examination (Duration: 45min)

Prerequisites
none

Workload
120 hours

14.206 Course: Process Analysis: Modeling, Data Mining, Machine Learning [T-ETIT-111214]

Responsible: Dr.-Ing. Christian Borchert
Prof. Dr.-Ing. Michael Heizmann

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105594 - Process Analysis: Modeling, Data Mining, Machine Learning

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	3 CP	graded	Each summer term	1 terms	2

Events					
ST 2025	2302145	Process Analysis: Modeling, Data Mining, Machine Learning	2 SWS	Lecture / 🗣	Borchert

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 14.207 Course: Product Lifecycle Management [T-MACH-105147]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106195 - Product Lifecycle Management

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	2

Events					
WT 24/25	2121350	Product Lifecycle Management	2 SWS	Lecture / 🗣	Ovtcharova, Meyer, Rönnau

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Writen examination 90 min.

Prerequisites
None

Workload
120 hours

14.208 Course: Project Management in the Development of Products for Safety-Critical Applications [T-ETIT-109148]

Responsible: Dr.-Ing. Manfred Nolle
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-104475 - Project Management in the Development of Products for Safety-Critical Applications

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	3

Events					
WT 24/25	2311641	Project Management in the Development of Products for Safety-Critical Applications	2 SWS	/	Nolle
WT 24/25	2311643	Tutorial for 2311641 Project Management in the Development of Products for Safety-Critical Applications	1 SWS	Practice /	Nolle

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

T 14.209 Course: ProVIL - Product Development in a Virtual Idea Laboratory [T-MACH-106738]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Tobias Düser

Organisation: KIT Department of Mechanical Engineering

Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Version
Coursework	4 CP	pass/fail	Each summer term	1

Events					
ST 2025	2146210	ProVIL - Product Development in a Virtual Idea Laboratory	4 SWS	Lecture / 🖥	Albers, Düser

Legend: 🖥 Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
colloquia and presentations.

Prerequisites
none

Additional Information
Offered for the last time in summer semester 2025.

The course is offered in German.

Workload
120 hours

T 14.210 Course: Quality Management [T-MACH-102107]

Responsible: Prof. Dr.-Ing. Gisela Lanza
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105332 - Quality Management

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each winter term	3

Events					
WT 24/25	2149667	Quality Management	2 SWS	Lecture /	Lanza, Stamer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Written Exam (60 min)

Prerequisites
It is not possible to combine this brick with brick Quality Management [T-MACH-112586].

Workload
120 hours

T 14.211 Course: Quantum Detectors and Sensors [T-ETIT-111234]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105606 - Quantum Detectors and Sensors

Type	Credits	Grading	Recurrence	Expansion	Version
Written examination	6 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2312706	Quantum Detectors and Sensors	3 SWS	Lecture / 🗣	Kempf
WT 24/25	2312707	Exercise for 2312706 Quantum Detectors and Sensors	1 SWS	Practice / 🗣	Ilin
WT 25/26	2312706	Quantum Detectors and Sensors	3 SWS	Lecture / 🗣	Kempf
WT 25/26	2312707	Exercise for 2312706 Quantum Detectors and Sensors	1 SWS	Practice / 🗣	Ilin

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of success takes place in the form of a written examination lasting 120min. The grade corresponds to the result of the written examination.

Prerequisites
None

Recommendations
Successful completion of the module "Superconductivity for Engineers" is recommended.

14.212 Course: Quantum Engineering [T-ETIT-113909]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106954 - Quantum Engineering

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	1

Events					
ST 2025	2312100	Quantum Engineering	3 SWS	Lecture / 🗣	Kempf
ST 2025	2312101	Tutorial to 2312100 Quantum Engineering	1 SWS	Practice / 🗣	Kempf, Mitarbeiter*innen

Legend: 🖥 Online, ❃ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

The module grade is the grade of the written exam.

Prerequisites
none

T 14.213 Course: Quantum Machine Learning [T-ETIT-111838]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105889 - Quantum Machine Learning

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2302126	Quantum Machine Learning	2 SWS	Lecture / 🗣	Gardi

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 14.214 Course: Radar Systems Engineering [T-ETIT-100729]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100420 - Radar Systems Engineering

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	2

Events					
WT 24/25	2308454	Radar Systems Engineering	3 SWS	Lecture / 🗣	Zwick, Younis
WT 24/25	2308455	Rechnerübung zu 2308454 Radar Systems Engineering	1 SWS	Practice / 🧩	Bhutani
WT 25/26	2308454	Radar Systems Engineering	3 SWS	Lecture / 🗣	Zwick, Younis
WT 25/26	2308455	Exercise to 2308454 Radar Systems Engineering	1 SWS	Practice / 🧩	Bhutani

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.215 Course: Radio Frequency Integrated Circuits and Systems [T-ETIT-110358]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105123 - Radio Frequency Integrated Circuits and Systems

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each summer term	2

Events					
ST 2025	2308419	Radio Frequency Integrated Circuits and Systems	2 SWS	Lecture / 🗣	Ulusoy
ST 2025	2308421	Workshop for 2308421 Radio Frequency Integrated Circuits and Systems	2 SWS	Practice / 🗣	Ulusoy, Tsai

Legend: 🖥 Online, ❃ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The success criteria will be determined by an oral examination (approx. 20-30 min.)

Recommendations
The lecture materials to „Grundlagen der Hochfrequenztechnik“ and „Halbleiterbauelemente“ are recommended.

T 14.216 Course: Radio Receivers [T-ETIT-106431]

Responsible: Prof. Dr. Friedrich Jondral
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103241 - Radio Receivers

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2310531	Radio Receivers	2 SWS	Lecture / 🗣	Jondral
WT 25/26	2310531	Radio Receivers	2 SWS	Lecture / 🗣	Jondral

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.217 Course: Radio-Frequency Electronics [T-ETIT-113910]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106955 - Radio-Frequency Electronics

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	1

Events					
WT 24/25	2308503	Radio-Frequency Electronics	2 SWS	Lecture / 🗣	Ulusoy
WT 24/25	2308504	Exercise for 2308503 Radio-Frequency Electronics	1 SWS	Practice / 🧩	Kuo
WT 25/26	2308503	Radio-Frequency Electronics	2 SWS	Lecture / 🗣	Ulusoy
WT 25/26	2308504	Exercise for 2308503 Radio-Frequency Electronics	1 SWS	Practice / 🧩	Kuo

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

The module grade is the grade of the written examination.

Prerequisites
none

T 14.218 Course: Registration for Certificate Issuance - Supplementary Studies on Science, Technology and Society [T-FORUM-113587]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation: General Studies. Forum Science and Society (FORUM)

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Recurrence	Version
Coursework	0 CP	pass/fail	Each term	1

Prerequisites

In order to register, it is mandatory that the basic module and the advanced module have been completed and that the grades for the partial performances in the advanced module are available.

Registration as a partial achievement means the issue of a certificate.

14.219 Course: Regulatory Affairs and Quality Management in Medical Device Product Development [T-ETIT-113872]

Responsible: Dipl.-Ing. Uwe Philippeit
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106920 - Regulatory Affairs and Quality Management in Medical Device Product Development

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each summer term	1

Assessment
Success control takes place in the form of other types of examination. The examination consists of:

1. Creation of an excerpted product file intended for the approval of a medical device in groups of 3-5 students. Participants can also suggest products themselves.
2. Presentation of the results after the end of the lecture period.
3. Written exam

The overall impression is rated.

The module grade results of the assessment of the project work and the written exam. Details will be given during the lecture.

Prerequisites
none

T 14.220 Course: Reinforcement Learning [T-INFO-111255]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Prof. Dr. Gerhard Neumann

Organisation: KIT Department of Informatics

Part of: M-INFO-105623 - Reinforcement Learning

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	2

Events					
WT 24/25	2400163	Reinforcement Learning		Lecture / Practice (/ 🗣	Neumann, Lioutikov, Zhou

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The success control takes place in the form of a written exam, usually 90 minutes in length, according to § 4 Abs. 2 Nr. 1 SPO.

A bonus can be acquired through successful participation in the exercise as a success control of a different kind (§4(2), 3 SPO 2008) or study performance (§4(3) SPO 2015). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4). The bonus is only valid for the main and post exams of the semester in which it was earned. After that, the grade bonus expires.

Prerequisites
None.

Recommendations
• Students should be familiar with the content of the "Foundations of Artificial Intelligence" lecture.
• Good Python knowledge is required.
• Good mathematical background knowledge is required.

T 14.221 Course: Reliability and Test Engineering [T-MACH-111840]

Responsible: Dr.-Ing. Thomas Gwosch
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106050 - Reliability and Test Engineering

Type	Credits	Grading	Recurrence	Expansion	Version
Examination of another type	5 CP	graded	Each winter term	1 terms	2

Events					
WT 24/25	2145350	Reliability and Test Engineering (Lecture)	1 SWS	Lecture /	Gwosch
WT 24/25	2145351	Workshop Reliability and Test Engineering	2 SWS	Practical course /	Gwosch

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The grade is composed of the evaluation of a final report following the practical part. The assessment criteria are as follows:

- Structure of the report
- Comprehensibility and comprehensibility
- Preparation of the tests
- Use of test and reliability methods
- Formulation and answering of test hypotheses
- Test evaluation, comprehensible results

Attendance and active participation in the lab is mandatory.

Prerequisites
none

Recommendations
None

Additional Information
The course is offered in English.

Workload
150 hours

14.222 Course: Rheology of Polymers [T-CIWVT-108884]

Responsible: Prof. Dr. Norbert Willenbacher
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104329 - Rheology of Polymers

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2242050	Rheology of Polymers	2 SWS	Lecture / 🗣	Willenbacher

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 14.223 Course: Robotics II - Humanoid Robotics [T-INFO-114152]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-107123 - Robotics II - Humanoid Robotics

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2400074	Robotics II: Humanoid Robotics	2 SWS	Lecture / 🗣	Asfour

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites

- M-INFO-100816 - Robotics II - Learning and planning robots Module must not have been started.
- T-INFO-101391 - Anthropomatics: Humanoid RoboticsPartial work must not have been started.

Recommendations
Having visited the lectures on Robotics I - Introduction to Robotics and Mechano-Informatics and Robotics is recommended.

T 14.224 Course: Scientific Group Project in Medical Ultrasound Imaging [T-ETIT-113613]

Responsible: Dr. Nicole Ruiter
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106775 - Scientific Group Project in Medical Ultrasound Imaging

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each winter term	1

Assessment
The examination takes place in form of an ungraded intermediate presentation and a graded final presentation and report.

The module grade results of the assessment of the final presentation and the report. Details will be given during the lecture.

Prerequisites
none

T 14.225 Course: Self Assignment-HOC-SPZ-FORUM-graded [T-ETIT-111688]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Version
Examination of another type	2 CP	graded	1

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Additional Information
Placeholder for self-booking of a graded interdisciplinary qualification, which was provided at the House of Competence, the "Sprachenzentrum" or the Center for Applied Cultural Studies and Studium Generale.

Title and credits of the achievement are adopted.

T 14.226 Course: Self Assignment-HOC-SPZ-FORUM-graded [T-ETIT-111529]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Version
Examination of another type	2 CP	graded	1

Self Service Assignment of Supplementary Studies

This course can be used for self service assignment of grades acquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Additional Information

Placeholder for self-booking of a graded interdisciplinary qualification, which was provided at the House of Competence, the "Sprachenzentrum" or the Center for Applied Cultural Studies and Studium Generale.

Title and credits of the achievement are adopted.

14.227 Course: Self Assignment-HOC-SPZ-FORUM-graded [T-ETIT-111689]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Version
Examination of another type	2 CP	graded	1

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Additional Information
Placeholder for self-booking of a graded interdisciplinary qualification, which was provided at the House of Competence, the "Sprachenzentrum" or the Center for Applied Cultural Studies and Studium Generale.

Title and credits of the achievement are adopted.

T 14.228 Course: Self Assignment-HOC-SPZ-Forum-ungraded [T-ETIT-111690]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Version
Coursework	2 CP	pass/fail	1

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Additional Information
Placeholder for self-booking of a ungraded interdisciplinary qualification, which was provided at the House of Competence, the "Sprachenzentrum" or the Center for Applied Cultural Studies and Studium Generale.

Title and credits of the achievement are adopted.

T 14.229 Course: Self Assignment-HOC-SPZ-FORUM-ungraded [T-ETIT-111533]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Version
Coursework	2 CP	pass/fail	1

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Additional Information
Placeholder for self-booking of a ungraded interdisciplinary qualification, which was provided at the House of Competence, the "Sprachenzentrum" or the Center for Applied Cultural Studies and Studium Generale.

Title and credits of the achievement are adopted.

14.230 Course: Self Assignment-HOC-SPZ-FORUM-ungraded [T-ETIT-112899]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Version
Coursework	2 CP	pass/fail	1

Additional Information
Placeholder for self-booking of a ungraded interdisciplinary qualification, which was provided at the House of Competence, the "Sprachenzentrum" or the Center for Applied Cultural Studies and Studium Generale.

Title and credits of the achievement are adopted.

T 14.231 Course: Self Assignment-HOC-SPZ-FORUM-ungraded [T-ETIT-112898]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Version
Coursework	2 CP	pass/fail	1

Self Service Assignment of Supplementary Studies

This course can be used for self service assignment of grades acquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Additional Information

Placeholder for self-booking of a ungraded interdisciplinary qualification, which was provided at the House of Competence, the "Sprachenzentrum" or the Center for Applied Cultural Studies and Studium Generale.

Title and credits of the achievement are adopted.

T 14.232 Course: Self Assignment-HOC-SPZ-FORUM-ungraded [T-ETIT-111691]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Version
Coursework	2 CP	pass/fail	1

Self Service Assignment of Supplementary Studies
This course can be used for self service assignment of grades acquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Additional Information
Placeholder for self-booking of a ungraded interdisciplinary qualification, which was provided at the House of Competence, the "Sprachenzentrum" or the Center for Applied Cultural Studies and Studium Generale.

Title and credits of the achievement are adopted.

T 14.233 Course: Seminar Advanced Concepts for Flexible and Soft Optoelectronic Devices and Sensors [T-ETIT-113427]

Responsible: Prof. Dr. Gerardo Hernandez Sosa
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106674 - Seminar Advanced Concepts for Flexible and Soft Optoelectronic Devices and Sensors

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each summer term	1

Events					
ST 2025	2313766	Seminar Advanced Concepts for Flexible and Soft Optoelectronic Devices and Sensors	2 SWS	Seminar / 🗣	Hernandez Sosa

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination consists of a written journal article and an oral presentation of the student's work, both given in English. The overall impression is rated.

The module grade results of the assessment of the written paper and the oral presentation. Details will be given during the lecture.

Prerequisites
none

T 14.234 Course: Seminar Creating a Patent Specification [T-ETIT-100754]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Version
Coursework	3 CP	pass/fail	Each summer term	1

Events					
ST 2025	2311633	Seminar Creating a Patent Specification	2 SWS	Seminar / 🗣	Stork

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.235 Course: Seminar Electrocatalysis [T-ETIT-111256]

Responsible: Prof. Dr.-Ing. Ulrike Krewer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105629 - Seminar Electrocatalysis

Type	Credits	Grading	Recurrence	Expansion	Version
Examination of another type	3 CP	graded	Each term	1 terms	1

Events					
WT 24/25	2304238	Seminar Electrocatalysis	2 SWS	Seminar / 🗣	Röse
ST 2025	2304302	Seminar Elektrokatalyse	2 SWS	Seminar / 🗣	Röse

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.236 Course: Seminar Embedded Systems [T-ETIT-100753]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Prof. Dr.-Ing. Eric Sax
Prof. Dr. Wilhelm Stork

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-100455 - Seminar Embedded Systems

Type	Credits	Grading	Recurrence	Version
Examination of another type	4 CP	graded	Each term	3

Events					
WT 24/25	2311627	Seminar Embedded Systems	2 SWS	Seminar / 🗣	Becker, Sax, Stork
ST 2025	2311627	Seminar Embedded Systems	2 SWS	Seminar / 🧩	Becker, Sax, Stork

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Prerequisites
none

T 14.237 Course: Seminar New Components and Systems of Power Electronics [T-ETIT-100713]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100396 - Seminar New Components and Systems of Power Electronics

Type	Credits	Grading	Recurrence	Version
Examination of another type	4 CP	graded	Each term	2

Events					
WT 24/25	2306317	New Components and Systems of Power Electronics	3 SWS	Seminar / 🗣	Hiller
ST 2025	2306317	New Components and Systems of Power Electronics	3 SWS	Seminar / 🗣	Hiller

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.238 Course: Seminar on Applied Superconductivity [T-ETIT-111243]

Responsible: Prof. Dr. Tabea Arndt
Prof. Dr. Bernhard Holzapfel
Prof. Dr. Sebastian Kempf
Prof. Dr.-Ing. Mathias Noe

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105615 - Seminar on Applied Superconductivity

Type	Credits	Grading	Recurrence	Expansion	Version
Examination of another type	3 CP	graded	Each summer term	1 terms	2

Events					
WT 24/25	2310551	Seminar on Applied Superconductivity	2 SWS	Seminar / ✕	Arndt, Holzapfel, Kempf, Noe
ST 2025	2310542	Seminar on Applied Superconductivity	2 SWS	Seminar / 🗣	Kempf, Arndt, Holzapfel, Noe

Legend: 📱 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Elaboration of a scientific topic and presentation of a talk on the topic within the seminar of about 30min.

T 14.239 Course: Seminar Project Management for Engineers [T-ETIT-100814]

Responsible: Prof. Dr.-Ing. Mathias Noe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Version
Coursework	3 CP	pass/fail	Each summer term	1

Assessment
Type of Examination: Oral exam

Duration of Examination: approx. 30 minutes

Prerequisites
none

Additional Information
Not applicable in summer term 2022

Exam and Seminar are held in English.

Detailled information on contents, competence goals, and work load at:

M-ETIT-100551 – Seminar Project Management for Engineers

T 14.240 Course: Seminar Project Management for Engineers [T-ETIT-108820]

Responsible: Dr. Christian Day
Prof. Dr.-Ing. Mathias Noe

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Version
Coursework (oral)	3 CP	pass/fail	Each summer term	2

Events					
ST 2025	2312684	Project Management for Engineers	2 SWS	Seminar / 🗣	Noe

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

14.241 Course: Seminar Selected Topics in Communications [T-ETIT-100962]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100441 - Seminar Selected Topics in Communication

Type	Credits	Grading	Recurrence	Version
Examination of another type	4 CP	graded	Each term	1

Events					
WT 24/25	2310512	Seminar Selected Topics in Communications	3 SWS	Seminar /	Jäkel
ST 2025	2310512	Seminar Selected Topics in Communications	3 SWS	Seminar /	Schmalen, Jäkel
WT 25/26	2310512	Seminar Selected Topics in Communications	3 SWS	Seminar /	Jäkel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Prerequisites
none

T 14.242 Course: Seminar Sensors [T-ETIT-100707]

Responsible: Dr. Wolfgang Menesklou
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100380 - Seminar Sensors

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each term	1

Events					
WT 24/25	2304233	Seminar Sensor Technology	2 SWS	Seminar / 🗣	Menesklou
ST 2025	2304233	Seminar Sensorik	2 SWS	Seminar / 🗣	Menesklou

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.243 Course: Seminar: Assistive robotics and exoskeletons in medical applications [T-INFO-112922]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106400 - Seminar: Assistive robotics and exoskeletons in medical applications

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each winter term	1

Assessment
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). This includes the preparation of a term paper in form aof a scientific paper (6 pages double column) an oral presentation with slides (30 Min + 15 Min discussion) . Students may redraw from the examination during the first two weeks after the topic has been communicated.

Participation in the block seminar is mandatory.
Students have to actively participate in all discussions.

Recommendations
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) is helpful

Additional Information
Max 10 Participants

T 14.244 Course: Seminar: Digital Accessibility and Assistive Technologies [T-INFO-111832]

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: M-INFO-105884 - Seminar: Digital Accessibility and Assistive Technologies

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each summer term	1

Events					
WT 24/25	2400129	Seminar Digital Accessibility and Assisitive Technologies	2 SWS	Seminar /	Stiefelhagen, Schwarz

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-INFO-104742 - Seminar Accessibility - Assistive Technologies for Visually Impaired Persons must not have been started.

T 14.245 Course: Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society [T-INFO-113398]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: M-INFO-106651 - Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each summer term	1

Events					
ST 2025	2400161	Exploring Robotics: Insights from Science Fiction, Research and Society	2 SWS	Seminar / 🗣	Bruno, Maure, Yang

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

The overall impression is evaluated. The following partial aspects are included in the grading: Term paper (approx. 6 pages in double-column format), Presentation (duration approx. 10+10 min.).

Prerequisites
None.

Recommendations
Knowledge of the content of modules Robotics I - Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics is helpful.

T 14.246 Course: Seminar: Human-Robot Interaction [T-INFO-113116]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: M-INFO-106498 - Seminar: Human-Robot Interaction

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each winter term	1

Events					
WT 24/25	2400194	Human-Robot Interaction - Seminar	2 SWS	Seminar / 🗣	Bruno, Maure

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). The overall impression is evaluated. The following partial aspects are included in the grading: Term paper (approx. 6 pages in double-column format), Presentation (duration approx. 10+10 min.).

Prerequisites
None.

Recommendations
Knowledge of the content of modules Robotics I - Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics is helpful.

T 14.247 Course: Sensors [T-ETIT-101911]

Responsible: Dr. Wolfgang Menesklou
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100378 - Sensors

Type	Credits	Grading	Recurrence	Version
Written examination	3 CP	graded	Each summer term	2

Events					
ST 2025	2304231	Sensors	2 SWS	Lecture / 🗣	Menesklou

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

14.248 Course: Signal Processing in Communications [T-ETIT-100747]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100443 - Signal Processing in Communications

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	3

Events					
ST 2025	2310534	Signal Processing in Communications	3 SWS	Lecture / Blended	Jäkel
ST 2025	2310535	Practice to 2310534 Signal Processing in Communications	1 SWS	Practice / Blended	Jäkel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Success control takes place in the form of a written examination lasting 120 min.

The module grade is the grade of the written exam.

Prerequisites
none

T 14.249 Course: Signal Processing Lab [T-ETIT-113369]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106633 - Signal Processing Lab

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	1

Events					
ST 2025	2302134	Signal Processing Lab	4 SWS	Practical course / 🧩	Wahls, van Wijk

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written examination lasting 120 minutes.

Prerequisites
none

Recommendations
Knowledge of the contents of the modules "Signals and Systems", "Measurement Technology" and "Methods of Signal Processing" is strongly recommended.

Additional Information
A prerequisite for admission to the examination is the submission of protocols of all experiments. The quality of the protocols will be assessed; they must be acceptable for admission to the examination.

Attendance is compulsory during all practical sessions, including the introductory session. Admission to the examination will not be granted for even one unexcused absence.

T 14.250 Course: Signal Processing Methods [T-ETIT-113837]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106899 - Signal Processing Methods

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each winter term	1

Events					
WT 24/25	2302113	Signal Processing Methods	2 SWS	Lecture /	Wahls
WT 24/25	2302115	Tutorial to 2302113 Signal Processing Methods	2 SWS	Practice /	Wahls, Al-Hammadi

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Written exam, approx. 120 minutes.
The module grade is the grade of the written exam.

Prerequisites
none

Recommendations
Familiarity with signals and systems (in particular, Fourier transforms) and probability theory at the Bachelor level is assumed.

14.251 Course: Signal Processing with Nonlinear Fourier Transforms and Koopman Operators [T-ETIT-113428]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106675 - Signal Processing with Nonlinear Fourier Transforms and Koopman Operators

Type	Credits	Grading	Recurrence	Version
Written examination	6 CP	graded	Each summer term	1

Events					
ST 2025	2302135	Signal Processing with Nonlinear Fourier Transforms and Koopman Operators	2 SWS	Lecture / 🗣	Wahls
ST 2025	2302136	Practice to 2302135 Signal Processing with Nonlinear Fourier Transforms and Koopman Operators	2 SWS	Practice / 🗣	Wahls, Liang

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination in this module consists of programming assessments and a graded written examination of 120 minutes.

The programming assignments are either pass or fail. They must be passed during the lecture period for admission to the written examination.

The module grade is the grade of the written exam.

Prerequisites
none

T 14.252 Course: SIL Entrepreneurship Project [T-WIWI-110166]

Responsible: Prof. Dr. Orestis Terzidis
Organisation: KIT Department of Economics and Management
Part of: M-ETIT-105073 - Student Innovation Lab

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each winter term	1

Events					
WT 24/25	2545082	SIL Entrepreneurship Project	4 SWS	Seminar	Terzidis

Assessment
Alternative exam assessment (§4(2), 3 SPO). The final grade is a result from both, the grade of the term paper and its presentation, as well as active participation during the seminar. In addition, smaller, ungraded tasks are provided in the course to monitor progress.

Prerequisites
None

Recommendations
None

Workload
90 hours

T 14.253 Course: Simulation and Optimization in Robotics and Biomechanics [T-INFO-113123]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106504 - Simulation and Optimization in Robotics and Biomechanics

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each winter term	4

Events					
WT 24/25	2400160	Simulation and Optimization in Robotics and Biomechanics	4 SWS	Lecture / Practice (/ 🗣	Mombaur

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as an oral examination (§ 4 Abs. 2 No. 1 SPO) lasting up to 30 minutes. It can be repeated once.

As a prerequisite for the participation in the oral exam, students must regularly and successfully participate in the exercises. Students must regularly submit exercise sheets. The number of exercise sheets and the scale for passing will be announced at the beginning of the course.

Prerequisites
none

Recommendations
General principles of robotics are strongly recommended (e.g. from "Robotics I - Introduction to Robotics": T-INFO-101465, T-INFO-108014 or T-INFO-114190).

Additional Information
Limitation to 30 participants

T 14.254 Course: Single-Photon Detectors [T-ETIT-108390]

Responsible: Dr. Konstantin Ilin
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-101971 - Single-Photon Detectors

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2312680	Single-Photon Detectors	2 SWS	Lecture / 🗣	Ilin
WT 24/25	2312694	Tutorial for 2312680 Single-Photon Detectors	1 SWS	Practice / 🗣	Ilin
WT 25/26	2312680	Single-Photon Detectors	2 SWS	Lecture / 🗣	Ilin
WT 25/26	2312694	Tutorial for 2312680 Single-Photon Detectors	1 SWS	Practice / 🗣	Ilin

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.255 Course: Software Engineering [T-ETIT-108347]

Responsible: Dr. Clemens Reichmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100450 - Software Engineering

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	4

Events					
ST 2025	2311611	Software Engineering	2 SWS	Lecture / 🗣	Reichmann

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success control takes place in the form of an oral examination lasting approx. 25 minutes.

The module grade is the grade of the oral examination.

Prerequisites
none

T 14.256 Course: Sol-Gel Processes [T-CIWVT-108822]

Responsible: Dr.-Ing. Steffen Peter Müller
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104489 - Sol-Gel Processes

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	1

Events					
WT 24/25	2220320	Sol-Gel Processes	2 SWS	Lecture / 🗣	Müller

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

14.257 Course: Source Coding Techniques [T-ETIT-110673]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105273 - Source Coding Techniques

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	3 CP	graded	Each winter term	1 terms	2

Events					
ST 2025	2310565	Source Coding Techniques	2 SWS	Lecture / ✕	Schmalen
WT 25/26	2310565	Source Coding Techniques	2 SWS	Lecture / Blended	Schmalen

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Assessment
The assessment will be in the form of an oral exam aprox. 20 minutes. The module grade is the grade of the oral exam.

Prerequisites
Knowledge of basic engineering mathematics including integral transformations and probability theory as well as basic knowledge of communications engineering.

Recommendations
Previous visit to the lecture "Telecommunications I", "Probability Theory" and "Signals and Systems" is recommended. Knowledge from the lectures "Applied Information Theory" is helpful, but not necessary.

14.258 Course: Strategy Derivation for Engineers [T-ETIT-111369]

Responsible: Prof. Dr. Tabea Arndt
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105803 - Interdisciplinary Qualifications

Type	Credits	Grading	Recurrence	Version
Coursework (oral)	3 CP	pass/fail	Each winter term	2

Events					
WT 24/25	2314010	Strategy Derivation for Engineer	2 SWS	Seminar /	Arndt
WT 25/26	2314010	Strategy Derivation for Engineers	2 SWS	Seminar /	Arndt

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Prerequisites
none

T 14.259 Course: Superconducting Magnet Technology [T-ETIT-113440]

Responsible: Prof. Dr. Tabea Arndt
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106684 - Superconducting Magnet Technology

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	2

Events					
ST 2025	2312698	Superconducting Magnet Technology	3 SWS	Lecture / Practice (/	Arndt

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The examination takes place in form of an oral exam (abt. 30 minutes).

Two timeslots (weeks) for examination dates will be announced (usually near end of lecture period & end of semester).

The module grade is the grade of the oral exam.

Prerequisites
none

T 14.260 Course: Superconducting Materials [T-ETIT-111096]

Responsible: Prof. Dr. Bernhard Holzapfel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105521 - Superconducting Materials

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each term	2

Events					
WT 24/25	2312717	Superconducting Materials Part I	2 SWS	Lecture / 🗣	Holzapfel, Hänisch
ST 2025	2312696	Superconducting Materials Part II	2 SWS	Lecture / 🗣	Holzapfel, Hänisch

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of success takes place in the form of an oral examination lasting 40 minutes.

The oral examination includes the contents of Superconducting Materials Part I (offered every winter term) and Superconducting Materials Part II (offered every summer term).

Prerequisites
none

Recommendations
Knowledge of the basic course “Superconductivity for Engineers” is required

T 14.261 Course: Superconducting Nanowire Detectors [T-ETIT-111236]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105609 - Superconducting Nanowire Detectors

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	4 CP	graded	Each summer term	1 terms	2

Events					
ST 2025	2312671	Superconducting Nanowire Detectors	2 SWS	Lecture / 🗣	Ilin
ST 2025	2312673	Practice to 2312671 Superconducting Nanowire Detectors	1 SWS	Practice / 🗣	Ilin

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
Oral Exam (20 min.)

T 14.262 Course: Superconductivity for Engineers [T-ETIT-111239]

Responsible: Prof. Dr. Bernhard Holzapfel
Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105611 - Superconductivity for Engineers

Type	Credits	Grading	Recurrence	Expansion	Version
Written examination	5 CP	graded	Each winter term	1 terms	3

Events					
WT 24/25	2312708	Superconductivity for Engineers	2 SWS	Lecture / 🗣	Kempf, Holzapfel
WT 24/25	2312709	Exercise for 2312708 Superconductivity for Engineers	1 SWS	Practice / 🗣	Ilin, Hänisch
WT 25/26	2312708	Superconductivity for Engineers	2 SWS	Lecture / 🗣	Kempf, Holzapfel
WT 25/26	2312709	Exercise for 2312708 Superconductivity for Engineers	1 SWS	Practice / 🗣	Ilin, Hänisch

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of success takes place in the form of a written examination lasting 120min. The grade corresponds to the result of the written examination.

Prerequisites
none

T 14.263 Course: Surface Science, without Exercises [T-PHYS-113099]

Responsible: TT-Prof. Dr. Philip Willke
Prof. Dr. Wulf Wulfhekel
PD Dr. Khalil Zakeri-Lori

Organisation: KIT Department of Physics

Part of: M-PHYS-106483 - Surface Science, without Exercises

Type	Credits	Grading	Recurrence	Version
Oral examination	8 CP	graded	Irregular	1

Events					
ST 2025	4021121	Surface Science	4 SWS	Lecture / 🗣	Willke, Zakeri-Lori

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.264 Course: Sustainable Product Engineering [T-MACH-114033]

Responsible: Dr.-Ing. Karl-Friedrich Ziegahn
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107189 - Sustainable Product Engineering: Sustainable Product Design - Long-term Business Success with Sustainably Developed Products

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2146193	Sustainable Product Engineering	2 SWS	Lecture / 🗣	Ziegahn

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written exam (90 min)

Prerequisites
none

Recommendations
None

Additional Information
The course is offered in German.

Workload
120 hours

T 14.265 Course: System Integration and Communication Structures in Industry 4.0 and IoT [T-ETIT-112212]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106026 - System Integration and Communication Structures in Industry 4.0 and IoT

Type	Credits	Grading	Recurrence	Expansion	Version
Oral examination	3 CP	graded	Each winter term	1 terms	1

Events					
WT 24/25	2311614	System Integration and Communication Structures in Industry 4.0 and IoT	2 SWS	Lecture / 🗣	Babel

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

14.266 Course: System Integration in Micro- and Nanotechnology [T-MACH-105555]

Responsible: apl. Prof. Dr. Ulrich Gengenbach
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105315 - System Integration in Micro- and Nanotechnology

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2106033	System Integration in Micro- and Nanotechnology I	2 SWS	Lecture / 🗣	Gengenbach

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
oral exam (Duration: 30 min)

Prerequisites
none

Workload
120 hours

T 14.267 Course: System Integration in Micro- and Nanotechnology 2 [T-MACH-110272]

Responsible: apl. Prof. Dr. Ulrich Gengenbach
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105316 - System Integration in Micro- and Nanotechnology 2

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2105040	System Integration in Micro- and Nanotechnology 2	2 SWS	Lecture / 🗣	Gengenbach

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Oral exam, approx. 15 min.

Prerequisites
None

Workload
120 hours

T 14.268 Course: System-on-Chip Laboratory [T-ETIT-100798]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Prof. Dr. Ivan Peric

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-100451 - System-on-Chip Laboratory

Type	Credits	Grading	Recurrence	Version
Examination of another type	6 CP	graded	Each winter term	1

Events					
WT 24/25	2311612	Laboratory System-on-Chip	4 SWS	Practical course / 🗣	Becker, Peric

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.269 Course: Systems and Software Engineering [T-ETIT-100675]

Responsible: Prof. Dr.-Ing. Eric Sax
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100537 - Systems and Software Engineering

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each winter term	2

Events					
WT 24/25	2311605	Systems and Software Engineering	2 SWS	Lecture /	Sax
WT 24/25	2311607	Tutoral for 2311605 Systems and Software Engineering	1 SWS	Practice /	Nägele

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Written exam, approximately 90 minutes.

Students are given the opportunity to earn a grade bonus through separate task assignments. If the grade of the written exam is between 4.0 and 1.3, the bonus improves the grade by a maximum of one grade level (0.3 or 0.4). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. Bonus points do not expire and remain valid for exams taken at a later date:

The grade is determined by the written exam and the bonus points.

Prerequisites
none

T 14.270 Course: Systems Engineering for Automotive Electronics [T-ETIT-100677]

Responsible: Prof. Dr.-Ing. Jürgen Bortolazzi
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100462 - Systems Engineering for Automotive Electronics

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2311642	Systems Engineering for Automotive Electronics	2 SWS	Lecture / 🖥	Bortolazzi
ST 2025	2311644	Tutorial for 2311642 Systems Engineering for Automotive Electronics	1 SWS	Practice / 🖥	Beck

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Prerequisites
none

T 14.271 Course: Team Project: Sensors and Electronics [T-ETIT-111007]

Responsible: Prof. Dr.-Ing. Ahmet Cagri Ulusoy
Prof. Dr.-Ing. Thomas Zwick

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105465 - Team Project: Sensors and Electronics

Type	Credits	Grading	Recurrence	Expansion	Version
Coursework	3 CP	pass/fail	Each term	1 terms	2

Events					
WT 24/25	2308425	Team Project: Sensors and Electronics	2 SWS	Project (P /	Ulusoy, Zwick

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
see module description

T 14.272 Course: Technical Acoustic [T-ETIT-104579]

Responsible: Dr. Nicole Ruiter
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-101835 - Technical Acoustic

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each winter term	1

Events					
WT 24/25	2305296	Technical Acoustic	2 SWS	Lecture /	Ruiter
WT 25/26	2305296	Technical Acoustic	2 SWS	Lecture /	Ruiter

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Success control is carried out as part of an overall oral examination (approx. 20 minutes) of the selected courses, with which the minimum requirement for CP is met.

Prerequisites
none

Additional Information
There is a course with the same name and partial achievement at the KIT Department of Mechanical Engineering (LV 2158107, T-MACH-111382, every summer semester). Please check which course (and associated partial achievement) is offered in your degree program.

T 14.273 Course: Technical Optics [T-ETIT-100804]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100538 - Technical Optics

Type	Credits	Grading	Recurrence	Version
Written examination	5 CP	graded	Each winter term	1

Events					
WT 24/25	2313720	Technical Optics	2 SWS	Lecture / 🗣	Neumann
WT 24/25	2313722	Technical Optics (Tutorial to 2313720)	1 SWS	Practice / 🗣	Neumann

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 14.274 Course: Technologies in Radiotherapy [T-ETIT-114338]

Responsible: Prof. Dr.-Ing. Maria Francesca Spadea
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107292 - Technologies in Radiotherapy

Type	Credits	Grading	Recurrence	Version
Oral examination	6 CP	graded	Each winter term	1

Assessment
The examination takes place within the framework of an oral overall examination where also the project developed during the course will be discussed (approx. 30 minutes).

The module grade is the grade of the oral exam.

Prerequisites
none

T 14.275 Course: Test of Embedded Systems in Industrial Contexts [T-ETIT-100811]

Responsible: Prof. Dr.-Ing. Eric Sax
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100546 - Test of Embedded Systems in Industrial Contexts

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2311648	Test of Embedded Systems in Industrial Contexts	2 SWS	/ 🗣	Schmerler
WT 24/25	2311649	Test of Embedded Systems in Industrial Contexts (Tutorial to 2311649)	1 SWS	Practice / 🗣	Ransiek

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

14.276 Course: Thermal-Fluid-Dynamics [T-MACH-106372]

Responsible: Dr. Sebastian Ruck
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107112 - Thermal-Fluid-Dynamics

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2189423	Thermal-Fluid-Dynamics	2 SWS	Lecture / 🗣	Ruck
WT 25/26	2189423	Thermal-Fluid-Dynamics	2 SWS	Lecture / 🗣	Ruck

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
oral exam of about 30 minutes

Prerequisites
none

Workload
120 hours

T 14.277 Course: Tutorial Introduction to the Finite Element Method [T-MACH-110330]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Dr.-Ing. Tom-Alexander Langhoff

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106209 - Introduction to the Finite Element Method

Type	Credits	Grading	Recurrence	Version
Coursework	1 CP	pass/fail	Each summer term	1

Events					
ST 2025	2162257	Tutorial Introduction to the Finite Element Method	1 SWS	Practice / 🗣	Lauff, Klein, Langhoff, Böhlke

Legend: 🖥 Online, ♻ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Successful participation in this course allows for registration to the Exam "Introduction to the Finite Element Method" (see 76-T-MACH-105320)

For students of Mechanical Engineering (BSc) that have chosen the Major Field "Continuum Mechanics" the prerequisites consist of successfully solving the written homework sheets as well as the computational homework sheets during the associated computer tutorials.

For students of Mechanical Engineering that have chosen a different Major Field and for students from different fields of study the prerequisites consist of successfully solving only the written homework sheets.

Additional Information
Knowledge of the contents of the courses "Continuum Mechanics of Solids and Fluids" and "Mathematical Methods of Continuum Mechanics" as well as the corresponding tutorials are expected.

Due to capacity reasons it is possible that not all students of this course can be admitted to the computer tutorials. Students of the bachelor's degree program in mechanical engineering who have chosen the Major Field Continuum Mechanics (SP-Nr 13) will be admitted to the computer tutorials in any case.
If additional places are available in the computer tutorials for this course, these will be allocated according to the BSc average grade.

Workload
30 hours

T 14.278 Course: Tutorial Mathematical Methods in Continuum Mechanics [T-MACH-110376]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-106210 - Mathematical Methods in Continuum Mechanics

Type	Credits	Grading	Recurrence	Expansion	Version
Coursework	2 CP	pass/fail	Each winter term	1 terms	2

Events					
WT 24/25	2161255	Tutorial Mathematical Methods in Confinuum Mechanics	2 SWS	Practice / 🗣	Lauff, Klein, Böhlke

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
successfully solving the homework sheets. Details are announced in the first lecture.

Prerequisites
None

Workload
60 hours

T 14.279 Course: Ubiquitous Computing [T-INFO-114188]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-107161 - Ubiquitous Computing

Type	Credits	Grading	Recurrence	Version
Oral examination	5 CP	graded	Each winter term	1

Events					
ST 2025	24844	Seminar: Ubiquitous Systems	2 SWS	Seminar / 🖥	Riedel, Beigl, Röddiger

Legend: 🖥 Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The course T-INFO-101326 - Ubiquitous Computing must not have been started.

T 14.280 Course: Ultrasound Imaging [T-ETIT-100822]

Responsible: Dr. Nicole Ruiter
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100560 - Ultrasound Imaging

Type	Credits	Grading	Recurrence	Version
Oral examination	3 CP	graded	Each summer term	1

Events					
ST 2025	2305295	Ultrasound Imaging	2 SWS	Lecture / 🗣	Ruiter

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

14.281 Course: Verified Numerical Methods [T-ETIT-109184]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-104493 - Verified Numerical Methods

Type	Credits	Grading	Recurrence	Version
Oral examination	4 CP	graded	Each winter term	1

Events					
WT 24/25	2303001	Verified numerical methods	2 SWS	Lecture /	Nagato-Plum
WT 24/25	2303002	Verified Numerical Methods (Tutorial to 2303001)	1 SWS	Practice /	Nagato-Plum

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

T 14.282 Course: Wearable Robotic Technologies [T-INFO-114145]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-107113 - Wearable Robotic Technologies

Type	Credits	Grading	Recurrence	Version
Written examination	4 CP	graded	Each summer term	1

Events					
ST 2025	2400062	Wearable Robotic Technologies	2 SWS	Lecture / 🗣	Asfour, Beigl

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites
Attending the lecture Mechano-Informatics and Robotics is recommended.

Recommendations
Attending the lecture Mechano-Informatics and Robotics is recommended.

T 14.283 Course: Workshop Finite Element Method in Electromagnetics [T-ETIT-114166]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107147 - Workshop Finite Element Method in Electromagnetics

Type	Credits	Grading	Recurrence	Version
Examination of another type	3 CP	graded	Each summer term	1

Events					
ST 2025	2306333	Workshop Finite Element Method in Electromagnetics	2 SWS	Seminar / 🖥	Brodatzki, Gjeset

Legend: 🖥 Online, Blended (On-Site/Online), On-Site, x Cancelled

Assessment
Success control takes place in the form of different types of examination consisting of a written assignment in the form of an written report.

The module grade is the grade of the written paper.

Prerequisites
none