Karlsruher Institut für Technologie

Module Handbook
M.Sc. Mechatronics and Information Technology 2025 (Master of Science)

SPO 2025

Summer term 2025

Date: 11/04/2025

KIT DEPARTMENTS OF MECHANICAL ENGINEERING / ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY

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1 Description of the degree program

1.1 List of abbreviations

Departments: ETIT KIT Department of Electrical Engineering
and Information Technology
KIT-Fakultät für Elektrotechnik und Informationstechnik

MACH KIT Department of Mechanical Engineering
KIT-Fakultät für Maschinenbau

INFO KIT Department of Informatics
KIT-Fakultät für Informatik

CIW KIT Department of Chemical and Process Engineering
KIT-Fakultät für Chemieingenieurwesen und Verfahrenstechnik

PHYS KIT Department of Physics
KIT-Fakultät für Physik

WIWI Department of Economics and Management
KIT-Fakultät für Wirtschaftswissenschaften

Semester: WS winter term (*Wintersemester*)

SS summer term (*Sommersemester*)

Achievements: V Lecture (*Vorlesung*)

Ü Exercise (*Übung*)

P Laboratory (*Praktikum*)

CR Credit Points (*Leistungspunkte*)

Pr Examination (*Prüfung*)

Miscellaneous: B.Sc. Degree program (*Studiengang*) Bachelor of Science

M.Sc. Degree program (*Studiengang*) Master of Science

SPO Study and examination regulations
(*Studien- und Prüfungsordnung*)

SWS contact hours per week (*Semesterwochenstunden*)

1.2 Subjects

The legal basis for the degree program and the conduct of examinations are the currently valid Study and Examination Regulations (Studien- und Prüfungsordnung, SPO)

(https://www.mach.kit.edu/Master-MIT.php).

The program degree M.Sc. Mechatronics and Information Technology consists of the following subjects, which are explained in more detail in this and the following chapter. A detailed list of the corresponding modules can be found in the chapter “Field of study structure”.

- Field of Specialization: 60 CR
  - Methodical (min. 8 CR)
  - General (min. 16 CR)
  - Internship/Lab Course (exactly 1)
  - Additive Electives
- Elective Area: 22 CR
  - Internship/Lab Course (max. 1)
- Interdisciplinary Qualifications: 8 CR
- Master’s Thesis: 30 CR

In total: 120 CR

1.2.1 Field of Specialization

Students choose a **Field of Specialization** (**FoS**) from the following list. Each field includes 60 CR:

- **Energy Technology** (*Energietechnik*)
- **Industrial Informatics and Systems Engineering** (*Industrieinformatik und Systems Engineering*)
- **Vehicle Systems Engineering** (*Fahrzeugtechnik*)
- **Micro System Technology** (*Mikrosystemtechnik*)
- **Automation, Control, and Robotics** (*Automation, Steuerung und Robotik*)
- **Autonomous Systems and AI** (*Autonome Systeme und KI*)
- **Design of Mechatronic Systems** (*Konstruktion Mechatronischer Systeme*)

The list of modules may be subject to adjustments resulting from the departure of teaching staff, the reorganization of courses and other circumstances. Therefore, the module list in the module handbook is adjusted to current conditions before each semester. In principle, students can choose all modules for their study plan that are included in the according areas of the recent module handbook. Omitted modules cannot be started any more. If they have already been taken, they will of course remain valid. Exams will be offered two additional terms after the course was given at last.

1.3 Curriculum

The general study plan shows the structure of the study program:

<table>
<tr><th colspan="5">Master MIT SS25 - Version: 24.06.2024</th></tr>
<tr><th colspan="4">1. - 3. Sem</th><th>4. Sem</th></tr>
<tr><td colspan="4">Field of Specialization in Mechatronics and Information Technology (Σ 60 CP):</td><td rowspan="4">Master's Thesis
(30 CP)</td></tr>
<tr><td>Mandatory Electives – Methodical
(at least 8 CP)</td><td>Mandatory Electives – General
(at least 16 CP)</td><td>Internship / Lab Course
(exactly one)</td><td>Additive Electives</td></tr>
<tr><td colspan="4">Elective Area in Mechatronics and Information Technology (22 CP)</td></tr>
<tr><td colspan="4">Interdisciplinary Qualifications (8 CP)</td></tr>
</table>

1.4 Additional Examinations

According to SPO Article 15, additional examinations can be acquired, that may result in up to 30 credit points more than required for passing the Master's examination. When registering for an examination in a module, this must already be declared as an additional examination. The assignment of a module can be changed again later on request.

Additional examinations are not included in the overall grade, but are listed in the Transcript of Records.

1.5 Recognition of external study achievements

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

- Master SPO 2025 of 2025-01-17, Article 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.

There are two options for recognition:

- **Recognition instead of a KIT event**
  An event taught at KIT is replaced by the recognized event. The examination whether the acquired competences are equivalent to the KIT event is carried out by the subject examiner who conducts the event to be replaced at KIT.
- **Recognition of the original event**
  The event will be recognized with the original title. The course can be taken in the Interdisciplinary Subject, in the Interdisciplinary Qualifications, or in the Additional Examinations. The examination whether the acquired competences justify a recognition is carried out by the program consultant.

Experience has shown that recognition "instead of" is difficult, because the competencies taught in courses are usually determined by the lecturer and are rarely the same at other universities. Recognition of "the original", on the other hand, only checks whether the competencies acquired are appropriate to a university course.

If a comparable grading system is used, the grade of the performance to be recognized is taken over. If the grading system is not comparable, the grade will be converted.

The exact procedure is described at "Recognition of external examinations" (https://www.mach.kit.edu/english/4522.php).

1.6 Semester abroad and student mobility

The KIT departments support and promote stays abroad. For this purpose, there are a number of partnerships with foreign universities. Please contact the departments for up-to-date information. However, students are also encouraged to contact foreign universities on their own.

It is advisable to complete most of the **Methodical** and **General** modules in the Field of Specialization before the stay abroad. The work done at the foreign institution can then be recognized in the **Additive Electives**, the **Elective Area** and in the **Interdisciplinary Qualifications**. Therefore, the third semester is well suited for a stay abroad.

Prior to the stay abroad, the achievements to be made at the foreign university are fixed in a written Learning Agreement. The current form and detailed information can be found on the websites of the KIT Department of Electrical Engineering and Information Technology (https://www.etit.kit.edu/english/internationales.php) and the KIT Department of Mechanical Engineering (https://www.mach.kit.edu/english/4201.php). Under the title “Recognition at the Sending Institution” it is stated in which subject the modules in the degree program Mechatronics and Information Technology are recognized at KIT. Please contact a program consultant with the completed form.

After the stay abroad, the examination results obtained abroad will be recognized in accordance with the procedure in section 1.5.

1.7 Calculation of grades

The module grades in the **Field of Specialization** and the **Elective Area** are weighted with the corresponding credit points to form the overall grade.

The calculation of grades is based on the regulations of the study and examination regulations SPO, Article §7 as well as Article §20, paragraph 2.

1.8 Master’s Thesis

The **Master's Thesis** should demonstrate that the student is able to work on a problem from the field of mechatronics and information technology independently and within a limited time, using scientific methods that correspond to the state of the art in research. The module **Master’s Thesis** is assigned to 30 credit points. It consists of the **Master’s Thesis** and a final presentation of the results. The presentation has to take place within the preparation of the **Master’s Thesis**.

The prerequisite for admission to the module **Master’s Thesis** is that the student is usually in the 2nd year of study and has successfully completed module examinations in the sum of 75 CR.

The recommended preparation time is four months in full-time. The maximum preparation time is six months.

The **Master’s Thesis** may be completed at all institutes at the KIT Department of Electrical Engineering and Information Technology and the KIT Department of Mechanical Engineering.

Due to the interdisciplinary orientation, the participation of institutes of other faculties is desired. With the approval of the examination board, external **Master's Theses** can also be approved, provided that supervision by a university lecturer is guaranteed. The registration of the **Master’s Thesis** has to be done electronically in the Campus Management by the students themselves (https://campus.studium.kit.edu/english/index.php), but only after consultation and approval by the supervising professor.

2 Goals, structure and acquisition of competences

2.1 Conformity of module structure with competence goals

The Master's degree program is structured according to the following concept (see general study plan in the previous chapter):

- Intensive specialization in an area of choice. For this purpose, seven **Fields of Specializatio**n (**FoS**) with a total of 60 credit points are offered. Each **FoS** consists of **Methodical** modules (at least 8 CR) and **General**, mainly applied, modules (at least 16 CR), which are specified according to the chosen Field of Specialization. All of the **Methodical** modules may be chosen in the **General** elective block also. Within each **FoS** exactly one **Internship/Lab Course** must be selected. In addition, further courses (**Additive Electives**) of the areas electrical and mechanical engineering as well as information and computer technology are offered, which the students can compile themselves. Within this area a second **Internship/Lab Course** may be chosen.
- During the preparation of their **Master's Thesis**, students are guided to conduct independent scientific research.

An essential fundamental component of the Master's degree program is the great freedom that students are given in the selection of elective modules, the Interdisciplinary Qualifications, and the entire scheduling of studies. This way the students' self and social competence can be optimally promoted.

The structure of the Master's degree program and its modules thus support the qualification goals, formulated above:
The fundamentally oriented courses of the **Methodical** and **General** modules of each **FoS** may be primarily completed in the first two terms. Based on this the students can specialize in choosing further modules of the **Additive Electives**. At the same time, starting in the first term, the Interdisciplinary Qualifications can be chosen freely.

Finally, the fourth term is reserved for the Master's Thesis.

2.2 Acquisition of competences

In the Master's degree program, the acquisition of interdisciplinary competencies is promoted through seminars, university internships, **Interdisciplinary Qualifications**, and the **Master's Thesis**, as well as through the general organization of the studies.

Most students complete a seminar as part of the **Additive Electives** (seminars are offered by many institutes and are basically structured in the same way). There they specifically learn to conduct independent literature research, have to apply oral and technical presentation skills and prepare documentations. They learn to work in a self-organized and reflexive manner and improve their communicative, organizational, and didactical skills. They have to analyze a topic independently and present it to an expert audience.

In the **Internships** and **Lab Courses** (in each **FoS** exactly one can be chosen), the focus is on imparting expert knowledge and the practical handling of laboratory equipment or software tools. Here, students will sharpen their analytical skills through playful handling of technology and, at the same time, learn how to work together in teams and develop their own ideas and solutions. Within the **Additive Electives** a second **Internship/Lab Course** may be chosen

The **Interdisciplinary Qualifications** with an amount of 8 CR are scheduled within the first to third term. 4 CR have to be chosen from the elective block **Engineering Ethics** and another 4 CR may be chosen freely from the **Further Interdisciplinary Qualifications**.

In addition, courses from the Language Center (Sprachenzentrum, SPZ), the House of Competence (HoC), or the FORUM can be chosen. The **Interdisciplinary Qualifications** are intended to build up competencies in interdisciplinary thinking, in conveying expert knowledge from non-electrical or non-mechanical engineering disciplines, as well as in writing and speaking a foreign language.

Achievements can be booked in the module "**Interdisciplinary Qualifications** (Überfachliche Qualifikationen)" by the students themselves. Students can access the module via the menu item "Examinations – Exam Registration and Unregistration" at the Campus Management Portal, which is also used to access the study schedule. Here you will find a tab "ÜQ/SQ-Leistungen", which displays the list of unassigned own achievements.

In the following, the taken Interdisciplinary Qualifications have to be assigned to the courses (Teilleistungen) of SPZ, HoC, or FORUM with the title "Self Assignment-HOC-SPZ-FORUM..." according to the grading scale, graded or ungraded. Title and credits of the achievement are adopted automatically

Further interdisciplinary qualifications or other modules can be acquired within the subject **Additional Examinations**.

The **Master's Thesis**, which must be completed in the fourth term, corresponds to 30 CR. Students learn how to apply scientific methods in the development of new ideas and solutions. They train their analytical thinking as well as working efficiently towards a goal under a given timeline. In addition, students learn to organize themselves and their work process effectively. Knowledge gaps are identified and closed. The Master's Thesis ends with a final presentation of about 20 minutes followed by a discussion (defense). During the preparation of the presentation, the students are guided and supported by their supervisors. The students learn to communicate own and collaboratively developed results in written and oral form. While working on the **Master's Thesis**, it is expected to attend the presentations and defenses of fellow students. This trains to communicate and collaborate with specialists in related disciplines.

The ability to work independently, to organize oneself optimally, and to clearly structure even large long-term tasks can hardly be conveyed in a course by simple explanation. In order to enable students to train themselves optimally in this respect, a large degree of freedom in the selection of courses, in the **Additive Electives**, the **Interdisciplinary Qualifications**, and the entire scheduling of studies is an essential part of the Master's degree program. Only in this way students can optimally attain self- and social competence.

3 General Information

3.1 Study program details

KIT-Department	KIT Departments of Mechanical Engineering / 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	English
Grade calculation	Weighted by (Weight * CP)
Additional Information	Link to study program www.stg-mit.kit.edu Department https://www.mach.kit.edu/Master-MIT.php Business unit Studium und Lehre https://www.sle.kit.edu/vorstudium/master-mechatronik-informationstechnik.php

3.2 Content

The academic qualifications obtained in the Bachelor's degree are further deepened and supplemented in the Master's degree. The graduates are able to apply the scientific knowledge and methods independently and to evaluate their significance and reach for the solution of complex scientific and social problems.

The field of study is chosen by the students through the selection of the Field of Specialization and the modules in the Elective Area.

3.3 Qualification Goals

The competence goals of the Master’s degree program Mechatronics and Information Technology are divided into the following four main competence profiles:

1. **Expertise**: Students get to know the fundamentals of the discipline, as well as current research topics, processes, and results.
2. **Research and problem-solving skills**: Students learn the skills and techniques to meet challenges in research and industry.
3. **Assessment and planning skills**: Students participate in professional and research discourse and apply acquired knowledge, as well as learned techniques.
4. **Personal and social skills**: Students work on (their own) research projects, are integrated into a scientific team, are capable of independent and sustained professional and scientific development, and assess the social and societal impact of their activities.

For points 1 and 2 the focus is on lecturer activity, for points 3 and 4 correspondingly on student activity.

For the Master’s degree program, these competence requirements can be further described in the following objectives:

Expert knowledge

The graduates of the Master’s degree program Mechatronics and Information Technology

1. have an in-depth knowledge of mathematics and physics and an advanced expert knowledge of electrical and mechanical engineering as well as information technology. They are able to recognize and evaluate demanding technical and scientific tasks and problems in mechatronics and information technology and to formulate approaches to solve them.
2. master demanding scientific methods of their discipline and have learned to use them to analyze identified problems or subject-related issues according to the state of their knowledge.
3. possess in-depth knowledge in a combination of the core competences of mechatronics and information technology (e.g. automation and control technology, electrical energy systems, high-voltage technology, electrical drives, power electronics, digital technology, information technology, digital signal processing, communications engineering, high-frequency technology, measurement technology, imaging techniques, lighting technology, optoelectronics, circuitry, microelectronics, optical communication systems, materials science, construction and product development, engineering mechanics, robotics, modern software techniques).

Research and problem-solving skills

The graduates of the Master’s degree program Mechatronics and Information Technology

1. are qualified to work as engineers and scientists in one of the main application fields of mechatronics and information technology (e.g. Automotive Engineering, Power Engineering, Automation Technology, Industrial Handling, Microsystems Technology, Medical Technology).
2. are familiar with the procedures for the analysis and design of components, circuits, systems, and equipment in mechatronics.
3. are familiar with advanced methods of presenting and processing information, programming, algorithmic formulation of processes, and the use of programming tools.
4. possess an in-depth understanding of the methods of mechatronics and information technology.
5. are capable of further qualification through a doctorate program (PhD).

Assessment and planning skills

The graduates of the Master’s degree program Mechatronics and Information Technology

1. can evaluate mechatronic designs based on elements of electrical and mechanical engineering as well as information technology, using various solution alternatives.
2. recognize limits of the validity of theories and solutions in a wide variety of applications and new developments.
3. can critically question results and transfer solutions to other areas of application.

Personal and social skills

The graduates of the Master’s degree program Mechatronics and Information Technology

1. are familiar with independent project work as well as interdisciplinary teamwork, are able to grasp the results of others, and are able to communicate their own and team results in writing and orally.
2. are able to familiarize themselves independently with new and complex subject areas in technical sciences and their methods.
3. are able to work scientifically on research-related problems and develop complex assemblies or systems.

4. possess a deeper understanding of applications of mechatronics and information technology in various fields of work, know the limits and dangers involved, and apply their knowledge responsibly and for the benefit of society, taking safety and ecological requirements into account. They actively contribute to the opinion-forming process in society with regard to scientific and technical issues.
5. are able to communicate and cooperate with specialists in an interdisciplinary manner.

3.4 Studies and Examination Regulations

https://www.sle.kit.edu/english/vorstudium/master-mechatronics-information-technology.php

4 Field of study structure

Mandatory	
Master's Thesis	30 CR
Field of Specialization in Mechatronics and Information Technology	60 CR
Elective Area in Mechatronics and Information Technology	22 CR
Interdisciplinary Qualifications *This field will not influence the calculated grade of its parent.*	8 CR

4.1 Master's Thesis

Credits
30

Mandatory		
M-ETIT-107192	Master's Thesis	30 CR

4.2 Field of Specialization in Mechatronics and Information Technology

Credits
60

Field of Specialization in Mechatronics and Information Technology (Election: at most 1 item)	
Energy Technology	60 CR
Industrial Informatics and Systems Engineering	60 CR
Vehicle Systems Engineering	60 CR
Micro System Technology	60 CR
Automation, Control, and Robotics	60 CR
Autonomous Systems and AI	60 CR
Design of Mechatronic Systems	60 CR

4.2.1 Energy Technology

Part of: Field of Specialization in Mechatronics and Information Technology

Credits
60

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

To see English modules with English titles and German modules with German titles visit the German website**.**

The primarily mentioned modules (alphabetically ordered) are given in English, the further below mentioned ones in German (alphabetically ordered).

Mandatory Electives – Methodical (Election: at least 8 credits)		
	- Modules in English Language -	
M-ETIT-100539	Communication Systems and Protocols	5 CR
M-MACH-107032	Mathematical Methods in Fluid Mechanics	6 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
	- Modules in German Language -	
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-MACH-107036	Numerical Fluid Mechanics	4 CR
Mandatory Electives – General (Election: at least 16 credits)		
	- Modules in English Language -	
M-ETIT-100539	Communication Systems and Protocols	5 CR
M-ETIT-105394	Electric Power Transmission & Grid Control	6 CR
M-MACH-107032	Mathematical Methods in Fluid Mechanics	6 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-ETIT-104567	Power Electronics	6 CR
	- Modules in German Language -	
M-MACH-107031	Analysis Tools for Combustion Diagnostics	4 CR
M-ETIT-100532	Batteries and Fuel Cells	5 CR
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-ETIT-105915	Control of Power-Electronic Systems	6 CR
M-ETIT-100515	Design of Electrical Machines	5 CR
M-MACH-102707	Fundamentals of Combustion I	4 CR
M-MACH-102690	Fundamentals of Energy Technology	8 CR
M-MACH-107122	Introduction to Nuclear Energy	4 CR
M-MACH-107036	Numerical Fluid Mechanics	4 CR
Internship/Lab Course (Election: 1 item)		
	- Modules in English Language -	
M-ETIT-107138	Electric Drives and Power Electronics Lab	6 CR
M-MACH-107206	Laboratory Exercise in Energy Technology	4 CR
M-ETIT-107159	Laboratory Information Systems in Power Engineering	6 CR
M-INFO-105955	Practical Course: Smart Energy System	6 CR
	- Modules in German Language -	
M-ETIT-100381	Batteries and Fuel Cells Laboratory	6 CR
M-ETIT-102350	Laboratory Solar Energy	6 CR
Additive Electives (Election:)		
	- Modules in English Language -	
M-MACH-107062	Combined Cycle Power Plants	6 CR
M-ETIT-100539	Communication Systems and Protocols	5 CR
M-ETIT-106689	Components of Power Systems	3 CR
M-MACH-107157	Computational Fluid Dynamics (CFD) for Energy Technologies	4 CR
M-ETIT-106971	Electric Drives for E-Mobility	4 CR
M-ETIT-105394	Electric Power Transmission & Grid Control	6 CR
M-ETIT-105883	Electrocatalysis	5 CR
M-ETIT-101969	Energy Storage and Network Integration	4 CR
M-MACH-107066	Engineering Materials for the Energy Transition	4 CR
M-MACH-107117	Fundamentals of Combustion II	4 CR
M-WIWI-105403	Liberalised Power Markets	6 CR
M-MACH-107032	Mathematical Methods in Fluid Mechanics	6 CR

M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-WIWI-100500	Renewable Energy-Resources, Technologies and Economics	4 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-ETIT-104567	Power Electronics	6 CR
M-ETIT-100524	Solar Energy	6 CR
M-MACH-101924	Solar Thermal Energy Systems	4 CR
M-MACH-107219	Thermal Turbomachines I	8 CR
M-ETIT-107147	Workshop Finite Element Method in Electromagnetics	3 CR
	- Modules in German Language -	
M-MACH-107031	Analysis Tools for Combustion Diagnostics	4 CR
M-ETIT-100400	Basics of Converter Control	3 CR
M-ETIT-100532	Batteries and Fuel Cells	5 CR
M-ETIT-100377	Battery and Fuel Cells Systems	3 CR
M-MACH-107060	CO2-Neutral Combustion Engines and their Fuels I	4 CR
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-ETIT-105915	Control of Power-Electronic Systems	6 CR
M-ETIT-100515	Design of Electrical Machines	5 CR
M-MACH-107139	Energy Systems I - Renewable Energy	4 CR
M-MACH-107120	Flows and Heat Transfer in Energy Technology	4 CR
M-MACH-107124	Fusion Technology A	4 CR
M-MACH-107154	Fusion Technology B	4 CR
M-MACH-102707	Fundamentals of Combustion I	4 CR
M-MACH-102690	Fundamentals of Energy Technology	8 CR
M-MACH-107150	Fundamentals of Reactor Safety for the Operation and Dismantling of Nuclear Power Plants	4 CR
M-WIWI-100498	Introduction into Energy Economics	5 CR
M-MACH-102717	Heat and Mass Transfer	4 CR
M-MACH-107075	Heat Pumps	4 CR
M-ETIT-105060	High-Voltage Technology	6 CR
M-MACH-107097	Holistic Approach of Managing Power Plant Operation under Uncertainty and Volatility	4 CR
M-ETIT-100399	Industrial Circuitry	3 CR
M-MACH-107119	Innovative Nuclear Systems	4 CR
M-MACH-107122	Introduction to Nuclear Energy	4 CR
M-MACH-107223	Magnet Technology of Fusion Reactors	4 CR
M-MACH-107043	Materials Recycling and Sustainability	4 CR
M-MACH-107042	Nuclear Power and Reactor Technology	4 CR
M-MACH-107121	Nuclear Power Plant Technology	4 CR
M-MACH-107036	Numerical Fluid Mechanics	4 CR
M-ETIT-100513	Photovoltaics	6 CR
M-ETIT-102261	Power Electronics for Photovoltaics and Wind Energy *First usage possible until Sep 30, 2025.*	3 CR
M-ETIT-106067	Power Electronic Systems in Energy Technology	6 CR
M-MACH-107061	Energy Topology and Resilience	4 CR
M-ETIT-100413	Power Systems and Economy	3 CR
M-ETIT-100394	Practical Aspects of Electrical Drives	4 CR
M-ETIT-106506	Power System Protection and Automation	3 CR
M-MACH-107071	Reactor Physics	4 CR
M-MACH-107116	Reactor Safety 1: Fundamentals	4 CR
M-ETIT-105916	Real Time Control of Electrical Drives	6 CR
M-ETIT-105629	Seminar Electrocatalysis	3 CR
M-ETIT-100396	Seminar New Components and Systems of Power Electronics	4 CR

M-ETIT-100537	Systems and Software Engineering	5 CR
M-MACH-107112	Thermal-Fluid-Dynamics	4 CR
M-MACH-102388	Thermal Solar Energy	4 CR
M-MACH-105732	Windpower	4 CR

4.2.2 Industrial Informatics and Systems Engineering

Part of: Field of Specialization in Mechatronics and Information Technology

Credits 60

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

To see English modules with English titles and German modules with German titles visit the German website**.**

The primarily mentioned modules (alphabetically ordered) are given in English, the further below mentioned ones in German (alphabetically ordered).

Mandatory Electives – Methodical (Election: at least 8 credits)		
	- Modules in English Language -	
M-MACH-105296	Computational Intelligence	4 CR
M-ETIT-106953	Cyber-Physical Modeling	6 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-ETIT-106899	Signal Processing Methods	6 CR
	- Modules in German Language -	
M-ETIT-103264	Information Fusion	4 CR
M-INFO-100825	Pattern Recognition	6 CR
Mandatory Electives – General (Election: at least 16 credits)		
	- Modules in English Language -	
M-MACH-105296	Computational Intelligence	4 CR
M-ETIT-106953	Cyber-Physical Modeling	6 CR
M-ETIT-106040	Digital Twin Engineering	4 CR
M-ETIT-100449	Hardware Modeling and Simulation	4 CR
M-ETIT-106789	IT/OT-Security Seminar	4 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-ETIT-106899	Signal Processing Methods	6 CR
M-ETIT-100537	Systems and Software Engineering	5 CR
	- Modules in German Language -	
M-ETIT-103264	Information Fusion	4 CR
M-INFO-100825	Pattern Recognition	6 CR
M-ETIT-106673	Practical Machine Learning	6 CR
M-MACH-106662	Re:Invent - Revolutionary Business Models as the Basis for Product Innovations	4 CR
Internship/Lab Course (Election: 1 item)		
	- Modules in English Language -	
M-MACH-105725	Seamless Engineering	9 CR
M-ETIT-106633	Signal Processing Lab	6 CR
M-ETIT-105073	Student Innovation Lab	15 CR
	- Modules in German Language -	
M-MACH-102699	Laboratory Mechatronics	4 CR
M-INFO-105958	Practical Course: Machine Learning and Intelligent Systems	8 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Additive Electives (Election:)		
	- Modules in English Language -	
M-INFO-107198	Advanced Artificial Intelligence	6 CR
M-ETIT-100539	Communication Systems and Protocols	5 CR
M-MACH-105296	Computational Intelligence	4 CR
M-ETIT-106953	Cyber-Physical Modeling	6 CR
M-ETIT-106040	Digital Twin Engineering	4 CR
M-INFO-107169	Machine Learning - Foundations and Algorithms	6 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-ETIT-106780	Practical Tools for Control Engineers	4 CR
M-WIWI-100500	Renewable Energy-Resources, Technologies and Economics	4 CR
M-INFO-106504	Simulation and Optimization in Robotics and Biomechanics	6 CR
	- Modules in German Language -	

M-MACH-105968	Artificial Intelligence in Production	8 CR
M-MACH-106468	Control of Mobile Machines	4 CR
M-ETIT-100449	Hardware Modeling and Simulation	4 CR
M-ETIT-103264	Information Fusion	4 CR
M-INFO-100895	Information Processing in Sensor Networks	6 CR
M-ETIT-100367	Information Technology in Industrial Automation Systems	3 CR
M-WIWI-100498	Introduction into Energy Economics	5 CR
M-MACH-106525	Introduction to Bionics	4 CR
M-MACH-105282	IT-Fundamentals of Logistics: Opportunities for Digital Transformation	4 CR
M-ETIT-106789	IT/OT-Security Seminar	4 CR
M-MACH-105298	Logistics and Supply Chain Management	9 CR
M-INFO-100825	Pattern Recognition	6 CR
M-ETIT-106673	Practical Machine Learning	6 CR
M-ETIT-104475	Project Management in the Development of Products for Safety-Critical Applications	4 CR
M-MACH-106662	Re:Invent - Revolutionary Business Models as the Basis for Product Innovations	4 CR
M-ETIT-106970	Seminar Industrial Process and Plant Engineering	4 CR
M-ETIT-106899	Signal Processing Methods	6 CR
M-ETIT-100450	Software Engineering	3 CR
M-INFO-100829	Stochastic Information Processing	6 CR
M-ETIT-106026	System Integration and Communication Structures in Industry 4.0 and IoT	3 CR
M-ETIT-100537	Systems and Software Engineering	5 CR

4.2.3 Vehicle Systems Engineering

Part of: Field of Specialization in Mechatronics and Information Technology

Credits
60

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

To see English modules with English titles and German modules with German titles visit the German website**.**

The primarily mentioned modules (alphabetically ordered) are given in English, the further below mentioned ones in German (alphabetically ordered).

Mandatory Electives – Methodical (Election: at least 8 credits)		
	- Modules in English Language -	
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-ETIT-100537	Systems and Software Engineering	5 CR
	- Modules in German Language -	
M-MACH-106468	Control of Mobile Machines	4 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-MACH-107053	Simulation with Lumped Parameters	4 CR
Mandatory Electives – General (Election: at least 16 credits)		
	- Modules in English Language -	
M-MACH-107148	Automotive Vision	6 CR
M-MACH-107151	Data-Driven Algorithms in Vehicle Technology	4 CR
M-MACH-106926	Decision-Making and Motion Planning for Automated Driving	6 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-ETIT-100537	Systems and Software Engineering	5 CR
	- Modules in German Language -	
M-MACH-100501	Automotive Engineering I	8 CR
M-ETIT-100532	Batteries and Fuel Cells	5 CR
M-MACH-107060	CO2-Neutral Combustion Engines and their Fuels I	4 CR
M-MACH-106468	Control of Mobile Machines	4 CR
M-MACH-107041	Mobile Machines	8 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-MACH-102683	Rail Vehicle Technology	4 CR
M-MACH-107053	Simulation with Lumped Parameters	4 CR
Internship/Lab Course (Election: 1 item)		
	- Modules in English Language -	
M-ETIT-107138	Electric Drives and Power Electronics Lab	6 CR
M-MACH-105725	Seamless Engineering	9 CR
	- Modules in German Language -	
M-ETIT-100381	Batteries and Fuel Cells Laboratory	6 CR
M-MACH-106744	Cognitive Automobiles - Laboratory	6 CR
M-MACH-102695	Motor Vehicle Laboratory	4 CR
M-MACH-107052	Practical Course: Autonomous Driving	6 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Additive Electives (Election:)		
	- Modules in English Language -	
M-MACH-107148	Automotive Vision	6 CR
M-MACH-107151	Data-Driven Algorithms in Vehicle Technology	4 CR
M-MACH-106926	Decision-Making and Motion Planning for Automated Driving	6 CR
M-ETIT-106971	Electric Drives for E-Mobility	4 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-MACH-107074	Project Workshop: Automotive Engineering	6 CR
M-ETIT-100537	Systems and Software Engineering	5 CR
M-MACH-107143	Validation of Technical Systems	4 CR
	- Modules in German Language -	
M-MACH-100501	Automotive Engineering I	8 CR
M-MACH-100502	Automotive Engineering II	4 CR
M-ETIT-100532	Batteries and Fuel Cells	5 CR
M-MACH-107060	CO2-Neutral Combustion Engines and their Fuels I	4 CR

M-MACH-107180	CO2-Neutral Combustion Engines and their Fuels II	5 CR
M-MACH-106468	Control of Mobile Machines	4 CR
M-MACH-107055	Design and Development of Mobile Machines	4 CR
M-MACH-107082	Design and Optimization of Conventional and Electrified Automotive Transmissions	4 CR
M-ETIT-100515	Design of Electrical Machines	5 CR
M-MACH-107078	Development of Hybrid Powertrains	4 CR
M-MACH-107059	Development of Oil-Hydraulic Powertrain Systems	4 CR
M-MACH-102700	Dynamics of the Automotive Drive Train	4 CR
M-MACH-107160	Engine Measurement Techniques	4 CR
M-MACH-105824	Fundamentals in the Development of Commercial Vehicles	4 CR
M-MACH-105288	Handling Characteristics of Motor Vehicles I	4 CR
M-MACH-107073	Handling Characteristics of Motor Vehicles II	4 CR
M-MACH-107158	Hydrogen and reFuels - Energy Conversion in Combustion Engines	4 CR
M-MACH-106514	Innovation and Project Management in Rail Vehicle Engineering	4 CR
M-MACH-107210	Mathematical Methods in Hydraulics	6 CR
M-MACH-107041	Mobile Machines	8 CR
M-ETIT-100394	Practical Aspects of Electrical Drives	4 CR
M-MACH-105346	Product- and Production-Concepts for modern Automobiles	4 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-MACH-107072	Python Algorithms for Automotive Engineering	4 CR
M-MACH-102683	Rail Vehicle Technology	4 CR
M-MACH-106513	Railway System Digitalisation	4 CR
M-MACH-107044	Railways in the Transportation Market	4 CR
M-ETIT-100378	Sensors	3 CR
M-MACH-107053	Simulation with Lumped Parameters	4 CR
M-MACH-107070	Tires and Wheel Development for Passenger Cars	4 CR
M-MACH-107058	Tractors	4 CR
M-MACH-107056	Vehicle Drive Technology	4 CR
M-MACH-102703	Vehicle Lightweight Design - Strategies, Concepts, Materials	4 CR
M-MACH-106515	Vehicle Systems for Urban Mobility	4 CR

4.2.4 Micro System Technology

Part of: Field of Specialization in Mechatronics and Information Technology

Credits
60

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

To see English modules with English titles and German modules with German titles visit the German website**.**

The primarily mentioned modules (alphabetically ordered) are given in English, the further below mentioned ones in German (alphabetically ordered).

Mandatory Electives – Methodical (Election: at least 8 credits)		
	- Modules in English Language -	
M-MACH-105296	Computational Intelligence	4 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
	- Modules in German Language -	
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-ETIT-100361	Distributed Discrete Event Systems	4 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
Mandatory Electives – General (Election: at least 16 credits)		
	- Modules in English Language -	
M-MACH-105296	Computational Intelligence	4 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-MACH-107183	Polymers in MEMS A: Chemistry, Synthesis and Applications	4 CR
M-MACH-107035	Polymers in MEMS B: Physics, Microstructuring and Applications	4 CR
M-MACH-107164	Quantum Machines I	4 CR
M-MACH-107165	Quantum Machines II	4 CR
	- Modules in German Language -	
M-MACH-100489	BioMEMS - Microsystems Technologies for Life Sciences and Medicine I	4 CR
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-ETIT-100361	Distributed Discrete Event Systems	4 CR
M-MACH-102691	Introduction to Microsystem Technology I	4 CR
M-MACH-102706	Introduction to Microsystem Technology II	4 CR
M-MACH-106210	Mathematical Methods in Continuum Mechanics	6 CR
M-MACH-100487	Microactuators	4 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-ETIT-100378	Sensors	3 CR
Internship/Lab Course (Election: 1 item)		
	- Modules in English Language -	
M-MACH-107195	Microsystem Product Design for Young Entrepreneurs	4 CR
M-ETIT-105464	MMIC Design Laboratory	6 CR
M-MACH-107196	NMR Micro Probe Hardware Conception and Construction	4 CR
M-MACH-107034	Practical Course Polymers in MEMS	2 CR
M-MACH-105725	Seamless Engineering	9 CR
	- Modules in German Language -	
M-ETIT-100478	Laboratory Nanotechnology	6 CR
M-MACH-105479	Practical Training in Basics of Microsystem Technology	4 CR
M-ETIT-100451	System-on-Chip Laboratory	6 CR
Additive Electives (Election:)		
	- Modules in English Language -	
M-ETIT-103802	Adaptive Optics	3 CR
M-MACH-105296	Computational Intelligence	4 CR
M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-MACH-107185	Mechanical Properties of Nanomaterials and Microsystems	4 CR
M-MACH-102714	Microenergy Technologies	4 CR
M-MACH-105486	Micro System Simulation	4 CR
M-ETIT-100535	Microwave Engineering	5 CR
M-ETIT-106921	Modern VLSI Technologies	6 CR
M-ETIT-105604	Nano- and Quantum Electronics	6 CR
M-MACH-107183	Polymers in MEMS A: Chemistry, Synthesis and Applications	4 CR

M-MACH-107035	Polymers in MEMS B: Physics, Microstructuring and Applications	4 CR
M-MACH-107085	Polymers in MEMS C: Biopolymers and Bioplastics	4 CR
M-ETIT-105606	Quantum Detectors and Sensors	6 CR
M-MACH-107164	Quantum Machines I	4 CR
M-MACH-107165	Quantum Machines II	4 CR
M-ETIT-106955	Radio-Frequency Electronics	6 CR
	- Modules in German Language -	
M-MACH-102698	Actuators and Sensors in Nanotechnology	4 CR
M-MACH-100489	BioMEMS - Microsystems Technologies for Life Sciences and Medicine I	4 CR
M-MACH-100490	BioMEMS - Microsystems Technologies for Life Sciences and Medicine II	4 CR
M-MACH-100491	BioMEMS - Microsystems Technologies for Life Sciences and Medicine III	4 CR
M-MACH-105483	BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV	4 CR
M-MACH-105484	BioMEMS - Microfludic Chipsystems V	4 CR
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-MACH-105485	Current Topics on BioMEMS	4 CR
M-ETIT-100361	Distributed Discrete Event Systems	4 CR
M-MACH-107207	Introduction to Nanotechnology	4 CR
M-MACH-105478	Fabrication Processes in Microsystem Technology	4 CR
M-INFO-100895	Information Processing in Sensor Networks	6 CR
M-ETIT-100474	Integrated Systems and Circuits	4 CR
M-MACH-102691	Introduction to Microsystem Technology I	4 CR
M-MACH-102706	Introduction to Microsystem Technology II	4 CR
M-MACH-106210	Mathematical Methods in Continuum Mechanics	6 CR
M-MACH-100487	Microactuators	4 CR
M-ETIT-100454	Microsystem Technology	3 CR
M-MACH-107063	Miniaturized Heat Transfer	4 CR
M-MACH-105292	Novel Actuators and Sensors	4 CR
M-ETIT-100484	Optoelectronic Measurement Engineering	3 CR
M-MACH-107064	Physical Basics of Laser Technology	5 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-ETIT-100455	Seminar Embedded Systems	4 CR
M-ETIT-100378	Sensors	3 CR
M-MACH-105315	System Integration in Micro- and Nanotechnology	4 CR
M-MACH-105316	System Integration in Micro- and Nanotechnology 2	4 CR

4.2.5 Automation, Control, and Robotics

Part of: Field of Specialization in Mechatronics and Information Technology

Credits
60

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

To see English modules with English titles and German modules with German titles visit the German website**.**

The primarily mentioned modules (alphabetically ordered) are given in English, the further below mentioned ones in German (alphabetically ordered).

Mandatory Electives – Methodical (Election: at least 8 credits)		
	- Modules in English Language -	
M-ETIT-106953	Cyber-Physical Modeling	6 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-INFO-107130	Robotics III - Sensors and Perception in Robotics	3 CR
	- Modules in German Language -	
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-MACH-107087	Probabilistic Measurement and Estimation	4 CR
Mandatory Electives – General (Election: at least 16 credits)		
	- Modules in English Language -	
M-INFO-107198	Advanced Artificial Intelligence	6 CR
M-MACH-106903	Biologically Inspired Robots	3 CR
M-ETIT-106953	Cyber-Physical Modeling	6 CR
M-MACH-107088	Deep Learning for Engineers	6 CR
M-MACH-106457	Machine Learning for Robotic Systems 1	5 CR
M-MACH-101923	Machine Vision	8 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-INFO-107130	Robotics III - Sensors and Perception in Robotics	3 CR
	- Modules in German Language -	
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-MACH-107087	Probabilistic Measurement and Estimation	4 CR
Internship/Lab Course (Election: 1 item)		
	- Modules in English Language -	
M-MACH-106905	CAD Engineering Project for Intelligent Systems	3 CR
M-MACH-106904	Practical Course: Software Development and Application of Mobile, Bio-Inspired Robots	6 CR
M-INFO-107155	Robotics - Practical Course	6 CR
M-MACH-105725	Seamless Engineering	9 CR
M-ETIT-105073	Student Innovation Lab	15 CR
	- Modules in German Language -	
M-MACH-105475	Virtual Engineering Lab	4 CR
M-ETIT-105467	Control Theory Laboratory	6 CR
M-INFO-105252	Machine Learning - Basic Methods	5 CR
M-ETIT-106673	Practical Machine Learning	6 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Additive Electives (Election:)		
	- Modules in English Language -	
M-INFO-107198	Advanced Artificial Intelligence	6 CR
M-MACH-107148	Automotive Vision	6 CR
M-MACH-106903	Biologically Inspired Robots	3 CR
M-MACH-105296	Computational Intelligence	4 CR
M-ETIT-106953	Cyber-Physical Modeling	6 CR
M-MACH-107088	Deep Learning for Engineers	6 CR
M-MACH-107089	Hot Research Topics in AI for Engineering Applications	4 CR
M-INFO-107152	Humanoid Robots - Seminar	3 CR
M-MACH-106457	Machine Learning for Robotic Systems 1	5 CR
M-MACH-106652	Machine Learning for Robotic Systems 2	5 CR
M-MACH-101923	Machine Vision	8 CR
M-INFO-102555	Motion in Human and Machine - Seminar	3 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-INFO-105623	Reinforcement Learning	6 CR

M-INFO-107123	Robotics II - Humanoid Robotics	3 CR
M-INFO-107130	Robotics III - Sensors and Perception in Robotics	3 CR
M-MACH-106902	Seminar: Bionic Algorithms and Robot Technologies	3 CR
M-ETIT-106899	Signal Processing Methods	6 CR
	- Modules in German Language -	
M-MACH-102698	Actuators and Sensors in Nanotechnology	4 CR
M-INFO-100826	Automated Visual Inspection and Image Processing	6 CR
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-MACH-106468	Control of Mobile Machines	4 CR
M-MACH-105348	Control Technology	4 CR
M-INFO-105753	Deep Learning for Computer Vision I: Basics	3 CR
M-MACH-107045	Digital Control	4 CR
M-ETIT-100361	Distributed Discrete Event Systems	4 CR
M-ETIT-100453	Hardware/Software Co-Design	4 CR
M-INFO-100824	Human-Machine-Interaction in Anthropomatics: Basics	3 CR
M-ETIT-103264	Information Fusion	4 CR
M-INFO-100791	Innovative Concepts for Programming Industrial Robots	4 CR
M-INFO-100840	Localization of Mobile Agents	6 CR
M-MACH-100487	Microactuators	4 CR
M-MACH-105314	Modern Control Concepts III	4 CR
M-ETIT-100371	Nonlinear Control Systems	3 CR
M-ETIT-102310	Optimal Control and Estimation	3 CR
M-MACH-102702	Organ Support Systems	4 CR
M-MACH-107087	Probabilistic Measurement and Estimation	4 CR
M-INFO-100803	Real-Time Systems	6 CR
M-INFO-102212	Seminar Intelligent Industrial Robots	3 CR
M-ETIT-100378	Sensors	3 CR
M-INFO-100829	Stochastic Information Processing	6 CR

4.2.6 Autonomous Systems and AI

Part of: Field of Specialization in Mechatronics and Information Technology

Credits
60

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

To see English modules with English titles and German modules with German titles visit the German website**.**

The primarily mentioned modules (alphabetically ordered) are given in English, the further below mentioned ones in German (alphabetically ordered).

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Presumably, in the area "**Mandatory Electives – General**" the following courses are selectable:

- Machine Learning with Python (WiSe), T-MACH-113927
- Robotic Intelligence for mobile Systems (SoSe), T-MACH-114034

Booking can be done via Study Program Service ETIT/MIT.

Mandatory Electives – Methodical (Election: at least 8 credits)		
	- Modules in English Language -	
M-INFO-107198	Advanced Artificial Intelligence	6 CR
M-MACH-107088	Deep Learning for Engineers	6 CR
M-MACH-106457	Machine Learning for Robotic Systems 1	5 CR
M-MACH-101923	Machine Vision	8 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
	- Modules in German Language -	
M-MACH-107087	Probabilistic Measurement and Estimation	4 CR
Mandatory Electives – General (Election: at least 16 credits)		
	- Modules in English Language -	
M-INFO-107198	Advanced Artificial Intelligence	6 CR
M-MACH-107148	Automotive Vision	6 CR
M-MACH-106903	Biologically Inspired Robots	3 CR
M-MACH-107088	Deep Learning for Engineers	6 CR
M-MACH-106457	Machine Learning for Robotic Systems 1	5 CR
M-MACH-106652	Machine Learning for Robotic Systems 2	5 CR
M-MACH-101923	Machine Vision	8 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-INFO-107130	Robotics III - Sensors and Perception in Robotics	3 CR
	- Modules in German Language -	
M-MACH-105968	Artificial Intelligence in Production	8 CR
M-MACH-107087	Probabilistic Measurement and Estimation	4 CR
M-MACH-107072	Python Algorithms for Automotive Engineering	4 CR
Internship/Lab Course (Election: 1 item)		
	- Modules in English Language -	
M-MACH-106905	CAD Engineering Project for Intelligent Systems	3 CR
M-MACH-106830	Industrial Mobile Robotics Lab	4 CR
M-MACH-106904	Practical Course: Software Development and Application of Mobile, Bio-Inspired Robots	6 CR
M-MACH-105725	Seamless Engineering	9 CR
M-ETIT-105073	Student Innovation Lab	15 CR
	- Modules in German Language -	
M-MACH-106744	Cognitive Automobiles - Laboratory	6 CR
M-ETIT-105467	Control Theory Laboratory	6 CR
M-INFO-105958	Practical Course: Machine Learning and Intelligent Systems	8 CR
M-ETIT-106673	Practical Machine Learning	6 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Additive Electives (Election:)		
	- Modules in English Language -	
M-INFO-107198	Advanced Artificial Intelligence	6 CR
M-MACH-107148	Automotive Vision	6 CR
M-MACH-106903	Biologically Inspired Robots	3 CR
M-MACH-105296	Computational Intelligence	4 CR
M-ETIT-106953	Cyber-Physical Modeling	6 CR
M-MACH-107151	Data-Driven Algorithms in Vehicle Technology	4 CR
M-INFO-107197	Deep Learning and Neural Networks	6 CR
M-MACH-107088	Deep Learning for Engineers	6 CR
M-MACH-107089	Hot Research Topics in AI for Engineering Applications	4 CR
M-ETIT-105461	Introduction to Automotive and Industrial Lidar Technology	3 CR
M-MACH-106457	Machine Learning for Robotic Systems 1	5 CR
M-MACH-106652	Machine Learning for Robotic Systems 2	5 CR

M-MACH-101923	Machine Vision	8 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-INFO-107130	Robotics III - Sensors and Perception in Robotics	3 CR
	- Modules in German Language -	
M-MACH-105968	Artificial Intelligence in Production	8 CR
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-MACH-107045	Digital Control	4 CR
M-ETIT-100361	Distributed Discrete Event Systems	4 CR
M-ETIT-103264	Information Fusion	4 CR
M-MACH-105313	Modern Control Concepts II	4 CR
M-MACH-105314	Modern Control Concepts III	4 CR
M-ETIT-100371	Nonlinear Control Systems	3 CR
M-ETIT-102310	Optimal Control and Estimation	3 CR
M-MACH-107087	Probabilistic Measurement and Estimation	4 CR
M-MACH-107072	Python Algorithms for Automotive Engineering	4 CR
M-INFO-100803	Real-Time Systems	6 CR
M-INFO-100829	Stochastic Information Processing	6 CR

4.2.7 Design of Mechatronic Systems

Part of: Field of Specialization in Mechatronics and Information Technology

Credits 60

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

To see English modules with English titles and German modules with German titles visit the German website.

The primarily mentioned modules (alphabetically ordered) are given in English, the further below mentioned ones in German (alphabetically ordered).

- - - - - - - - -

During summer term 2025 modules will be added in "**Internship/Lab Course**".

Mandatory Electives – Methodical (Election: at least 8 credits)		
	- Modules in German Language -	
M-MACH-105307	Data Analytics for Engineers	5 CR
M-MACH-107142	Leadership in Interdisciplinary Teams	4 CR
M-MACH-107144	Power Tool Design	4 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
Mandatory Electives – General (Election: at least 16 credits)		
	- Modules in English Language -	
M-MACH-107190	Drive System Engineering B: Stationary Machinery	4 CR
	- Modules in German Language -	
M-MACH-105307	Data Analytics for Engineers	5 CR
M-MACH-107142	Leadership in Interdisciplinary Teams	4 CR
M-MACH-105107	Machine Tools and Industrial Handling	8 CR
M-MACH-107041	Mobile Machines	8 CR
M-MACH-105292	Novel Actuators and Sensors	4 CR
M-MACH-102702	Organ Support Systems	4 CR
M-MACH-107144	Power Tool Design	4 CR
M-ETIT-100394	Practical Aspects of Electrical Drives	4 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-ETIT-104475	Project Management in the Development of Products for Safety-Critical Applications	4 CR
Internship/Lab Course (Election: 1 item)		
	- Modules in English Language -	
M-MACH-105725	Seamless Engineering	9 CR
	- Modules in German Language -	
M-MACH-102684	CAE-Workshop	4 CR
M-ETIT-100460	Laboratory in Software Engineering	6 CR
M-MACH-102699	Laboratory Mechatronics	4 CR
M-MACH-107145	Power Tool Design Project Work	8 CR
M-MACH-102711	Production Techniques Laboratory	4 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
M-MACH-105475	Virtual Engineering Lab	4 CR
Additive Electives (Election:)		
	- Modules in English Language -	
M-ETIT-106040	Digital Twin Engineering	4 CR
M-MACH-107190	Drive System Engineering B: Stationary Machinery	4 CR
M-MACH-107188	Innovation2Business – Innovation Strategy in the Industrial Corporate Practice	4 CR
M-ETIT-100450	Software Engineering	3 CR
M-ETIT-100537	Systems and Software Engineering	5 CR
M-INFO-107161	Ubiquitous Computing	5 CR
M-MACH-107143	Validation of Technical Systems	4 CR
M-INFO-107113	Wearable Robotic Technologies	4 CR
	- Modules in German Language -	
M-ETIT-100466	Analog Circuit Design	4 CR
M-MACH-105968	Artificial Intelligence in Production	8 CR
M-ETIT-100532	Batteries and Fuel Cells	5 CR
M-MACH-106468	Control of Mobile Machines	4 CR
M-MACH-105307	Data Analytics for Engineers	5 CR
M-ETIT-100473	Digital Circuit Design	4 CR
M-MACH-105612	Dynamics of Electro-Mechanical Systems	5 CR
M-ETIT-103264	Information Fusion	4 CR
M-ETIT-100474	Integrated Systems and Circuits	4 CR
M-MACH-107141	Integrated Product Development	18 CR

M-MACH-106525	Introduction to Bionics	4 CR
M-MACH-107142	Leadership in Interdisciplinary Teams	4 CR
M-MACH-102696	Lightweight Engineering Design	4 CR
M-MACH-102694	Machine Dynamics	5 CR
M-MACH-105107	Machine Tools and Industrial Handling	8 CR
M-MACH-107041	Mobile Machines	8 CR
M-MACH-105292	Novel Actuators and Sensors	4 CR
M-MACH-102702	Organ Support Systems	4 CR
M-MACH-107144	Power Tool Design	4 CR
M-ETIT-100394	Practical Aspects of Electrical Drives	4 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-ETIT-104475	Project Management in the Development of Products for Safety-Critical Applications	4 CR
M-MACH-105418	ProVIL - Product Development in a Virtual Idea Laboratory	4 CR
M-MACH-105332	Quality Management	4 CR
M-MACH-106662	Re:Invent - Revolutionary Business Models as the Basis for Product Innovations	4 CR
M-MACH-107140	Strategic Product Development - Identification of Potentials of Innovative Products	4 CR
M-MACH-100291	Structural Materials	6 CR
M-MACH-107189	Sustainable Product Engineering: Sustainable Product Design - Long-term Business Success with Sustainably Developed Products	4 CR

4.3 Elective Area in Mechatronics and Information Technology

Credits
22

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

To see English modules with English titles and German modules with German titles visit the German website**.**

The primarily mentioned modules (alphabetically ordered) are given in English, the further below mentioned ones in German (alphabetically ordered).

Elective Area in Mechatronics and Information Technology (Election:)		
	- Modules in English Language -	
M-ETIT-103802	Adaptive Optics	3 CR
M-INFO-107198	Advanced Artificial Intelligence	6 CR
M-ETIT-106815	Advanced Communications Engineering	6 CR
M-ETIT-106956	Antennas and Beamforming	4 CR
M-MACH-107148	Automotive Vision	6 CR
M-MACH-106903	Biologically Inspired Robots	3 CR
M-ETIT-105616	Channel Coding: Algebraic Methods for Communications and Storage	3 CR
M-MACH-107062	Combined Cycle Power Plants	6 CR
M-ETIT-100539	Communication Systems and Protocols	5 CR
M-ETIT-106689	Components of Power Systems	3 CR
M-MACH-107157	Computational Fluid Dynamics (CFD) for Energy Technologies	4 CR
M-MACH-105296	Computational Intelligence	4 CR
M-ETIT-106953	Cyber-Physical Modeling	6 CR
M-MACH-107151	Data-Driven Algorithms in Vehicle Technology	4 CR
M-MACH-106926	Decision-Making and Motion Planning for Automated Driving	6 CR
M-INFO-107197	Deep Learning and Neural Networks	6 CR
M-MACH-107088	Deep Learning for Engineers	6 CR
M-ETIT-106040	Digital Twin Engineering	4 CR
M-MACH-107190	Drive System Engineering B: Stationary Machinery	4 CR
M-ETIT-106971	Electric Drives for E-Mobility	4 CR
M-ETIT-105394	Electric Power Transmission & Grid Control	6 CR
M-ETIT-105883	Electrocatalysis	5 CR
M-ETIT-101969	Energy Storage and Network Integration	4 CR
M-MACH-107066	Engineering Materials for the Energy Transition	4 CR
M-ETIT-100566	Field Propagation and Coherence	4 CR
M-MACH-107117	Fundamentals of Combustion II	4 CR
M-ETIT-100449	Hardware Modeling and Simulation	4 CR
M-ETIT-106963	Hardware Synthesis and Optimization	6 CR
M-MACH-107089	Hot Research Topics in AI for Engineering Applications	4 CR
M-INFO-107152	Humanoid Robots - Seminar	3 CR
M-MACH-107188	Innovation2Business – Innovation Strategy in the Industrial Corporate Practice	4 CR
M-ETIT-105461	Introduction to Automotive and Industrial Lidar Technology	3 CR
M-ETIT-106789	IT/OT-Security Seminar	4 CR
M-WIWI-105403	Liberalised Power Markets	6 CR
M-WIWI-106604	Machine Learning and Optimization in Energy Systems	4 CR
M-MACH-106457	Machine Learning for Robotic Systems 1	5 CR
M-MACH-106652	Machine Learning for Robotic Systems 2	5 CR
M-INFO-107169	Machine Learning - Foundations and Algorithms	6 CR
M-MACH-101923	Machine Vision	8 CR
M-MACH-107223	Magnet Technology of Fusion Reactors	4 CR
M-MACH-107032	Mathematical Methods in Fluid Mechanics	6 CR
M-MACH-107185	Mechanical Properties of Nanomaterials and Microsystems	4 CR
M-ETIT-106672	Medical Image Processing for Guidance and Navigation	9 CR
M-MACH-102714	Microenergy Technologies	4 CR
M-ETIT-100535	Microwave Engineering	5 CR
M-ETIT-107007	Microwaves Measurement Techniques *First usage possible from Apr 01, 2026.*	4 CR
M-ETIT-106921	Modern VLSI Technologies	6 CR
M-INFO-102555	Motion in Human and Machine - Seminar	3 CR
M-ETIT-105604	Nano- and Quantum Electronics	6 CR
M-ETIT-100430	Nonlinear Optics	6 CR

M-MATH-105831	Numerical Methods	5 CR
M-MATH-106972	Numerical Methods with Programming Practice	6 CR
M-ETIT-106974	Optical Engineering and Machine Vision	6 CR
M-ETIT-100436	Optical Transmitters and Receivers	6 CR
M-ETIT-100506	Optical Waveguides and Fibers	4 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-ETIT-104485	Photonics and Communications Lab	6 CR
M-MACH-107183	Polymers in MEMS A: Chemistry, Synthesis and Applications	4 CR
M-MACH-107035	Polymers in MEMS B: Physics, Microstructuring and Applications	4 CR
M-MACH-107085	Polymers in MEMS C: Biopolymers and Bioplastics	4 CR
M-ETIT-104567	Power Electronics	6 CR
M-ETIT-106780	Practical Tools for Control Engineers	4 CR
M-MACH-107074	Project Workshop: Automotive Engineering	6 CR
M-ETIT-105606	Quantum Detectors and Sensors	6 CR
M-MACH-107165	Quantum Machines II	4 CR
M-MACH-107164	Quantum Machines I	4 CR
M-ETIT-106955	Radio-Frequency Electronics	6 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-WIWI-100500	Renewable Energy-Resources, Technologies and Economics	4 CR
M-INFO-107123	Robotics II - Humanoid Robotics	3 CR
M-INFO-107130	Robotics III - Sensors and Perception in Robotics	3 CR
M-MACH-106902	Seminar: Bionic Algorithms and Robot Technologies	3 CR
M-ETIT-103447	Seminar Novel Concepts for Solar Energy Harvesting	3 CR
M-ETIT-106899	Signal Processing Methods	6 CR
M-ETIT-106675	Signal Processing with Nonlinear Fourier Transforms and Koopman Operators	6 CR
M-INFO-106504	Simulation and Optimization in Robotics and Biomechanics	6 CR
M-ETIT-100450	Software Engineering	3 CR
M-ETIT-100524	Solar Energy	6 CR
M-MACH-101924	Solar Thermal Energy Systems	4 CR
M-ETIT-103042	Spaceborne Radar Remote Sensing	6 CR
M-ETIT-106684	Superconducting Magnet Technology	4 CR
M-ETIT-106683	Superconducting Power Systems	4 CR
M-ETIT-100537	Systems and Software Engineering	5 CR
M-MACH-107219	Thermal Turbomachines I	8 CR
M-INFO-107161	Ubiquitous Computing	5 CR
M-MACH-107143	Validation of Technical Systems	4 CR
M-MACH-101283	Virtual Engineering A	9 CR
M-INFO-107113	Wearable Robotic Technologies	4 CR
M-ETIT-107147	Workshop Finite Element Method in Electromagnetics	3 CR
	- Modules in German Language -	
M-MACH-102698	Actuators and Sensors in Nanotechnology	4 CR
M-ETIT-100466	Analog Circuit Design	4 CR
M-MACH-107031	Analysis Tools for Combustion Diagnostics	4 CR
M-ETIT-100444	Applied Information Theory	6 CR
M-MACH-105968	Artificial Intelligence in Production	8 CR
M-INFO-100826	Automated Visual Inspection and Image Processing	6 CR
M-MACH-100501	Automotive Engineering I	8 CR
M-MACH-100502	Automotive Engineering II	4 CR
M-MACH-102693	Automotive Vision	6 CR
M-ETIT-100400	Basics of Converter Control	3 CR
M-MACH-105302	Basics of Technical Logistics II	6 CR
M-ETIT-100532	Batteries and Fuel Cells	5 CR

M-ETIT-100377	Battery and Fuel Cells Systems	3 CR
M-ETIT-100549	Bioelectric Signals	3 CR
M-MACH-105484	BioMEMS - Microfludic Chipsystems V	4 CR
M-MACH-100489	BioMEMS - Microsystems Technologies for Life Sciences and Medicine I	4 CR
M-MACH-100490	BioMEMS - Microsystems Technologies for Life Sciences and Medicine II	4 CR
M-MACH-100491	BioMEMS - Microsystems Technologies for Life Sciences and Medicine III	4 CR
M-MACH-105483	BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV	4 CR
M-MACH-107059	Development of Oil-Hydraulic Powertrain Systems	4 CR
M-MACH-107060	CO2-Neutral Combustion Engines and their Fuels I	4 CR
M-MACH-107180	CO2-Neutral Combustion Engines and their Fuels II	5 CR
M-MACH-105180	Continuum Mechanics	5 CR
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-MACH-106468	Control of Mobile Machines	4 CR
M-ETIT-105915	Control of Power-Electronic Systems	6 CR
M-MACH-105348	Control Technology	4 CR
M-MACH-105485	Current Topics on BioMEMS	4 CR
M-MACH-105307	Data Analytics for Engineers	5 CR
M-INFO-105753	Deep Learning for Computer Vision I: Basics	3 CR
M-INFO-105755	Deep Learning for Computer Vision II: Advanced Topics	3 CR
M-MACH-107055	Design and Development of Mobile Machines	4 CR
M-MACH-107082	Design and Optimization of Conventional and Electrified Automotive Transmissions	4 CR
M-ETIT-100515	Design of Electrical Machines	5 CR
M-MACH-102712	Design with Plastics	4 CR
M-MACH-107020	Development of Automated Production Systems	4 CR
M-MACH-107078	Development of Hybrid Powertrains	4 CR
M-ETIT-105415	Digital Beam-Forming for Imaging Radar	4 CR
M-ETIT-100473	Digital Circuit Design	4 CR
M-MACH-107045	Digital Control	4 CR
M-MACH-105476	Digitalization of Products, Services & Production	4 CR
M-ETIT-100361	Distributed Discrete Event Systems	4 CR
M-MACH-105800	Drive Train of Mobile Machines	4 CR
M-MACH-105612	Dynamics of Electro-Mechanical Systems	5 CR
M-MACH-102700	Dynamics of the Automotive Drive Train	4 CR
M-MACH-102688	Elements of Technical Logistics	4 CR
M-MACH-105015	Elements of Technical Logistics incl. Project	6 CR
M-MACH-107139	Energy Systems I - Renewable Energy	4 CR
M-MACH-107061	Energy Topology and Resilience	4 CR
M-MACH-107160	Engine Measurement Techniques	4 CR
M-MACH-105478	Fabrication Processes in Microsystem Technology	4 CR
M-MACH-107120	Flows and Heat Transfer in Energy Technology	4 CR
M-MACH-105824	Fundamentals in the Development of Commercial Vehicles	4 CR
M-MACH-102707	Fundamentals of Combustion I	4 CR
M-MACH-107150	Fundamentals of Reactor Safety for the Operation and Dismantling of Nuclear Power Plants	4 CR
M-MACH-102690	Fundamentals of Energy Technology	8 CR
M-MACH-107124	Fusion Technology A	4 CR
M-MACH-107154	Fusion Technology B	4 CR
M-MACH-105288	Handling Characteristics of Motor Vehicles I	4 CR
M-MACH-107073	Handling Characteristics of Motor Vehicles II	4 CR
M-ETIT-100453	Hardware/Software Co-Design	4 CR
M-MACH-102717	Heat and Mass Transfer	4 CR
M-MACH-107075	Heat Pumps	4 CR

M-ETIT-105060	High-Voltage Technology	6 CR
M-ETIT-100417	High-Voltage Test Technique	4 CR
M-MACH-107097	Holistic Approach of Managing Power Plant Operation under Uncertainty and Volatility	4 CR
M-INFO-100725	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	3 CR
M-INFO-100824	Human-Machine-Interaction in Anthropomatics: Basics	3 CR
M-MACH-107158	Hydrogen and reFuels - Energy Conversion in Combustion Engines	4 CR
M-ETIT-103264	Information Fusion	4 CR
M-INFO-100895	Information Processing in Sensor Networks	6 CR
M-MACH-105281	Information Systems and Supply Chain Management	3 CR
M-ETIT-100367	Information Technology in Industrial Automation Systems	3 CR
M-MACH-106514	Innovation and Project Management in Rail Vehicle Engineering	4 CR
M-INFO-100791	Innovative Concepts for Programming Industrial Robots	4 CR
M-MACH-107119	Innovative Nuclear Systems	4 CR
M-ETIT-100457	Integrated Intelligent Sensors	3 CR
M-MACH-107141	Integrated Product Development	18 CR
M-ETIT-100474	Integrated Systems and Circuits	4 CR
M-MACH-105109	International Production Engineering	8 CR
M-WIWI-100498	Introduction into Energy Economics	5 CR
M-MACH-106525	Introduction to Bionics	4 CR
M-MACH-102691	Introduction to Microsystem Technology I	4 CR
M-MACH-102706	Introduction to Microsystem Technology II	4 CR
M-MACH-107207	Introduction to Nanotechnology	4 CR
M-MACH-107122	Introduction to Nuclear Energy	4 CR
M-ETIT-100399	Industrial Circuitry	3 CR
M-MACH-105282	IT-Fundamentals of Logistics: Opportunities for Digital Transformation	4 CR
M-MACH-107142	Leadership in Interdisciplinary Teams	4 CR
M-ETIT-100485	Lighting Engineering	4 CR
M-MACH-102696	Lightweight Engineering Design	4 CR
M-INFO-100840	Localization of Mobile Agents	6 CR
M-MACH-105298	Logistics and Supply Chain Management	9 CR
M-MACH-102694	Machine Dynamics	5 CR
M-WIWI-105003	Machine Learning 1	5 CR
M-WIWI-105006	Machine Learning 2	5 CR
M-MACH-105107	Machine Tools and Industrial Handling	8 CR
M-MACH-104984	Material Flow in Logistic Systems	9 CR
M-MACH-102727	Materials for Lightweight Construction	4 CR
M-MACH-107043	Materials Recycling and Sustainability	4 CR
M-MACH-106210	Mathematical Methods in Continuum Mechanics	6 CR
M-MACH-107210	Mathematical Methods in Hydraulics	6 CR
M-MACH-105486	Micro System Simulation	4 CR
M-MACH-100487	Microactuators	4 CR
M-ETIT-100454	Microsystem Technology	3 CR
M-ETIT-100424	Microwaves Measurement Techniques *First usage possible until Mar 31, 2026.*	4 CR
M-MACH-107063	Miniaturized Heat Transfer	4 CR
M-MACH-107041	Mobile Machines	8 CR
M-MACH-105308	Modern Control Concepts I	4 CR
M-MACH-105313	Modern Control Concepts II	4 CR
M-MACH-105314	Modern Control Concepts III	4 CR
M-ETIT-100427	Modern Radio Systems Engineering	6 CR
M-ETIT-100371	Nonlinear Control Systems	3 CR
M-MACH-105292	Novel Actuators and Sensors	4 CR

M-MACH-107042	Nuclear Power and Reactor Technology	4 CR
M-MACH-107121	Nuclear Power Plant Technology	4 CR
M-MACH-107036	Numerical Fluid Mechanics	4 CR
M-ETIT-102310	Optimal Control and Estimation	3 CR
M-ETIT-100484	Optoelectronic Measurement Engineering	3 CR
M-MACH-102702	Organ Support Systems	4 CR
M-INFO-100825	Pattern Recognition	6 CR
M-ETIT-100513	Photovoltaics	6 CR
M-MACH-107064	Physical Basics of Laser Technology	5 CR
M-ETIT-100481	Plasma Sources	4 CR
M-ETIT-106067	Power Electronic Systems in Energy Technology	6 CR
M-ETIT-102261	Power Electronics for Photovoltaics and Wind Energy *First usage possible until Sep 30, 2025.*	3 CR
M-ETIT-100413	Power Systems and Economy	3 CR
M-ETIT-106506	Power System Protection and Automation	3 CR
M-MACH-107144	Power Tool Design	4 CR
M-ETIT-100394	Practical Aspects of Electrical Drives	4 CR
M-ETIT-106673	Practical Machine Learning	6 CR
M-MACH-105289	Principles of Whole Vehicle Engineering I	2 CR
M-MACH-105290	Principles of Whole Vehicle Engineering II	2 CR
M-MACH-107087	Probabilistic Measurement and Estimation	4 CR
M-MACH-105346	Product- and Production-Concepts for modern Automobiles	4 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-ETIT-104475	Project Management in the Development of Products for Safety-Critical Applications	4 CR
M-MACH-105418	ProVIL - Product Development in a Virtual Idea Laboratory	4 CR
M-MACH-107072	Python Algorithms for Automotive Engineering	4 CR
M-MACH-105332	Quality Management	4 CR
M-MACH-103232	Rail System Technology	4 CR
M-MACH-102683	Rail Vehicle Technology	4 CR
M-MACH-106513	Railway System Digitalisation	4 CR
M-MACH-107044	Railways in the Transportation Market	4 CR
M-MACH-106662	Re:Invent - Revolutionary Business Models as the Basis for Product Innovations	4 CR
M-MACH-107071	Reactor Physics	4 CR
M-MACH-107116	Reactor Safety 1: Fundamentals	4 CR
M-ETIT-105916	Real Time Control of Electrical Drives	6 CR
M-INFO-100803	Real-Time Systems	6 CR
M-MACH-105477	Seminar Data-Mining in Production	3 CR
M-ETIT-105629	Seminar Electrocatalysis	3 CR
M-ETIT-100455	Seminar Embedded Systems	4 CR
M-MACH-104197	Seminar for Rail System Technology	3 CR
M-ETIT-106970	Seminar Industrial Process and Plant Engineering	4 CR
M-INFO-102212	Seminar Intelligent Industrial Robots	3 CR
M-ETIT-100396	Seminar New Components and Systems of Power Electronics	4 CR
M-ETIT-100378	Sensors	3 CR
M-MACH-107053	Simulation with Lumped Parameters	4 CR
M-INFO-100829	Stochastic Information Processing	6 CR
M-MACH-107140	Strategic Product Development - Identification of Potentials of Innovative Products	4 CR
M-MACH-107189	Sustainable Product Engineering: Sustainable Product Design - Long-term Business Success with Sustainably Developed Products	4 CR
M-ETIT-106026	System Integration and Communication Structures in Industry 4.0 and IoT	3 CR
M-MACH-105315	System Integration in Micro- and Nanotechnology	4 CR
M-MACH-105316	System Integration in Micro- and Nanotechnology 2	4 CR
M-MACH-105318	Technical Design in Product Development	4 CR

M-ETIT-100538	Technical Optics	5 CR
M-MACH-102388	Thermal Solar Energy	4 CR
M-MACH-107112	Thermal-Fluid-Dynamics	4 CR
M-MACH-107070	Tires and Wheel Development for Passenger Cars	4 CR
M-MACH-107058	Tractors	4 CR
M-MACH-107056	Vehicle Drive Technology	4 CR
M-MACH-102703	Vehicle Lightweight Design - Strategies, Concepts, Materials	4 CR
M-MACH-106515	Vehicle Systems for Urban Mobility	4 CR
M-MACH-105293	Virtual Engineering 1	4 CR
M-MACH-105732	Windpower	4 CR
Internship/Lab Course (Election: at most 1 item)		
	- Modules in English Language -	
M-MACH-106905	CAD Engineering Project for Intelligent Systems	3 CR
M-ETIT-107136	Communications Engineering Laboratory	6 CR
M-ETIT-102266	Digital Hardware Design Laboratory	6 CR
M-ETIT-107138	Electric Drives and Power Electronics Lab	6 CR
M-ETIT-107137	Electrical Energy Systems Lab	6 CR
M-MACH-106830	Industrial Mobile Robotics Lab	4 CR
M-ETIT-106973	Microwave Engineering Lab	6 CR
M-ETIT-105464	MMIC Design Laboratory	6 CR
M-ETIT-100464	Optical Design Lab	6 CR
M-MACH-107034	Practical Course Polymers in MEMS	2 CR
M-INFO-105955	Practical Course: Smart Energy System	6 CR
M-MACH-106904	Practical Course: Software Development and Application of Mobile, Bio-Inspired Robots	6 CR
M-INFO-107155	Robotics - Practical Course	6 CR
M-MACH-105725	Seamless Engineering	9 CR
M-ETIT-106633	Signal Processing Lab	6 CR
M-ETIT-105073	Student Innovation Lab	15 CR
	- Modules in German Language -	
M-ETIT-100381	Batteries and Fuel Cells Laboratory	6 CR
M-MACH-102684	CAE-Workshop	4 CR
M-MACH-106744	Cognitive Automobiles - Laboratory	6 CR
M-ETIT-105467	Control Theory Laboratory	6 CR
M-ETIT-102264	Digital Hardware Design Laboratory	6 CR
M-MACH-105291	Lab Computer-Aided Methods for Measurement and Control	4 CR
M-ETIT-100468	Lab Course on Nanoelectronics	6 CR
M-ETIT-100470	Laboratory FPGA Based Circuit Design	6 CR
M-ETIT-100460	Laboratory in Software Engineering	6 CR
M-ETIT-107159	Laboratory Information Systems in Power Engineering	6 CR
M-ETIT-103448	Laboratory Mechatronic Measurement Systems	6 CR
M-MACH-102699	Laboratory Mechatronics	4 CR
M-ETIT-100478	Laboratory Nanotechnology	6 CR
M-ETIT-100477	Laboratory Optoelectronics	6 CR
M-ETIT-102350	Laboratory Solar Energy	6 CR
M-MACH-102695	Motor Vehicle Laboratory	4 CR
M-MACH-107145	Power Tool Design Project Work	8 CR
M-MACH-107052	Practical Course: Autonomous Driving	6 CR
M-INFO-105958	Practical Course: Machine Learning and Intelligent Systems	8 CR
M-ETIT-106673	Practical Machine Learning	6 CR
M-INFO-102224	Practical Project Robotics and Automation I (Software)	6 CR
M-INFO-102230	Practical Project Robotics and Automation II (Hardware)	6 CR

M-MACH-105479	Practical Training in Basics of Microsystem Technology	4 CR
M-MACH-102711	Production Techniques Laboratory	4 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
M-ETIT-100451	System-on-Chip Laboratory	6 CR
M-MACH-105475	Virtual Engineering Lab	4 CR

4.4 Interdisciplinary Qualifications

Credits
8

Mandatory		
M-ETIT-107193	Interdisciplinary Qualifications	8 CR

5 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

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 ETIT 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.

Registration and admission to module examinations

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

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.

6 Publisher

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Tel.: 0721/608-42469, -47516 oder -42746

Module Coordination:

Dr. Andreas Barth, modulkoordination@etit.kit.edu

7 Modules

7.1 Module: Actuators and Sensors in Nanotechnology [M-MACH-102698]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-105238	Actuators and Sensors in Nanotechnology	4 CR	Kohl

Competence Certificate
oral exam: 45 min

Prerequisites
keine

Competence Goal
The students can:

- describe the principles of actuation and sensing and exemplify them
- describe important nano fabrication technologies and assess the influence of process parameters
- illustrate the layout and function of nano actuators and sensors and determine their characteristic properties (time constants, sensitivities, forces, etc.)
- evaluate their suitability for specific applications

Content
- Physical principles of actuation and sensing
- Scaling and size effects
- Fabrication technologies
- Selected developments
- Applications

The lecture includes amongst others the following topics:

- Nano technologies
- Nano electro mechanical systems (NEMS)
- Nano magneto mechanical and multiferroic systems
- Polymer-based nano actuators
- Nano motors, molecular systems
- Adaptive nano optical systems
- Nanosensors: concepts, materials, fabrication
- Examples on different categories of materials and applications:

  - C-based, MeOx-based nano sensors
  - Physical, chemical, biological nano sensors

- Multivariant data analysis / interpretation

Module grade calculation
Module grade calculation
The module grade is the grade of the written exam.

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

Recommendation

The lecture addresses students in the fields of mechanical engineering, mechatronics and information technology, materials science and engineering, physics, electrical engineering and economic sciences. A comprehensive introduction is given in the basics and current developments on the nanoscopic length scale.

Literature

- Lecture notes

- 2. Balzani, V., Credi, A., & Venturi, M., Molecular devices and machines: concepts and perspectives for the nanoworld, 2008

- „Nanowires and Nanobelts, - Materials, Properties and Devices -, Volume 2: Nanowires and Nanobelts of Functional Materials", Edited by Zhong Lin Wang, Springer, 2003, ISBN 10 0-387-28706-X

- „Sensors Based on Nanostructured Materials", Edited by Francisco J. Arregui, Springer, 2009, ISBN: 978-0-387-77752-8

- "Multivariate Datenanalyse – Methodik und Anwendungen in der Chemie", R. Henrion, G. Henrion, Springer 1994, ISBN 3-540-58188-X

M 7.2 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	English	4	3

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

Competence Certificate
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

Recommendation
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 7.3 Module: Advanced Artificial Intelligence [M-INFO-107198]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

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

Competence Certificate
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

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

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

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	1

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

Competence Certificate
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.

Annotation
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

Recommendation
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.

Learning type
Lecture: 3 SWS, Exercise: 1 SWS

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

Responsible: Prof. Dr. Ivan Peric
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

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

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

M 7.6 Module: Analysis Tools for Combustion Diagnostics [M-MACH-107031]

Responsible: Dr.-Ing. Heiko Kubach
Jürgen Pfeil

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105167	Analysis Tools for Combustion Diagnostics	4 CR	Pfeil

Competence Certificate
see individual course

Competence Goal
After completing the course, students will be able to
- Design and create optical accesses to combustion engines.
- Model, analyze and evaluate an engine process thermodynamically.
- Name and explain modern methods for analyzing processes in combustion engines and special measurement methods such as optical measurements and laser measurement techniques.
- Differentiate which experimental method is particularly suitable for a specific analysis question due to its advantages and disadvantages.

Translated with DeepL.com (free version)

Content
- Pressure indexing
- Energy balance on the engine
- Energy conversion in the combustion chamber
- Thermodynamic models for calculating the energy conversion
- Optical accesses for engines
- Methods for determining flow velocities
- Measurement of flame propagation
- Special measurement methods (2-color method, spectroscopy, LIF,...)

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h
(for details see individual course)

M 7.7 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

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

Competence Certificate
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

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

M 7.8 Module: Applied Information Theory [M-ETIT-100444]

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

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

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

Competence Certificate
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 7.9 Module: Artificial Intelligence in Production [M-MACH-105968]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each term	2 terms	German	4	1

Mandatory			
T-MACH-112115	Artificial Intelligence in Production	4 CR	Fleischer
T-MACH-112121	Seminar Application of Artificial Intelligence in Production	4 CR	Fleischer

Competence Certificate
T-MACH-112115 - Written Exam (90 min)

T-MACH-112121 - Alternative test achievement (graded)

Prerequisites
none

Competence Goal
The Students understand

- the relevance for the application of artificial intelligence in production and know the main drivers and challenges.
- the CRISP-DM process for implementing AI projects in production.
- the most important methods within the CRISP-DM phases and can theoretically select and practically apply them holistically based on practical issues.

Content
The module AI in Production is designed to teach students the practical, holistic integration of machine learning methods in production. The course is oriented towards the phases of the CRISP-DM process with the aim of developing a deep understanding of the necessary steps and content-related aspects (methods) within the individual phases. In addition to teaching the practical aspects of integrating the most important machine learning methods, the focus is primarily on the necessary steps for data generation and data preparation as well as the implementation and validation of the methods in an industrial environment. The focus of the module is on the practical teaching of the contents, based on production engineering issues. The necessary theoretical basics are taught in the course "Lecture AI in Production". In the course "Project internship Application of AI in Production", practice-relevant architectures of machine learning are used to solve current practical problems in the production environment. The implementation here is also oriented to the phases of the CRISP-DM.

Module grade calculation
The overall grade for the module is calculated from the LP-weighted grades of the partial examinations and cut off after the first decimal place.

Workload
Artificial Intelligence in Production
MACH:
regular attendance: 31,5 hours
self-study: 88,5 hours
WING:
regular attendance: 31,5 hours
self-study: 118,5 hours

Seminar Application of Artificial Intelligence in Production
regular attendance: 21 hours
self-study: 99 hours

Learning type
Lecture, Seminar

M 7.10 Module: Automated Visual Inspection and Image Processing (24169) [M-INFO-100826]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer

Organisation: KIT Department of Informatics

Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

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

M 7.11 Module: Automotive Engineering I [M-MACH-100501]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-100092	Automotive Engineering I	8 CR	Gießler

Competence Certificate
written exam; duration approximately 2 hours

Prerequisites
Only one out of the two moduls "M-MACH-100501 - Grundlagen der Fahrzeugtechnik I" and "M-MACH-102686 - Automotive Engineering I" is allowed.

Competence Goal
The students know the movements and the forces at the vehicle and are familiar with active and passive security. They have proper knowledge about operation of engines and alternative drives, the necessary transmission between engine and drive wheels and the power distribution, so that they can apply their knowledge effectively in actual practise. They have an overview of the components necessary for the drive and have the basic knowledge, to analyze, to judge and to develop the complex system "vehicle".

Content
The module provides an overview of:

1. History and future of the automobile

2. Driving mechanics: driving resistances and driving performances, mechanics of the longitudinal and transverse forces, passive safety

3. Engines: combustion engine, alternative drives (e.g. electric motor, fuel cell)

4. Transmission: clutches (e.g. friction clutch, visco clutch), transmission (e.g. mechanical transmission, hydraulic fluid transmission)

5. Power transmission and distribution: drive shafts, cardon joints, differentials

Workload
1. regular attendance lecture: 15 * 2 * 2 h = 60 h

2. pre and post processing lecture: 15 * 2 * 3 h = 90 h

3. examination preparation and presence in examination: 90 h

In total: 240 h = 8 LP

Literature
1. Mitschke, M./ Wallentowitz, H.: Dynamik der Kraftfahrzeuge, Springer-Verlag, Berlin, 2004

2. Braes, H.-H.; Seiffert, U.: Handbuch Kraftfahrzeugtechnik, Vieweg&Sohn Verlag, 2005

3. Gnadler, R.: Script to the lecture 'Automotive Engineering I'

7.12 Module: Automotive Engineering II [M-MACH-100502]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Dr.-Ing. Martin Gießler

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-102117	Automotive Engineering II	4 CR	Gießler

Competence Certificate
Written exam; duration approximately 1,5 h

Prerequisites
none

Competence Goal
The students have an overview of the modules, which are necessary for the road holding of a motor vehicle and the power transmission between vehicle bodywork and roadway. They have knowledge of different wheel suspensions, the tyres, the steering elements and the brakes. They know different execution forms, the function and the influence on the driving or brake behavior. They can apply their knowledge effectively in actual practise.They are able to develop the appropriate components correctly. They are ready to analyze, to judge and to optimize the complex relationship of the different components under consideration of boundary conditions.

Content
The module provides an overview of:

1. Chassis: Wheel suspensions (rear axles, front axles, kinematics of axles), tyres, springs, damping devices
2. Steering elements: Manual steering, servo steering, steer by wire
3. Brakes: Disc brake, drum brake, comparison of the designs

Workload
1. regular attendance lecture: 15 * 2 h = 30 h

2. pre and postprocessing lecture: 15 * 3 h = 45 h

3. examination preparation and presence in examnation: 45 h

In total: 120 h = 4 LP

Literature
1. Heißing, B./Ersoy, M.: Fahrwerkhandbuch: Grundlagen, Fahrdynamik, Komponenten, Systeme, Mechatronik, Perspektiven, Vieweg-Verlag, Wiesbaden, 2011

2. Breuer, B./Bill, K.-H.: Bremsenhandbuch: Grundlagen - Komponenten - Systeme - Fahrdynamik, Vieweg-Verlag, Wiesbaden, 2012

3. Gnadler, R.: Script to the lecture 'Automotive Engineering II'

7.13 Module: Automotive Vision [M-MACH-107148]

Responsible: Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-114149	Automotive Vision	6 CR	Lauer, Stiller

Competence Certificate
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 signal processing and artificial intelligence which can be used to evaluate video sequences, to relate the image content to a spatial context and to interpret the content semantically. This comprises, binocular reconstruction, recognition of movements in video sequences, state space modeling and Bayesian filters, and the recognition of road surfaces and object behavior. The participants have learned to analyze the algorithms mathematically, to implement them in software, and to apply them to tasks in autonomous driving and mobile robots. The participants are able to analyze problems in the areas mentioned before and to develop appropriate solutions.

Content
Sensory detection and interpretation of the environment form the basis for generating intelligent behavior. The ability to see opens up completely new perspectives for vehicles and represents a rapidly growing field of research and innovation in automotive technology. The first so-called driver assistance systems have already achieved respectable improvements in terms of comfort, safety and efficiency. However, it will probably take several decades of intensive research before automobiles have a performance comparable to the human visual system.
The lecture is aimed at students of mechanical engineering and related courses,
who wish to acquire an interdisciplinary qualification. It provides a holistic overview of the field of vehicle vision, from the basics of image acquisition and kinematic vehicle models to innovative metrological methods of image processing for seeing vehicles. The derivation of metrological methods of image processing is deepened and illustrated using current, practice-relevant application examples.

Module grade calculation
see individual course

Workload
180 hours

composed out of

hours of lecture: 15*3 h = 45 h

preparation time prior to and after lecture: 15*5 h = 75 h

exam preparation and exam: 60 h

Learning type
Lecture

Literature
TBA

M 7.14 Module: Automotive Vision [M-MACH-102693]

Responsible: Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	2

Mandatory			
T-MACH-105218	Automotive Vision	6 CR	Lauer, Stiller

Competence Certificate
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 signal processing and artificial intelligence which can be used to evaluate video sequences, to relate the image content to a spatial context and to interpret the content semantically. This comprises, binocular reconstruction, recognition of movements in video sequences, state space modeling and Bayesian filters, and the recognition of road surfaces and object behavior. The participants have learned to analyze the algorithms mathematically, to implement them in software, and to apply them to tasks in autonomous driving and mobile robots. The participants are able to analyze problems in the areas mentioned before and to develop appropriate solutions.

Content
Machine perception and interpretation of the environment forms the basis for the generation of intelligent behavior. Especially visual perception opens the door to novel automotive applications. Driver assistance systems already improve safety, comfort and efficiency in vehicles. Yet, several decades of research will be required to achieve an automated behavior with a performance equivalent to a human operator. The lecture addresses students in mechanical engineering and related subjects who intend to get an interdisciplinary knowledge in a state-of-the-art technical domain. Machine vision and advanced information processing techniques are presented to provide a broad overview on seeing vehicles. Application examples from cutting-edge and future driver assistance systems illustrate the discussed subjects. The lecture consists out of 2 hours/week of lecture and 1 hour/week of computer exercises. In the computer exercises methods introduced in the lecture will be implemented in MATLAB and tested experimentally.

Workload
180 hours

composed out of

hours of lecture: 15*3 h = 45 h

preparation time prior to and after lecture: 15*5 h = 75 h

exam preparation and exam: 60 h

Learning type
Lecture

Literature
TBA

M 7.15 Module: Basics of Converter Control [M-ETIT-100400]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	1

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

Prerequisites
none

M 7.16 Module: Basics of Technical Logistics II [M-MACH-105302]

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

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	3

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

Competence Certificate
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

Recommendation
Basics knowledge of technical logistics I is preconditioned

Learning type
Lectures

M 7.17 Module: Batteries and Fuel Cells [M-ETIT-100532]

Responsible: Prof. Dr.-Ing. Ulrike Krewer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-ETIT-100983	Batteries and Fuel Cells	5 CR	Krewer

Competence Certificate
Success is assessed in the form of a written examination lasting 120 minutes

Prerequisites
none

Competence Goal
Students gain an understanding of the structure and mode of operation of batteries and fuel cells. They acquire in-depth knowledge of materials, construction concepts, measurement methods, measurement data analysis and modeling, which gives them a practical insight into current areas of application and research topics of electrochemical energy storage and conversion (fuel cells). They are able to communicate with specialists from related disciplines in the field of batteries and fuel cells and can actively contribute to the opinion-forming process in society with regard to energy technology issues.

Content
Fuel cells and batteries used in innovative energy and environmental technology applications will be covered. The course is divided into three sections. Firstly, the basics of thermodynamics, electrochemistry and the lossy mass transport processes involved in energy conversion are discussed. The second section deals with the structure and functional principle of fuel cells and presents the most important approaches to electrical characterization and modelling. Applications in mobile and stationary systems in transportation and energy technology are discussed. The third section deals with electrochemical energy storage systems, with a focus on high-performance batteries for electric traction. Developments to increase energy density and power density are presented here, as well as the electrical characterization and modelling of batteries.

Module grade calculation
The module grade is the grade of the written examination.

Annotation
Will be changed to 6 CR in winter term 25/26 an provided in English.

Workload
1. lecture attendance time: 15 * 2 h = 30 h
2. Preparation and follow-up time for lecture: 15 * 6 h = 90 h
3. Exercise attendance time: 5 * 2 h = 10 h
4. Preparation and follow-up time for exercise: 5 * 4 h = 20 h
5. Exam preparation and attendance: included in preparation and follow-up time.

Total: 150 h = 5 CP

M 7.18 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: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German/English	4	1

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

Prerequisites
none

M 7.19 Module: Battery and Fuel Cells Systems [M-ETIT-100377]

Responsible: Dr.-Ing. Andre Weber

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100704	Battery and Fuel Cells Systems	3 CR	Weber

M 7.20 Module: Bioelectric Signals [M-ETIT-100549]

Responsible: Dr.-Ing. Axel Loewe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-101956	Bioelectric Signals	3 CR	Loewe

Competence Certificate
The success control is carried out as part of a written test of 90 minutes.

Prerequisites
none

Module grade calculation
The module grade is the grade of the written exam. The submission of the workshop tasks is a prerequisite for taking the written exam. If there is a very good oral discussion of the workshop tasks, 5 points can be earned for each of the two workshop parts (from 100). The bonus points are only taken into account if the exam is passed. Bonus points do not expire and are retained for examinations that may be taken at a later date. The final assessment of the bonus performance is carried out by the examiner and is documented.

Workload
Attendance time lecture: 8 * 1.5h = 12h

Preparation / follow-up lecture: 8 * 1h = 8h

Workshop tasks: 20h + 15h = 35h

Exam preparation and attendance in the same: 35h

Total: 90h

Recommendation
Knowledge of the basics of signal processing and physiology is helpful.

Fundamentals of linear electrical networks, Fourier transformation as well as differential equations and systems of linear equations and numerical solution methods

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

Responsible: Prof. Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	English	4	2

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

Competence Certificate
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 7.22 Module: BioMEMS - Microfludic Chipsystems V [M-MACH-105484]

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

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German/English	4	1

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

Competence Certificate
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

Learning type
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 7.23 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

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

Competence Certificate
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

M 7.24 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

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

Competence Certificate
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

7.25 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

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

Competence Certificate
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

M 7.26 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German/English	4	1

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

Competence Certificate
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

7.27 Module: CAD Engineering Project for Intelligent Systems [M-MACH-106905]

Responsible: Prof. Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each term	1 term	English	4	2

Mandatory			
T-MACH-113857	CAD Engineering Project for Intelligent Systems	3 CR	Rönnau

Competence Certificate
See partial achievement

Prerequisites
None

Competence Goal
Students are able to use CAD tools for design and 3D printing as a manufacturing process for intelligent systems such as biologically inspired robots.

Content
In this design project, students work in small groups using an agile approach to develop an innovative mechatronic component that meets previously defined requirements for an intelligent system.

To this end, students get to know a current CAD development environment and learn how to design the corresponding parts. The typical design and development process is followed from the idea to the finished model. The focus is on independent solution finding, teamwork, (robotic) functional fulfillment, 3D printing and manufacturing and biologically inspired design. The project results are presented at the end of the semester.

Workload
90h

- Initial design / idea of a (biologically inspired) mechatronic component: 15h
- Construction using CAD system and overall system design: 30h
- 3D printing, assembly, integration of electronics and functional tests: 30h
- Documentation and report: 5h
- Meetings: Kickoff, interim and final presentation and discussions as well as meetings with supervisors: 10h

M 7.28 Module: CAE-Workshop [M-MACH-102684]

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

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	4	3

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

Competence Certificate
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

Learning type
Seminar

Literature
The workshop script will be allocated at Ilias.

7.29 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	English	4	1

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

Competence Certificate
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*

Recommendation
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 7.30 Module: CO2-Neutral Combustion Engines and their Fuels I [M-MACH-107060]

Responsible: Prof. Dr. Thomas Koch
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-111550	CO2-Neutral Combustion Engines and their Fuels I	4 CR	Koch

Competence Certificate
oral exam, approx. 20 min.

Competence Goal
Students can explain the principle of an internal combustion engine. They can name and describe different engine concepts and their fuels and explain the difference between the concepts. They can analyze the engine concepts and evaluate them with regard to specific areas of application.

Content
- Introduction
- Principle of the internal combustion engine
- Characteristic parameters
- Components of the combustion engine
- Crank mechanism
- Fuels: Overview, properties
- reFuels and hydrogen: production, processes, potentials
- Conventional gasoline engine
- Conventional diesel engine
- Hydrogen engines
- Ammonia engines
- Methanol engines
- Diesel engines in HVO operation

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120 h
(for details see individual course)

M 7.31 Module: CO2-Neutral Combustion Engines and their Fuels II [M-MACH-107180]

Responsible: Prof. Dr. Thomas Koch
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-MACH-111560	CO2-Neutral Combustion Engines and their Fuels II	5 CR	Koch

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
The students can:

- Name, describe and explain boost systems
- Analyze engine maps
- Evaluate emissions and select suitable aftertreatment systems
- Explain the processes of transient operation and application
- Describe electrification and alternative drives

Content

- Boosting and air management
- Engine maps
- Exhaust emissions
- Exhaust gas aftertreatment
- Transient engine operation / Emission & application
- Application
- Electrification and alternative drives

Module grade calculation
The module grade is the grade of the oral exam.

Workload
150h
(for details see individual course)

M 7.32 Module: Cognitive Automobiles - Laboratory [M-MACH-106744]

Responsible: Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105378	Cognitive Automobiles - Laboratory	6 CR	Lauer, Stiller

Competence Certificate
see partial performance

Prerequisites
none

Competence Goal
After attending the course, participants will be familiar with modern technologies in the field of automated driving and will be able to use them independently. This includes techniques for recording the vehicle environment and vehicle control. Furthermore, students will be able to organize an automation project in a project team and carry it out independently.

Content
The course is designed as an interactive laboratory in which the participants independently develop a technical solution for the automation of a model vehicle. The work is carried out in small groups, which design and implement their technical solution together. At the end of the semester, the technical solution is evaluated as part of a race.

The technical tasks to be solved include

- the development of a camera-based environment detection system
- the development of behavior and trajectory planning
- the development of a vehicle control system

The development is carried out in the programming language C++ within the robot control environment ROS (robot operating system).

In addition to solving the technical tasks, each small group must also organize its project collaboration. This includes

- the development of a project plan
- structuring the collaboration within the group
- presenting the interim and final results
- developing a technical concept for solving the task at hand

At the beginning of the course, participants are taught basic knowledge of programming in C++, the robot control environment ROS, software version management and structured programming in software projects in several tutorials.

Module grade calculation
The module grade is the grade of the oral examination of the partial performance.

Annotation
The number of participants is limited to 20. If necessary, a selection procedure will be carried out. Places will be allocated according to prior knowledge. Details will be announced on the course homepage (ILIAS).

Workload
180 hours, of which

Attendance time during the presentations and meetings: 15 h

Follow-up of the content presented in the presentations: 15 h

Independent development of the contents of the lab in the form of research, programming, testing and creating presentations: 135 h

Exam preparation and presentation: 15 h

Recommendation
It is recommended to attend the courses Vehicle Vision or Behavior Generation for Vehicles before or at the same time. Programming skills in C++ are an advantage.

It is recommended to register early for the course.

M 7.33 Module: Combined Cycle Power Plants [M-MACH-107062]

Responsible: Prof. Dr.-Ing. Daniel Banuti
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-105444	Combined Cycle Power Plants	4 CR	Banuti, Schulenberg
T-MACH-105445	Simulator Exercises Combined Cycle Power Plants	2 CR	Banuti, Schulenberg

Competence Certificate
oral

Duration approx. 30 minutes

Prerequisites
We recommend to combine the lecture with the Simulator Exercises for Combined Cycle Power Plants (T-MACH-105445).

Competence Goal
On this basis, they can describe and analyze the specific behavior of the power plant components as well as the entire power plant in the grid. Participants in the lecture have a trained analytical thinking and judgment in power plant design.

Content
Layout of a combined cycle power plant, design and operation of gas turbines, of the heat recovery steam generator, of the feedwater system and cooling systems. Design and operation of steam turbines, of the generator and its electrical systems. System response to challinging grids, protection systems, water make-up and water chemistry. Design concepts of different power plant manufacturers, innovative power plant concepts.

Module grade calculation
see individual courses

Workload
180h
Attendance time. 60h
Self-study: 120h

M 7.34 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: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	English	4	1

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

Competence Certificate
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 7.35 Module: Communications Engineering Laboratory [M-ETIT-107136]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German/English	4	1

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

Competence Certificate
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.

Annotation
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

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

7.36 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: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	English	4	1

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

Competence Certificate
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

M 7.37 Module: Computational Fluid Dynamics (CFD) for Energy Technologies [M-MACH-107157]

Responsible: Dr. Ivan Otic
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-114187	CFD for Power Engineering	4 CR	Otic

Competence Certificate
Exam is oral (approx. 30 min)

Prerequisites
none

Competence Goal
At the completion of this course, students
- are able to understand fundamentals of non-linear partial differential equations.
- get working knowledge of computational techniques that can be used for solving engineering heat and mass transfer problems
- are able to understand fundamentals of statistical fluid mechanics and to derive RANS transport equations
- have learned how to computationally solve turbulent heat and mass transfer problems using Open-FOAM software
- are able to present their results in form of technical report.

Content
CFD Project:
- Part of this class is performing CFD simulations of turbulent heat and mass transfer using opensource CFD software OpenFOAM.
- After CFD analysis is completed students have to write a technical report.
- Projects are to be performed individually or in teams, but every student writes his own technical report.
- The technical report is part of the final examination.

Module grade calculation
The module grade is the grade of the oral examination.

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

7.38 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: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

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

Competence Certificate
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.

Learning type
Lecture

M 7.39 Module: Continuum Mechanics [M-MACH-105180]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Prof. Dr.-Ing. Bettina Frohnapfel

Organisation:

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-110377	Continuum Mechanics of Solids and Fluids	4 CR	Böhlke, Frohnapfel
T-MACH-110333	Tutorial Continuum Mechanics of Solids and Fluids	1 CR	Böhlke, Frohnapfel

Competence Certificate
written exam, 90 min. The tutorials T-MACH-110333 are prerequisites to the exam.

Prerequisites
none

Competence Goal
After having finished this module the students can list principles of continuum mechanics of solids and fluids. They can apply methods of tensor calculus and analysis in the framework of Continuum Mechanics for concrete examples and name numerical concepts for solving problems in modelling solids and/or fluids. Moreover, the students are able to solve problems in modelling solids and/or fluids using commercial software codes.

Content
This module aims to teach students the theoretical and practical aspects of continuum mechanics of solids and liquids. At the beginning there is an introduction to tensor calculus and kinematics. Then the balance equations of mechanics and thermodynamics are treated. The module gives an overview of the material theory of solids and fluids. This also includes the field equations for solids and fluids. Beyond thermomechanical couplings, the module imparts knowledge in dimensional analysis.

Annotation
none

Workload
1. Attendance lecture and tutorials: 15 * 2 h + 15* 2 h = 60 h
2. Preparation and recap of lecture and tutorials: 15 * 3 h = 45 h
3. Exam preparation and presence during exam: 45 h

Recommendation
none

Learning type
Lecture, tutorial, consultation hours

Literature
see containded bricks

7.40 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:
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

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

Competence Certificate
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)

Recommendation
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.

M 7.41 Module: Control of Mobile Machines [M-MACH-106468]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-MACH-111820	Control of Mobile Machines – Prerequisites	0 CR	Becker, Geimer
T-MACH-111821	Control of Mobile Machines	4 CR	Becker, Geimer

Competence Certificate
oral exam

Prerequisites
Programming skills

Competence Goal
Students learn the theoretical principles of data communication and the architecture of control systems in mobile machinery. They will also be able to identify influences and general conditions in use and derive practical and legal requirements for sensors and control systems. The students learn methods of machine learning for control and regulation tasks in mobile machines as well as their structure and the handling of training data. After participating in the exercise, they will be able to implement, train and validate a control system for a task.

Content

- Basics of sensors, controllers and control architectures in mobile machinery.
- Basics and functionalities of data communication in mobile machines (CAN-Bus, PROFIBUS, Ethernet, ...)
- Legal basis and general conditions (SIL level, ...)
- Requirements for sensors when used in mobile machines for different control tasks
  Introduction to machine learning methods and their application for the control of mobile machines
- Overview of current research and developments in the field of agricultural robotics
- Practical implementation of the lecture content by working on an assignment in the associated exercise.
- The results of the assignment will be summarized in a short report as a pre-requisite for the exam.

Module grade calculation
The module grade corresponds to the grade of the oral examination from T-MACH-111821 "Control of mobile machines".

Annotation
Basic knowledge of electrical engineering and computer science is recommended. First programming skills, preferably in Python, are necessary. The number of participants is limited, as hardware will be provided for the exercise. Prior registration is required, details will be announced on the web pages of the Institute of Vehicle Systems Engineering / Department of Mobile Machinery. In case of high registration numbers exceeding the capacities, a selection among all interested persons will take place according to qualification.

Workload
Attendance: 60h, Self-study: 60h

M 7.42 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: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	2

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

Prerequisites
none

7.43 Module: Control Technology [M-MACH-105348]

Responsible: Hon.-Prof. Dr. Christoph Gönnheimer
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105185	Control Technology	4 CR	Gönnheimer

Competence Certificate
Written Exam (60 min)

Prerequisites
None

Competence Goal
The students …

- are able to name the electrical controls which occur in the industrial environment and explain their function.
- can explain fundamental methods of signal processing. This involves in particular several coding methods, error protection methods and analog to digital conversion.
- are able to choose and to dimension control components, including sensors and actors, for an industrial application, particularly in the field of plant engineering and machine tools. Thereby, they can consider both, technical and economical issues.
- can describe the approach for projecting and writing software programs for a programmable logic control named Simatic S7 from Siemens. Thereby they can name several programming languages of the IEC 1131.

Content
The module control technology gives an integral overview of available control components within the field of industrial production systems.
The first part of the module deals with the fundamentals of signal processing and with control peripherals in the form of sensors and actors which are used in production systems for the detection and manipulation of process states.
The second part handles with the function of electric control systems in the production environment. The main focus in this chapter is laid on programmable logic controls, computerized numerical controls and robot controls. Finally the module ends with the topic of cross-linking and decentralization with the help of bus systems.
The module is very practice-oriented and illustrated with numerous examples from different branches.

The following topics will be covered:

- Signal processing
- Control peripherals
- Programmable logic controls
- Numerical controls
- Controls for industrial robots
- Distributed control systems
- Field bus
- Trends in the area of control technology

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

Learning type
Lecture

M 7.44 Module: Control Theory Laboratory [M-ETIT-105467]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-ETIT-111009	Control Theory Laboratory	6 CR	Hohmann

Prerequisites
None

M 7.45 Module: Current Topics on BioMEMS [M-MACH-105485]

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

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German/English	4	1

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

Competence Certificate
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

Learning type
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 7.46 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: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

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

Competence Certificate
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

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

Responsible: apl. Prof. Dr. Ralf Mikut
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	German	4	1

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

Competence Certificate
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.

Learning type
Lecture

7.48 Module: Data-Driven Algorithms in Vehicle Technology [M-MACH-107151]

Responsible: Dr.-Ing. Martin Gießler
Dr.-Ing. Stefan Scheubner

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-112126	Data-Driven Algorithms in Vehicle Technology	4 CR	Scheubner

Competence Certificate
written exam, 90 min

Prerequisites
none

Competence Goal
Goal of the Course: Students have a basic understanding of data-driven algorithms such as Markov Models, Machine Learning or Monte-Carlo Methods. The approach for building data-driven models in automobile technology are known to students and they are able to test algorithms in the programming language “Python”. Furthermore, students have learnt how to analyse the algorithm performance.

Content
Course Syllabus:
Motivation for the Course: Nowadays, engineers often develop technical systems using a
combination of hard- and software. This is true especially for modern passenger vehicle
development. In a digitalized world, such developments are built on knowledge gained from relevant data sources, e.g. the vehicle sensors. Therefore, engineers in automobile technology need qualifications from data science to successfully create new functionalities in the cars. To prevent remaining purely theoretical, the algorithms in this course are explained using a real-world problem of “EV Routing”. Students have the opportunity to test methods in Python with frequent exercises presented.

Content:
1. Introduction to function development as well as the prerequisites for the course (e.g.
Fundamentals for running Python code)
2. Fundamentals for EV Routing and relevant data sources
3. Parameter estimation and state classification algorithms to determine the current situation
of the vehicle
4. Learning methods for driver behaviour
5. Forecast algorithms to predict future energy consumption of an electric vehicle

Module grade calculation
see individual course

Workload
120h
(for details see individual course)

M 7.49 Module: Decision-Making and Motion Planning for Automated Driving [M-MACH-106926]

Responsible: Dr.-Ing. Maximilian Naumann
apl. Prof. Dr. Moritz Werling

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-113597	Decision-Making and Motion Planning for Automated Driving	6 CR	Naumann, Werling

Competence Certificate
Written exam, duration 60 minutes.

Prerequisites
None

Competence Goal
After successful completion of the course, students will be familiar with both foundational and modern methods in driver assistance, decision-making, and motion planning within the field of automated driving. They will learn how to develop intelligent systems capable of making safe and reliable real-time decisions. Participants will be able to analyze complex scenarios and driving environments and create algorithmic solutions based on their analyses. Additionally, they will gain the skills to theoretically analyze these methods, implement them in software, and apply them to current challenges in vehicle automation.

Content
Automated driving is rapidly evolving from basic assistance systems, like ABS and ESP, to advanced autonomous systems that will reshape how we interact with vehicles. The future of driving lies in the seamless integration of advanced technologies that take over tasks such as steering, braking, and acceleration, providing new standards of safety and comfort.

This course explores the exciting transition from driver support to full vehicle automation, focusing on how intelligent systems can make real-time decisions to ensure smooth, safe, and predictable driving even in complex, uncertain environments. Along the way, it introduces AI-driven techniques like reinforcement learning and imitation learning, which are key to enhancing decision-making capabilities. If you're passionate about cutting-edge automotive technology and want to understand how vehicles of tomorrow will think, plan, and navigate, this course will give you the tools to dive into the world of autonomous driving.

Workload
180 hours

Recommendation
Basic knowledge of control engineering and systems theory should be available from "Measurement and Control Systems" or from other lectures.

7.50 Module: Deep Learning and Neural Networks [M-INFO-107197]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114219	Deep Learning and Neural Networks	6 CR	Niehues

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students will learn about the structure and function of different types of neural networks.

Students should learn the methods for training the various networks and their application to problems.

Students should learn the areas of application of the different types of networks.

Given a concrete scenario, students should be able to select the appropriate type of neural network.

Content
This module introduces the use of neural networks for the solution of solving various problems in the field of machine learning, such as classification, prediction, control or inference. or inference. Different types of neural networks are covered and their areas of application are illustrated using examples.

Workload
180h.

Recommendation
Prior successful completion of the core module "Cognitive Systems" is recommended.

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

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German/English	4	1

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

Annotation
The course is partially given in German and English.

M 7.52 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	German/English	4	3

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

M 7.53 Module: Deep Learning for Engineers [M-MACH-107088]

Responsible: Prof. Dr.-Ing. Christoph Stiller
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-113882	Deep Learning for Engineers	6 CR	Stiller

Competence Certificate
written exam

60 min

Prerequisites
none

Competence Goal
Students are able to

• explain fundamentals of deep neural networks

• outline and to explain alternative architectures for deep neural networks

• explain training methods and their properties

• design, train and apply deep neural networks for basic engineering problems like machine vision, automotive control and robotics

• transfer this knowledge to other domains of applications

Content

- Introduction
- Multi-Layer Perceptrons
- Convolutional Neural Networks
- Backpropagation
- Uncertainties in Neural Networks
- Graph Neural Networks
- Transformers Reinforcement Learning
- Applications

Module grade calculation
see individual course

Workload
In total 180h:

Attendance time. 45h
Self-study: 135h

Literature
available in ILIAS

M 7.54 Module: Design and Development of Mobile Machines [M-MACH-107055]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-105311	Design and Development of Mobile Machines	4 CR	Geimer
T-MACH-108887	Design and Development of Mobile Machines - Advance	0 CR	Geimer, Siebert

Competence Certificate
The assessment consists of an oral exam (20 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date (T-MACH-105311).

A registration is mandatory, the details will be announced on the webpages of the *Institute of Vehicle System Technology / Institute of Mobile Machines.* In case of too many applications, attendance will be granted based on pre-qualification.

The course will be replenished by interestung lectures of professionals from leading hydraulic companies.

The prerequisite for the oral examination is the preparation of a semester report (T-MACH-108887).

Prerequisites
none

Content
Wheel loaders and excavators are highly specialized mobile machines. Their function is to detach, pick up and deposit materials near by. Significant size for dimensioning of the machines is the content of their standard shovel. In this lecture the main steps in dimensioning a wheel loader or excavator are beeing thought. This includes among others:

- Defining the size and dimensions,
- the dimensioning of the electric drive train,
- the dimensioning of the primary energy supply,
- Determining the kinematics of the equipment,
- the dimension of the working hydraulics and
- Calculations of strength

The entire design process of these machines is strongly influenced by the use of standards and guidelines (ISO/DIN-EN). Even this aspect is dealt with.

The lecture is based on the knowledge from the fields of mechanics, strength of materials, machine elements, propulsion and fluid technique. The lecture requires active participation and continued collaboration.

Module grade calculation
see individual course

Workload

- Attendance time: 21 hours
- Self-study: 99 hours

Recommendation
Knowledge in Fluid Power Systems (LV 2114093)

M 7.55 Module: Design and Optimization of Conventional and Electrified Automotive Transmissions [M-MACH-107082]

Responsible: Dr.-Ing. Hartmut Faust
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-110958	Design and Optimization of Conventional and Electrified Automotive Transmissions	4 CR	Faust

Competence Certificate
See individual course

Prerequisites
None

Competence Goal
Students acquire knowledge from current transmission, hybrid and pure electric drive developments about ...

- the functionality and design of conventional and electrified vehicle transmissions and their components
- design and functional principles of the most important components of manual, dual-clutch, continuously variable and planetary automatic transmissions
- Comfort-relevant correlations and remedial measures
- the hybridization and electrification of drivetrains on the basis of known transmission types and with special so-called Dedicated Hybrid Transmissions (DHT) as well as evaluation of the concepts at system level.

Content

- Transmission types: Manual (MT) & automated manual transmissions (AMT), planetary torque converter automatics (AT), dual clutch (DCT), continuously variable (CVT) and shared neutral transmissions (IVT), hybrid transmissions (serial, parallel, multimode, powersplit hybrids), e-axles
- Torsional vibration damper: Damped clutch disk, dual-mass flywheel, centrifugal pendulum-type absorber (FKP), lock-up damper for torque converters
- Starting elements: Dry single clutch, dry and wet double clutch, hydrodynamic torque converter, special forms, e-motorized
- Power transmission: Countershaft gearbox, planetary set, variator, synchronization, clutches, differentials, integration of electric motors
- Transmission control: actuators, hydraulic control, electronic control (TCU)
- Software application for tuning comfort & sportiness & for hybrid functionality
- Special designs: Drivetrains of commercial vehicles, hydrostat with power split, torque vectoring
- E-mobility:
    - 5 expansion stages of electrification, 4 hybrid configurations, 7 parallel hybrid architectures
    - Hybridized transmissions (P2, P2.5, P3, P4), Dedicated Hybrid Transmission (DHT; serial/parallel/multimode, power split, new concepts)
    - E-axle transmissions for pure electric vehicles (EV)

Module grade calculation
The module grade corresponds to the grade from the individual course.

Annotation
None

Workload
Attendance: 30h

Self-study: 90h

Recommendation
None

Learning type
Lecture

Literature
None

Base for
None

M 7.56 Module: Design of Electrical Machines [M-ETIT-100515]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	German	4	2

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

Prerequisites
none

Recommendation
Modul: Elektrische Maschinen und Stromrichter

M 7.57 Module: Design with Plastics [M-MACH-102712]

Responsible: Dipl.-Ing. Markus Liedel
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105330	Design with Plastics	4 CR	Liedel

Competence Certificate
Oral exam, about 20 minutes

Prerequisites
none

Competence Goal
Students will be able to
• distinguish polymer compounds from other construction materials regarding chemical differences, thermal behaviour and solid conditions.
• discuss main plastics processes regarding advantages and disadvantages of materials selection and part geometry design and to make appropiate selections.
• analyze complex application requirements concerning material impacts on strength and to use the classic dimensioning method specific to the application to evalute the lifetime part strength limit.
• evaluate part tolerances and geometry by appropiate methods considering molding shrinkage, production tolerances, post shrinkage, heat expansion, swelling, elastic and creep deformation.
• design plastic specific joining geometries like snap fits, screw bosses, weld seams and film hinges.
• detect classic molding failures and understand potential causes as well as to reduce the probability of molding failures by defining an optimized design.
• understand benefits and limits of selected simulation tools in the plastic technology discipline (strength, deformation, filling, warpage).
• assess polymer classes and plastic part designs with respect to suitable recycling concepts and ecological consequences.

Content
In module Design with Plastics, students learn the structure and properties of plastics, their processing process and their behaviour under environmental conditions. In addition, they deal with aspects of dimensioning in regard to strength and geometry, discuss design guidelines which are suitable for plastics and see several examples. Furthermore, basics regarding the joining of plastic components, structural foams, supporting simulation tools and trends in plastic technology are shown.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
The workload for the lecture “Design with Plastics” is 120 h per semester and consists of the presence during the lectures (21 h), preparation and rework time at home (50 h) and preparation time for the oral exam (49 h).

Recommendation
Polymerengineering I

Learning type
Lectures (Obligatory)

M 7.58 Module: Development of Automated Production Systems [M-MACH-107020]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-113999	Seminar Development of Automated Production Systems	4 CR	Fleischer

Competence Certificate
Alternative test achievement (graded):

- Presentation of the results (approx. 20 min) followed by a colloquium (approx. 15 min) with weighting 25%
- Written processing of the results with weighting 75%

Competence Goal
The students...

- are able to name and describe the automation tasks in production plants and the components required for implementation.
- understand the challenges that can arise when using automation solutions in production.
- are able to independently analyse a practical problem in production with regard to the application of automation.
- are able to assess the results of automation problems and, based on this, develop and apply practical solutions.

Content
The course ‘Development of Automated Production Systems’ aims at the practical project planning of automated production systems based on realistic industrial use cases. The content framework of the course results from the holistic, practical project planning task of an automated production plant. Firstly, the basics of production automation are taught as an introduction. The aspects of multi-machine systems and project planning are then examined in depth. An interdisciplinary approach to these sub-areas results in interfaces to Industry 4.0 approaches. The core of the course is the project planning of a use case based on the procedure taught. In doing so, the students should apply the methods taught in a problem-related and results-orientated manner and thus develop an automation solution.

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

7.59 Module: Development of Hybrid Powertrains [M-MACH-107078]

Responsible: Prof. Dr. Martin Doppelbauer
Prof. Dr. Thomas Koch

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-110817	Development of Hybrid Drivetrains	4 CR	Koch

Competence Certificate
oral exam, approx. 20 min.

Competence Goal
Students will be able to name and describe alternative drive concepts. They can explain the basics of hybridization. They can name and describe electrical components and explain how they work. They can analyse interactions between the components of the drivetrain and evaluate them in relation to system optimization.

Content

1. Introduction and Goal
2. Alternative Powertrains
3. Fundamentals of Hybrid Powertrains
4. Fundamentals of Electric Components of Hybrid Powertrains
5. Interactions in Hybrid Powertrain Development
6. Overall System Optimization

Module grade calculation
see individual course

Workload
120 h
(for details see individual course)

7.60 Module: Development of Oil-Hydraulic Powertrain Systems [M-MACH-107059]

Responsible: Hon.-Prof. Dr. Gerhard Ruben Geerling
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105441	Development of Oil-Hydraulic Powertrain Systems	4 CR	Geerling, Geimer

Competence Certificate
oral exam (approx. 20 min)

Prerequisites
none

Competence Goal
*After completing this part of the course, students will be able to evaluate how oil-hydraulic **drive** and **control systems** (Drive & Control of Fluid Power Systems) can be used sensibly and which **system architectures** are better and less suitable for a given problem.*

*They can create a **hydraulic circuit diagram** for a given task and can carry out calculations for the overall **system design** as well as sub-modules and machine elements and solve them on the basis of **model approaches**.*

*You will acquire in-depth knowledge of how an **oil hydraulic system** can be **planned** and **developed** holistically and iteratively in **product development processes (PEP)** using **project management approaches**.*

*In addition, you will be able to **set up** and **commission** the first simple oil hydraulic drive and circuit architectures and **measure** the **main status parameters** in a **practical laboratory exercise** at KIT/FAST/MOBIMA.*

Content
The block course offered by the Chair of Mobile Machinery (Mobima) teaches the basics of project planning and the development of mobile and stationary hydrostatic systems. The lecturer comes from a market-leading company in the field of fluid drive and control technology and provides in-depth insights into the project planning and development process of hydrostatic systems using practical examples. The contents of the lecture are:

- Marketing, planning, project planning
- Circuit types, oil hydrostatics, heat balance, hydraulic accumulators
- Filtration, noise reduction
- Design exercises, practical laboratory

Module grade calculation
see individual course

Annotation
Knowledge of fluid technology advantageous

Workload
120h
Attendance time: 20 hours
Self-study: 100 hours

Recommendation
Knowledge of fluid technology

7.61 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

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

Competence Certificate
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

Recommendation
Basics of signal processing and radar techniques are useful.

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

Responsible: Prof. Dr. Ivan Peric
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

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

Annotation
Will be changed to English in summer term 25.

7.63 Module: Digital Control [M-MACH-107045]

Responsible: Prof. Dr.-Ing. Michael Knoop
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105317	Digital Control	4 CR	Knoop

Competence Certificate
written exam

1 h

Prerequisites
none

Competence Goal
The lecture intoduces key methods for the analysis and design of digital feedback control systems. Starting point is the discretisation of linear, continuous-time models. State space based and z-transform based controller design techniques are presented for discrete-time, single-input single-output systems. Furthermore, plants with dead-time and deadbeat design are covered.

Content
1. Introduction into digital control:

Motivation for digital implementation of controllers Structure of digital feedback control loops Sample and hold units

2. State space analysis and design:

Discretisation of continuous-time systems Discrete-time state space equations

Stability - definition and criteria State feedback design by eigenvalue assignment PL state feedback controller Luenberger observer, separation theorem Systems with dead-time Deadbeat design

3. Analysis and design based on z-transform: z-transform - definition and theorems

Control loop description in the z domain

Stability criteria Root locus controller design Transfer of continuous-time controllers into discrete time controllers

Module grade calculation
see individual course

Workload
120h

Learning type
Lecture

Literature
Lunze, J.: Regelungstechnik 2, 9. Auflage, Springer Verlag, Berlin Heidelberg 2016.

Unbehauen, H.: Regelungstechnik, Band 2: Zustandsregelungen, digitale und nichtlineare Regelsysteme, 8. Auflage, Vieweg Verlag, Braunschweig 2000

Föllinger, O.: Lineare Abtastsysteme. 4. Auflage, R. Oldenbourg Verlag, München Wien 1990

Ogata, K.: Discrete-Time Control Systems. 2nd edition, Prentice-Hall, Englewood Cliffs 1994

Ackermann, J.: Abtastregelungen, Band I, Analyse und Synthese. 3. Auflage, Springer Verlag, Berlin Heidelberg 1988

7.64 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 Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

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

Competence Certificate
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 Conditions
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.).

Annotation
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).

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

M 7.65 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 Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	1

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

Prerequisites
none

Modeled Conditions
The following conditions have to be fulfilled:

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

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

Responsible: Prof. Dr.-Ing. Mike Barth

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-112224	Digital Twin Engineering	4 CR	

Competence Certificate
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

7.67 Module: Digitalization of Products, Services & Production [M-MACH-105476]

Responsible: Dr.-Ing. Bernd Pätzold
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-108491	Digitalization of Products, Services & Production	4 CR	Pätzold

Competence Certificate
Alternative exam assessment.
Two presentations in team work and two written compositions.

Prerequisites
None

Competence Goal
Students are able to

- describe the fundamental challenges and objectives of the progressive digitalization of products, service and production. In context of these challenges, students can name and explain the essential terms.
- illustrate the key drivers and fundamental technologies behind the digitalization of products, services and processes.
- describe the challenges of the ongoing digitalization and the corresponding changes in business processes and distinguish between them in regards to time and place. Furthermore, students are able to assign the IT-Architecture and systems to the corresponding process steps.
- highlight the requirement for future information management in networks of product development and production institutions and can clarify how to validated and safeguard the corresponding IT processes.
- to analyze the challenges of digitalization and present potential solution approaches via self-created scenarios for future developments.

Content

- Digitalization of products, services and production in the context of Industry 4.0 .
- Key drivers for ongoing digitalization and their impact on future product development and manufacturing.
- Methods and procedures to design the according transformation process.
- Intensive group discussions of use-case scenarios using practical examples from the industry.

Workload
120 hour

Learning type
Seminar

M 7.68 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: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

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

Prerequisites
none

M 7.69 Module: Drive System Engineering B: Stationary Machinery [M-MACH-107190]

Responsible: Sascha Ott
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

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

Competence Certificate
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.

Annotation
None

Workload
Attendance: 30h

Self-study: 90h

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

Learning type
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 7.70 Module: Drive Train of Mobile Machines [M-MACH-105800]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	2 terms	German	4	1

Mandatory			
T-MACH-105307	Drive Train of Mobile Machines	4 CR	Geimer

Competence Certificate
The final assessment will be an oral examination (appr. 20 min) taking place during the recess period. The examination will be offered in ervery semester and can be repeated at any regular examination date.

Prerequisites
None

Competence Goal
At the end of the lecture, participants can explain the structure and function of all discussed drive trains of mobile machines. They can analyze complex gearbox schematics and synthesize simple transmission functions using rough calculations.

Content
In this course the different drive trains of mobile machinery will be discussed.

The focus of this course is:

- mechanical gears
- torque converter
- hydrostatic drives
- power split drives
- electrical drives
- hybrid drives
- axles
- terra mechanics

Workload
120 h

Learning type
Lecture

Literature
Literature: Download of lecture slides from ILIAS. Further literature recommendations during lectures.

M 7.71 Module: Dynamics of Electro-Mechanical Systems [M-MACH-105612]

Responsible: Prof. Dr.-Ing. Alexander Fidlin
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-111260	Dynamics of Electro-Mechanical Systems	5 CR	Altoé, Fidlin

Competence Certificate
Written examination, 120 minutes

Prerequisites
None

Competence Goal
The students are able to describe the dynamical behaviour of electro-mechanical systems using uniform mathematical approach. They are able to analyse interactions between mechanical and electro-mechanical subsystems. They are familiar with the essential retroactive effects, are able to identify them and calculate their impact. The students become acquainted with the basic non-linear effects in the coupled electro-mechanical systems and are able to analyse them by means of appropriate simulation tools.

Content
The lecture conveys two kinds of describing electro-mechanical systems. The first one (described shortly) is based on state and flow variables, the second one (which is in focus of the course) is based on an energetic description and the Lagrange-Maxwell-Formalism. These methods are then applied in order to analyse the most important electro-mechanical systems. These include

- Dynamics of electro-mechanical converter and vibration exciters taking into account the load in resonance operation
- Dynamics of electrical machines taking into account the rotordynamic effects (imbalance, loss of stability, passage through resonance)
- Dynamics of piezo-electrical converters in sensor and actor operation

Learning type
Lecture and Tutorial

Literature
J. H. Williams: Fundamentals of Applied Dynamics, MIT Press, 2019

M 7.72 Module: Dynamics of the Automotive Drive Train [M-MACH-102700]

Responsible: Prof. Dr.-Ing. Alexander Fidlin
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-105226	Dynamics of the Automotive Drive Train	4 CR	Fidlin

Competence Certificate
A performance assessment is an oral exam (approx. 30 minutes).

Prerequisites
none

Competence Goal
After having attended this lecture students will be able to understand typical vibration phenomena in a vehicle powertrain and to simulate the essential components of the vehicle powertrain including components of the engine steering. The method of the simulation-based concept choice and the necessary interaction between OEMs and the delivering industry is part of the taught knowledge. The students will also gain experience in the application of numerical simulation methods for solving practical problems of torsion vibrations in highly non-linear systems.

Content
Lectures: The concept of a simulation- based optimization of the vehicle powertrain and its components. Modelling of the components of the power system including internal-combustion engine, torsional vibration damper (two mass flywheel, centrifugal force pendulum, internal damper/torsion damped clutch disc), hydrodynamical transformer, gear, Kardan wave, differential, wheels, driving manoeuvre and its appraisal incl. start, neutral gear, approach, acceleration drive, load alteration, gear alteration, shearing force, stop, and different special manoeuvres like change of intentions or misuse.

Exercise: Elementary numerical proceedings to simulate nonlinear dynamic systems. Modelling of the powertrain in a simulation environment SimulationX or MapleSim.

Workload
Each credit point is equivalent to 25-30 hours of workload (per student). This refers to an average student who shows an average performance. The workload is as follows:

- time of attendance lectures: 30 h
- time of attendance exercise: 30h
- self-study including exam preparation: 60

total 120 h - 4 credit points

Recommendation
Basic knowledge of the powertrain technology and elementary vibration knowledge are advantageous. The lectures refer to the book

H. Dresig, A. Fidlin: Schwingungen Mechanischer Antriebssysteme, 4. Auflage, Springer: Berlin - Heidelberg - New York, 2020, 655 S., ISBN: 978-3-662-59137-6

Especially chapter 6 and 7 are recommended.

Literature

- Dresig H. Schwingungen mechanischer Antriebssysteme, 2. Auflage, Springer, 2006
- Pfeiffer F., Mechanical System Dynamics, Springer, 2008
- Laschet A., Simulation von Antriebssystemen:Modellbildung der Schwingungssysteme und Beispiele aus der Antriebstechnik, Springer, 1988

7.73 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: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German/English	4	1

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

Competence Certificate
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

Recommendation

The courses

- Regelung elektrischer Antriebe und
- Leistungselektronik

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

7.74 Module: Electric Drives for E-Mobility [M-ETIT-106971]

Responsible: Prof. Dr. Martin Doppelbauer

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113936	Electric Drives for E-Mobility	4 CR	Doppelbauer

Competence Certificate
The success control takes place in the form of an oral examination of approximately 30 minutes.

Prerequisites
none

Competence Goal
The students will be able to assess the structure, performance and behavior of full-electric and hybrid drive systems for all types of traction applications from pedelecs to cars, utility vehicles, railroads and even large propulsion systems in ships. They can critically evaluate the different drive systems and components.

The students will be able to understand the latest developments in electric drive technology and future possibilities.

Content
This module is designed to provide students with the theoretical and practical aspects of electric drives for electric traction applications.

Table of content:

- Overview: Electric Drives in Hybrid and Electric Vehicles
- Fundamentals of Rotary Field Machines
- Fundamentals of Power Electronics
- Design of Synchronous Machines
- Design of Induction Machines
- Noise, Vibration and Harshness (NVH)
- Thermodynamics of Electric Machines

Module grade calculation
The module grade is the grade of the oral exam.

Workload
The workload includes (3 SWS):

1. attendance in lectures 15*2 h = 30 h
2. Attendance in exercises: 15*1 h = 15 h
3. preparation / follow-up: 15*3 h = 45 h
4. preparation of and attendance in examination: 30 h

   A total of 120 h

Recommendation
Basic knowledge in the field of electric machines and drives is helpful, for example by attending the course “Elektrische Maschinen und Stromrichter (EMS)” in the KIT-Bachelor.

Basic knowledge in the field of hybrid and electric vehicles is helpful, for example by attending the course “Hybridelektrische Fahrzeuge HEF)” in the KIT-Bachelor.

M 7.75 Module: Electric Power Transmission & Grid Control [M-ETIT-105394]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-110883	Electric Power Transmission & Grid Control	6 CR	Leibfried

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

Prerequisites
none

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-ETIT-105394 - Electric Power Transmission & Grid Control must not have been started.

Competence Goal
Students are familiar with the functionality and physical basics as well as the components of AC and DC of electric power transmission systems. They will be able to calculate transmission characteristics and carry out a basic design. They are also familiar with the functioning of grid control.

Content
The lecture initially deals with the characteristics and stability of electrical energy transmission. A central chapter deals with HVDC technology as a method for transmitting high power. FACTS elements, which are used to make energy transmission more flexible, are then dealt with. Finally, the dynamics of power plants and grids are discussed.

Module grade calculation
The module grade is the grade of the written exam.

Workload
The workload includes:

1. attendance in lectures and exercises: 30 + 30 h = 60 h
2. preparation / follow-up: 120 h

A total of 180 h = 6 CR

Recommendation

- Basic Knowledge in electrical network analysis
- Basic Knowledge about the functionality of electric grid components
- Basic Knowledge about the calculations of three-phase systems
- Basic Knowledge about symmetrical components, Park-transform and Clark-transform

7.76 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 Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German/English	4	1

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

Competence Certificate
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.

Annotation
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

7.77 Module: Electrocatalysis [M-ETIT-105883]

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

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	English	4	3

Mandatory			
T-ETIT-111831	Electrocatalysis	5 CR	Röse

Competence Certificate
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

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

7.78 Module: Elements of Technical Logistics [M-MACH-102688]

Responsible: Dr.-Ing. Martin Mittwollen
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-102159	Elements and Systems of Technical Logistics	4 CR	Fischer, Mittwollen

Competence Certificate
The assessment consists of an oral examination (approx. 20min) .

Prerequisites
none

Competence Goal
Students are able to:

- Describe elements and systems of technical logistics,
- Model and calculate structures and functions of special conveying machines,
- Describe interdependence of material flow systems and technique quantitatively and qualitatively and
- Equip material flow systems with appropriate machines.

Content
material flow systems and their (conveying) technical components

mechanical behaviour of conveyors;

structure and function of conveyor machines; elements of intralogistics (belt conveyor, racks, automatic guided vehicles, fan-in, bifurcation, and etc.)

sample applications and calculations in addition to the lectures inside practical lectures

Workload
Lecture and exercise: 4 LP = 120 h

1. Attendance time lecture: 28 h
2. Preparation/follow-up lecture: 56 h
3. Attendance time exercise: 12 h
4. Preparation/follow-up exercise: 24 h

M 7.79 Module: Elements of Technical Logistics incl. Project [M-MACH-105015]

Responsible: Dr.-Ing. Martin Mittwollen
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-102159	Elements and Systems of Technical Logistics	4 CR	Fischer, Mittwollen
T-MACH-108946	Elements and Systems of Technical Logistics - Project	2 CR	Fischer, Mittwollen

Competence Certificate
The assessment consists of an oral exam (20min) and presentation of performed project and defense (approx. 30min)

Prerequisites
none

Competence Goal
Students are able to:

- Describe elements and systems of technical logistics,
- Model and calculate structures and functions of special conveying machines,
- Describe interdependence of material flow systems and technique quantitatively and qualitatively and
- Equip material flow systems with appropriate machines.

Content
material flow systems and their (conveying) technical components

mechanical behaviour of conveyors;

structure and function of conveyor machines; elements of intralogistics (belt conveyor, racks, automatic guided vehicles, fan-in, bifurcation, and etc.)

sample applications and calculations in addition to the lectures inside practical lectures

Workload
Lecture and exercise: 6 LP = 180 h

1. Attendance time lecture: 28 h
2. Preparation/follow-up lecture: 56 h
3. Attendance time exercise: 12 h
4. Preparation/follow-up exercise: 24 h
5. Attendance time project: 4 h
6. Preparation/follow-up project: 56 h

Learning type
Lecture, tutorial, project

M 7.80 Module: Energy Storage and Network Integration [M-ETIT-101969]

Responsible: Prof. Dr.-Ing. Giovanni De Carne
apl. Prof. Dr. Francesco Grilli
Prof. Dr.-Ing. Mathias Noe

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-104644	Energy Storage and Network Integration	4 CR	Noe

Competence Certificate
Type of Examination: Oral exam

Duration of Examination: approx. 30 minutes

Prerequisites
see course (Teilleistung)

Competence Goal
Students understand the different types of energy storage and apply their knowledge for the selection and principal dimensioning of relevant energy storage tasks.

Furthermore, students can reflect the state-of-the-art of most important energy storage types, their fundamental characteristics and viability at given boundary conditions; they are enabled to elaborate and apply basic integration issues dependent on the grid structure for the different network types.

Practical work: The students are able to analyse real applications of energy storage and calculate basic design examples for the various storage options.

The students are able to discuss topic-related aspects in English using the technical terminology of the field of study.

Content
The lecture provides an overview of the different storage types and their fundamental integration into the power supply grid.

Thereby, within the scope of this lecture, the necessity and the motivation for converting and storing energy will be given. Starting from the definition of fundamental terms different physical and chemical storage types along with their theoretical and practical basis are described. In particular, the decoupling of energy production and energy consumption, and the provision of different energy scales (time, power, density) will be discussed. Furthermore, the challenge of energy transport and re-integration into the different grid types is considered.

1. Motivation for the need of energy storage in energy systems

a. National and international situation

b. Storage motivation

2. Terms and definitions

a. Different energy types

b. Definitions energy content

c. Definitions energy- and power density

3. Thermal energy storage

a. Classification

b. Sensitive heat storage

c. Latent heat storage

d. Reaction heat storage

4. Mechanical energy storage

a. Flywheels

b. Compressed air

c. Pumpes storage systems

5. Electrodynamic energy storage

a. Main principles

b. Capacitive and inductive storage

6. Electrochemical energy storage

a. Working principles

b. Batteries

c. Fuel Cells

7. Electric Power Systems

a. Storage tasks

b. Storage íntegration

c. Planning reserves

The obligatory **practical work** (23689) is related to real applications of energy storage and to basic design examples for the various storage options.

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

Course material will be available on ILIAS. The link to ILIAS and Up-to-date information will be available via the ITEP-homepage prior to the beginning of the semester (https://www.itep.kit.edu/148.php).

Module grade calculation
The module grade is the grade of the oral exam.

Annotation
Exam and Lecture will be held in English.

Workload
Approximately 120h workload of the student. The workload includes:

45h - attendance in lectures an exercises

45h - preparation / follow-up

30h - preparation of and attandance in examination

Recommendation
Basic knowledge in the fields of Electrical Engineering and Thermodynamics is helpful.

M 7.81 Module: Energy Systems I - Renewable Energy [M-MACH-107139]

Responsible: apl. Prof. Dr. Ron Dagan
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German/English	4	1

Mandatory			
T-MACH-105408	Energy Systems I: Renewable Energy	4 CR	Dagan

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
The student knows the principles of the feasibility of energy gain by means of renewable energies, in particular the solar energy.

Content
The course deals with fundamental aspects of renewable energies.

1. The first part deals with the basic concepts of absorbing solar beans, in an efficient manner accounting for the minimization of heat losses. In this context, selective topics on thermodynamics as well as fluid dynamics are introduced. In the second part few applications are discussed and optimizations techniques of solar collectors construction and their heat transfer are presented.
2. The use of solar energy as a source for heat generation is followed by the idea of electricity generation. Introductive aspects of Photovoltaic technologies are illuminated.
3. The last part presents additional regenerative energy sources such as wind and geothermal energy.

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h
(for details see individual course)

M 7.82 Module: Energy Topology and Resilience [M-MACH-107061]

Responsible: Dr. Sadeeb Simon Ottenburger
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-112755	Energy Topology and Resilience	4 CR	Ottenburger

Competence Certificate
Oral

Duration approx. 30 minutes

Prerequisites
No auxiliary meand

Competence Goal
After successful completion, students are able to distinguish resilience from other concepts such as sustainability and reliability, as well as to design initial approaches to graph-based resilience analysis for application in the planning of energy networks.

Content
After an introduction to resilience research, this lecture addresses current questions on the impact of utility grid design on supply security from a mathematical-physical perspective in the context of the energy transition and smart grids. With the addition of socio-economic constraints, solution approaches lead to hard optimization problems, since there are, e.g., many degrees of freedom in spatial-topological planning in addition to questions about the grid-intrinsic design. Resilience metrics are derived from an analytical understanding on systemic vulnerability and on systemic risks related to utility networks, which are then used in the formulation of optimization problems to identify resilient and techno-economically feasible utility networks.

Module grade calculation
see individual course

Workload
120h
(for details see individual course)

M 7.83 Module: Engine Measurement Techniques [M-MACH-107160]

Responsible: Dr.-Ing. Sören Bernhardt
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105169	Engine Measurement Techniques	4 CR	Bernhardt

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
- Understand and explain the basic structure of a combustion engine test. Name important parameters that influence the test.

- Understand and be able to explain measured variables and measurement principles for the physical phenomena of temperature, pressure, humidity, flow, torque and speed.

- Select the sensors suitable for a measurement task for a task with real-life relevance. Take into account the practical experience gained.

- Evaluate the usefulness of a measurement chain, especially with regard to the measurement accuracy of individual components and the measurement results.

Content
- System boundaries
- Test stand design
- Measuring principle bridge circuit
- Measured variables and measuring principles
  - Torque
  - rotational speed
  - Temperature
  - humidity
  - pressure
  - Flow rate
- Calculated variables

Module grade calculation
see individual course

Workload
120h
(for details see individual course)

7.84 Module: Engineering Materials for the Energy Transition [M-MACH-107066]

Responsible: Prof. Dr. Hans Jürgen Seifert
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-112691	Engineering Materials for the Energy Transition	4 CR	Seifert

Competence Certificate
The assessment consists of an oral exam (about 30 minutes).

Prerequisites
none

Competence Goal
The students will be enabled to evaluate the physical and chemical properties of engineering materials and their (potential) applications in technical systems relevant for the Energy Transition. They can quantitively describe the functional behavior of the materials used for energy storage and conversion. The students are qualified for rational selection of materials to be used for specific applications in the field of interest.

Content
The success of the Energy Transition in Germany and worldwide requires the design and construction of innovative technical facilities in the sectors e.g. Electricity, Transportation and Heating. This concerns the exploitation of primary energy but also the energy conversion, storage and usage, respectively. By this means, a climate-neutral and sustainable energy supply is ensured. Groundbreaking modern engineering materials are an indispensable inherent part of the required technical innovation and value chains. This course first introduces the students into the fundamental physical terms and target values of engineering materials and systems related to the Energy Transition. Examples for new materials developments in areas of renewable energies (wind power, photovoltaics, concentrated solar power), lithium-ion and post-lithium batteries, supercapacitors and thermal storage systems. The essential materials properties are discussed and the resulting contributions to the development of energy engineering systems are introduced. The advantages and disadvantages of alternative materials solutions are discussed.

Module grade calculation
The module grade is equal to the grade of the oral exam.

Workload
The workload for the module is 120 h per semester and consists of the presence during the lectures (21 h) as well as self-study for the lecture (99 h).

Recommendation
Knowledge of Materials Science

Learning type
Lectures

Literature
Handbook of Energy Storage; M. Sterner, I. Stadler (eds.); Springer Vieweg (2019).

Energiespeicher, M. Sterner, I. Stadler (Editoren); 2. Auflage; Springer Vieweg (2017).

Elektrochemische Speicher, P. Kurzweil, O.K. Dietlmeier; 2. Auflage; Springer Vieweg (2018).

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

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

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German/English	4	1

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

Competence Certificate
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

Learning type
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 7.86 Module: Field Propagation and Coherence [M-ETIT-100566]

Responsible: Prof. Dr. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

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

Competence Certificate
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

Recommendation
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

M 7.87 Module: Flows and Heat Transfer in Energy Technology [M-MACH-107120]

Responsible: Dr. Aurelian Florin Badea
Prof. Dr.-Ing. Xu Cheng

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105403	Flows and Heat Transfer in Energy Technology	4 CR	Cheng

Competence Certificate
A performance assessment will consist of an oral examination of approx. 20 minutes.

Prerequisites
none

Competence Goal
The objective of the module is the understanding of major processes in fluid dynamics and heat transfer in energy engineering. Through this lecture the students are capable of understanding the important physical processes and the selection of suitable methods for the analysis of the processes. With the discussion of some practical examples, the students can analyze the pressure drop and heat transfer in energy engineering systems.

Content
1. collection of sample applications
2. heat transfer and its application
3. convective fl uid dynamics and heat transfer
4. thermal radiation and its application
5. special cases

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h
(for details see individual course)

M 7.88 Module: Fundamentals in the Development of Commercial Vehicles [M-MACH-105824]

Responsible: Christof Weber
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	2 terms	German	4	1

Mandatory			
T-MACH-111389	Fundamentals in the Development of Commercial Vehicles	4 CR	Weber

Competence Certificate
Oral exam; duration approximately 30 minutes

Prerequisites
None

Competence Goal
The students have proper knowledge about the process of commercial vehicle development starting from the concept and the underlying original idea to the real design. They are able to plan, to steer, and to hanle this process. They can apply their knowledge effectively in actual practise. They know that the customer requirements, the technical realisability, the functionality and the economy are important drivers.

They are able to develop parts and components. Furthermore they have knowledge about different cab concepts, the interior and the interior design process. Consequently they are ready to analyze and to judge concepts of commercial vehicles as well as to participate competently in the commercial vehicle development.

They know the advantages and disadvantages of different drives. Furthermore they are familiar with components, such as transfer box, propeller shaft, powered and non-powered frontaxle etc. Beside other mechanical components, such as chassis, axle suspension and braking system, also electric and electronic systems are known. Consequently the student are able to analyze and to judge the general concepts as well as to adjust them precisely with the area of application. They can apply their knowledge effectively in actual practise.

Content
The module provides an overview of:

1.1. Introduction, definitions, history

1.2. Development tools

1.3. Complete vehicle

1.4. Cab, bodyshell work

1.5. Cab, interior fitting

1.6. Alternative drive systems

1.7. Drive train

1.8. Drive system diesel engine

1.9. Intercooled diesel engines

2.1. Gear boxes of commercial vehicles

2.2. Intermediate elements of the drive train

2.3. Axle systems

2.4. Front axles and driving dynamics

2.5. Chassis and axle suspension

2.6. Braking System

2.7. Systems

2.8. Excursion

Workload

1. regular attendance lecture: 8 * 4 h = 32 h
2. pre and postprocessing lecture: 8 * 6 h = 48 h
3. examination preparation and presence in examnation: 40 h

In total: 120 h = 4 LP (2 semester)

Learning type

Tutorial

Literature

1. SPECKERT, M.; RUF, N.; DRESSLER, K.; MÜLLER, R.; WEBER, C.; WEIHE, S.: Ein neuer Ansatz zur Ermittlung von Erprobungslasten für sicherheitsrelevante Bauteile; Kaiserslautern: Fraunhofer ITWM, 2009, 27 pp.; Berichte des Fraunhofer ITWM, 177; ISSN: 1434-9973

2. SPECKERT, M.; DRESSLER, K.; RUF, N.; MÜLLER, R.; WEBER, C.: Customer Usage Profiles, Strength Requirements and Test Schedules in Truck Engineering, in: Schindler, C. et al. (Eds.): Proceedings of the 1st Commercial Vehicle Technology Symposium (CVT 2010), Shaker Verlag, 2010, S. 298-307

3. TEUTSCH, R. RITTER, J.; WEBER, C.; KOLB, G.; VILCENS, B.; LOPATTA, A.: Einsatz eines Fahrerleitsystems zur Qualitätssteigerung bei der Betriebsfestigkeitserprobung, Proceedings, 1st Commercial Vehicle Technology Symposium Kaiserslautern, 16. – 18. März 2010

4. WEBER, C.; MÜLLER, R.; TEUTSCH, R.; DRESSLER, K.; SPECKERT, M.: A New Way to Customer Loads Correlation and Testing in Truck Engineering of Daimler Trucks, Proceedings of the 1st International Munich Chassis Symposium, chassis.tech, Munich, Germany, 8th - 9th Juni 2010

5. TEUTSCH, R.; WEBER, C.; MÜLLER, R.; SCHON, U.; EPPLER, R.: Einsatzspezifische Erprobung als Baustein zur Verringerung des Fahrzeuggewichts von Lastkraftwagen, DVM-Berichtsband 138, S. 189 – 201, 20

7.89 Module: Fundamentals of Combustion I [M-MACH-102707]

Responsible: Prof. Dr. Ulrich Maas
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105213	Fundamentals of Combustion I	4 CR	Maas

Competence Certificate
Written exam, graded, approx. 3 h

Prerequisites
none

Competence Goal
After completing the course, the students are able to analyze the functionality of technical combustion systems (e.g. piston engines, gas turbines, furnaces). With regard to environmental pollution, students can name the mechanisms of combustion and pollutant formation and assess concepts for reducing pollutants. They can explain the fundamental chemical and physical processes of combustion and name experimental methods for investigating flames. Furthermore, the students can also describe the differences between laminar and turbulent flames and explain the principles of ignition processes.

Content
The lecture gives an overview of the basic terms and phenomena of technical combustion. In a basic chapter, experimental methods for investigating flames are taught. Conservation equations for laminar flames are derived based on scientific phenomena. In addition, the laminar premixed flame and the laminar non-premixed flame are treated as examples. Knowledge of chemical reactions and their description with reaction mechanisms is conveyed. Furthermore, ignition processes are taught. The content of the lecture is deepened in exercises and applied to specific problems and tasks.

Module grade calculation
Grade of the written exam (100%)

Workload
General attendance: 30 h

Preparation time for the lecture: 30 h

General attendance (Tutorial): 30 h

Self-study: 30 h

Recommendation
none

Learning type
Lecture
Exercise course

Literature
Lecture notes,

Combustion - Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, authors: U. Maas, J. Warnatz, R.W. Dibble, Springer-Lehrbuch, Heidelberg 1996

M 7.90 Module: Fundamentals of Combustion II [M-MACH-107117]

Responsible: Dr. Viatcheslav Bykov
Prof. Dr. Ulrich Maas

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-114044	Fundamentals of Combustion II	4 CR	Bykov, Maas

Competence Certificate
See course

Prerequisites
none

Competence Goal
The students gain understanding of combustion fundamentals especially numerical aspects of turbulent reacting flows. The knowledge earned in this course will help them to apply these fundaments in the various branches of mechanical engineering like computational fluid dynamics, energy and power engineering, automotive engineering, etc. This course provides basic understanding of transport equations used not only in numerical combustion but also in fluid dynamics and complex interaction between turbulence and chemical kinetics. Different tools used in simulation of turbulent reacting flows are discussed which has a practical significance to reduce the massive computational costs associated with these simulations while maintaining accuracy. Applications of turbulent combustion fundamentals are discussed to understand knocking phenomena in engines, solid and liquid combustions, and effects of combustion on atmosphere.

After completion of this course students are able to:

- understand the basic understanding of governing transport equations for turbulent reacting flows.
- apply tools used in the simulations of turbulent reacting flows.
- learn basic knowledge about solid and liquid combustion and engine knocking phenomenon.

Content

- Thermodynamics of combustion processes
- Transport phenomena
- Three dimensional Navier-Stokes equations for reacting flows
- Tools in turbulent reacting flows
- Turbulent non-premixed flames
- Turbulent premixed flames
- Combustion of liquid and solid fuels
- Engine knock
- Effects of Combustion Processes on the Atmosphere

Module grade calculation
Grade corresponds to the grade of course

Annotation
Lectures are offered in German and English

Workload
120h
(for details see individual course)

Learning type
Lecture and tutorial

M 7.91 Module: Fundamentals of Energy Technology [M-MACH-102690]

Responsible: Dr. Aurelian Florin Badea
Prof. Dr.-Ing. Xu Cheng

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105220	Fundamentals of Energy Technology	8 CR	Badea, Cheng

Competence Certificate
A performance assessment will consist of a written examination of 90 minutes.

Prerequisites
none

Competence Goal
The objective of the module is to train the students on state of the art knowledge about the challenging fields of energy industry and the permanent competition between the economical profitability and the long-term sustainability. The students obtain basic knowledge on thermodynamics relevant to the energy sector and comprehensive knowledge on the energy sector: demand, energy types, energy mix, installations for energy production (conventional, nuclear and renewable), transport and energy storage, environmental impact and future tendencies. Students are able to use methods of economic efficiency optimization for the energy sector in a creative way, practice oriented, also specifically trained during the corresponding tutorial. The students are qualified for further training in energy engineering related fields and for (also research-related) professional activity in the energy sector.

Content
The following relevant fields of the energy industry are covered:
- Energy demand and energy situation
- Energy types and energy mix
- Basics. Thermodynamics relevant to the energy sector
- Conventional fossil-fired power plants
- Combined Cycle Power Plants
- Cogeneration
- Nuclear energy
- Regenerative energies: hydropower, wind energy, solar energy, other energy systems
- Energy demand structures. Basics of economic efficiency and calculus. Optimization
- Energy storage
- Transport of energy
- Power generation and environment. Future of the energy industry

Module grade calculation
The module grade is the grade of the written examination.

Workload
1. lectures: 15 * 3 h = 45 h

2. preparation for lectures: 15 * 2 h = 30 h

3. tutorials: 15 * 2 h = 30 h

4. preparation for tutorials: 15 * 1 h = 15 h

5. preparation for exam: 120 h

Total: 240 h = 8 LP

M 7.92 Module: Fundamentals of Reactor Safety for the Operation and Dismantling of Nuclear Power Plants [M-MACH-107150]

Responsible: Dr. Victor Hugo Sanchez-Espinoza
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German/English	4	1

Mandatory			
T-MACH-105530	Fundamentals of Reactor Safety for the Operation and Dismantling of Nuclear Power Pants	4 CR	Sanchez-Espinoza

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
The student can

- explain the basic principles of reactor safety and understand and classify the inherent safety characteristics of reactors
- understand the operating phases and types of a nuclear power plant
- understand and categorize the main mechanisms and components for heat removal and safety systems
- familiarize themselves with the main phases of dismantling a nuclear power plant
- estimate amount of radioactive materials generated in a nuclear power plant as well as the contamination and activation processes
- understand and classify the regulatory framework and radiation protection measures to minimize risks during decommissioning

Content
This lecture gives an introduction to reactor safety fundamentals for both the operation and the decommissioning of nuclear power plants with the focus on decommissioning. The lecture is devoted to:

- Nuclear power plants and operational aspects
- Reactor safety fundamentals as defense in depth, multi-barrier concepts
- Life cycle of a nuclear power plant and main strategies and challenges in the NPP decommissioning
- Physical processes responsible for the activation of reactor components during the operation of a nuclear power plant
- Radioactive waste generation in the core, classification and radiological relevance
- Waste classification, minimization methods and intermediate and final disposal
- Risk analysis and prevention, radiation protection issues and the regulatory framework for decommissioning
- Computational methods for the estimation of nuclei inventories, activation and dose rates of reactor components

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h
(for details see individual course)

M 7.93 Module: Fusion Technology A [M-MACH-107124]

Responsible: Dr. Sara Perez Martin
Dr. Klaus-Peter Weiss

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German/English	4	1

Mandatory			
T-MACH-105411	Fusion Technology A	4 CR	Perez Martin, Weiss

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
To transfer the basic physical concepts of particle physics, fusion and nuclear fission; this includes fundamental questions such as how: What is a plasma? How can it be ignited? What is the difference between magnetic and inertial fusion? Based on this, aspects of the stability of plasmas, their control and particle transport are discussed. After characterizing the plasma, the "fire" of fusion, the confinement in magnetic fields is sketched, which are built up with the help of magnetic technology. Here, knowledge of superconductivity, production and design of magnets is imparted. A reactor operation with a plasma as energy source requires a continuous operation of a tritium and fuel cycle, which is generated by the fusion reactor itself. Since fusion plasmas require small material densities, vacuum technology plays a central role. Finally, the heat generated in the fusion power plant must be converted into a power plant process and the reaction products removed. The functional basics and the structure of these fusion-typical in-vessel components are presented and the current challenges and the state of the art are demonstrated.

Content
The course describes the essential functional principles of a fusion reactor, beginning with plasma, magnet technology, the tritium and fuel cycle, vacuum technology and the associated material sciences. The physical basics will be taught and the engineering laws of scaling will be demonstrated. Special importance is attached to the understanding of the interfaces between the different subject areas, which essentially determine the engineering technical interpretations. Methods for identifying and evaluating the central parameters will be demonstrated. Based on the acquired perception skills, methods for the design of solution strategies will be taught and technical solutions will be identified, their weak points discussed and evaluated.

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h
(for details see individual course)

M 7.94 Module: Fusion Technology B [M-MACH-107154]

Responsible: Dr. Sara Perez Martin
Dr. Michael Rieth

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German/English	4	1

Mandatory			
T-MACH-105433	Fusion Technology B	4 CR	Perez Martin, Rieth

Competence Certificate
see individual course

Prerequisites
Knowledge of physics, heat and mass transfer, and design theory taught in the bachelor's degree. Attendance of the lecture Fusion technology A

Competence Goal
The lecture, which runs over 2 semesters, is aimed at students of engineering sciences and physics after the bachelor. The aim is an introduction to the current research and development on fusion and its long-term goal of a promising energy source. After a short insight into fusion physics, the lecture focuses on key technologies for a future fusion reactor.

Content
Fusion neutronics, materials science of thermally and neutronically highly loaded components, reactor scaling and safety as well as plasma heating and current drive. The section fusion neutronics develops the basics of fusion neutronics and its calculation methods, the nuclear physical design of a fusion reactor and the corresponding components (blankets, shielding, activation, tritium breeding ratio and dose rate). Since both neutron fluxes and area power density in a fusion power plant are significantly higher than those of other power plants, they require special materials. After an extension of existing material knowledge by fundamentals and methods for the calculation of radiation damage in materials, strategies for the material selection of functional and structural materials are shown and deepened by examples. The arrangement of components close to the plasma in a fusion power plant means changed requirements for system integration and energy conversion; these questions are the subject of the block reactor scaling and safety. In addition to the explanation of the safety objectives, the methods for achieving the objectives and the computational tools required to achieve them are dealt with in particular. To ignite the plasma, extreme temperatures of several million degrees are required. Special plasma heating methods are used for this purpose, such as electron cyclotron resonance heating (ECRH), ion cyclotron resonance heating (ICRH), current drive at the lower hybrid frequency and neutral particle injection. Their basic mode of action, design criteria, transmission options and performance are presented and discussed. In addition, the heating processes can also be used for plasma stabilization. Some considerations and limitations are presented.

Module grade calculation
see individual course

Workload
120h
(for details see individual course)

7.95 Module: Handling Characteristics of Motor Vehicles I [M-MACH-105288]

Responsible: Dr.-Ing. Martin Gießler
Dr.-Ing. Hans-Joachim Unrau

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-105152	Handling Characteristics of Motor Vehicles I	4 CR	Unrau

Competence Certificate
Oral examination, duration: approximately 30 minutes.

Competence Goal
The students know the basic connections between drivers, vehicles and environment. They can build up a vehicle simulation model, with which forces of inertia, aerodynamic forces and tyre forces as well as the appropriate moments are considered. They have proper knowledge in the area of tyre characteristics, since a special meaning comes to the tire behavior during driving dynamics simulation. Consequently they are ready to analyze the most importent influencing factors on the driving behaviour and to contribute to the optimization of the handling characteristics.

Content
1. Problem definition: Control loop driver - vehicle - environment (e.g. coordinate systems, modes of motion of the car body and the wheels)

2. Simulation models: Creation from motion equations (method according to D'Alembert, method according to Lagrange, programme packages for automatically producing of simulation equations), model for handling characteristics (task, motion equations)

3. Tyre behavior: Basics, dry, wet and winter-smooth roadway

Workload
The total work load for this module is about 120 Hours (4 Credits). The partition of the work load is carried out according to the credit points of the courses of the module. The work load for courses with 4 credit points is about 120 hours

Learning type
Lecture

M 7.96 Module: Handling Characteristics of Motor Vehicles II [M-MACH-107073]

Responsible: Dr.-Ing. Martin Gießler
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105153	Handling Characteristics of Motor Vehicles II	4 CR	Unrau

Competence Certificate
oral examination, duration: approximately 30 minutes

Prerequisites
none

Content
1. Vehicle handling: Bases, steady state cornering, steering input step, single sine, double track switching, slalom, cross-wind behavior, uneven roadway

2. stability behavior: Basics, stability conditions for single vehicles and for vehicles with trailer

Learning Objectives:

The students have an overview of common test methods, with which the handling of vehicles is gauged. They are able to interpret results of different stationary and transient testing methods. Apart from the methods, with which e.g. the driveability in curves or the transient behaviour from vehicles can be registered, also the influences from cross-wind and from uneven roadways on the handling characteristics are well known. They are familiar with the stability behavior from single vehicles and from vehicles with trailer. Consequently they are ready to judge the driving behaviour of vehicles and to change it by specific vehicle modifications.

Module grade calculation
see individual course

Workload
120h
(for details see individual course)

Literature
1. Zomotor, A.: Fahrwerktechnik: Fahrverhalten, Vogel Verlag, 1991

2. Mitschke, M./Wallentowitz, H.: Dynamik von Kraftfahrzeugen, Springer-Verlag, Berlin, 2004

3. Gnadler, R.; Unrau, H.-J.: Umdrucksammlung zur Vorlesung Fahreigenschaften von Kraftfahrzeugen II

7.97 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: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	2

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

Competence Certificate
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

7.98 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

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

Competence Certificate
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

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

M 7.99 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: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

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

Competence Certificate
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.

Annotation
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

Recommendation
Knowledge of the basics of digital technology and information technology is helpful.

7.100 Module: Heat and Mass Transfer [M-MACH-102717]

Responsible: Prof. Dr. Ulrich Maas
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105292	Heat and Mass Transfer	4 CR	Maas, Yu

Competence Certificate
Written exam, graded, approx. 3 hours

Prerequisites
none

Competence Goal
The students will have knowledge of the basic processes, laws and calculation methods of heat and mass transfer based on dimension analysis. Further, they can use it to analyze and derive application systems of industrial importance in the fields of mechanical engineering, energy and process engineering.

Content
The lecture gives an overview of stationary and unsteady heat conduction phenomena in homogeneous and composite bodies; such as plates, pipe shells and spherical shells. Molecular diffusion in gases and the analogy between diffusion and heat conduction are thought. The lecture provides an overview of convective, forced heat transfer in pipes / channels with a flow, as well as plates and profiles that are flown over. In addition, the module conveys knowledge of the mass / heat transfer analogy and the multiphase, convective heat transfer (condensation, evaporation), as well as the convective mass transfer is taught. This module is intended to convey to students the theoretical and practical aspects of the radiant heat transport of solids and gases. The content of the lecture is deepened in exercises and applied to specific problems and tasks.

Module grade calculation
Grade of the written exam (100%)

Workload
General attendance: 30 h

Preparation time for the lecture: 30 h

General attendance (Tutorial): 30 h

Self-study: 30 h

Recommendation
none

Learning type
Lecture
Exercise course

Literature

- Maas ; Vorlesungsskript "Wärme- und Stoffübertragung"
- Baehr, H.-D., Stephan, K.: "Wärme- und Stoffübertragung" , Springer Verlag, 1993
- Incropera, F., DeWitt, F.: "Fundamentals of Heat and Mass Transfer" , John Wiley & Sons, 1996
- Bird, R., Stewart, W., Lightfoot, E.: "Transport Phenomena" , John Wiley & Sons, 1960

M 7.101 Module: Heat Pumps [M-MACH-107075]

Responsible: Prof. Dr. Ulrich Maas
Dr. Heiner Wirbser

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105430	Heatpumps	4 CR	Maas, Wirbser

Competence Certificate
See individual course

Prerequisites
none

Competence Goal
The students:

- are able to describe the current energy situation and energy policy requirements and analyze their significance for the use of heat pumps.
- are able to characterize and evaluate the functionality and possible applications of different heat sources for heat pumps.
- can identify different types of heat pumps and analyze their respective advantages and disadvantages.
- are able to explain the thermodynamic principles of the heat pump process and understand the thermodynamic relationships. They can illustrate these using diagrams.
- have a profound understanding of the function of a heat pump and can explain the interaction of heat pumps and their components.
- are able to explain the functionality and possible applications of absorption and adsorption heat pumps.
- are able to assess the economic and ecological aspects of heat pump systems.
- are able to carry out basic calculations for the design of a heat pump system and carry out economic feasibility studies.
- are able to explain the function, possible applications and different types of heat accumulators in connection with heat pump systems.

Content
The aim of the lecture is to analyze the heat pump as a potential heating system for small and medium-sized systems and to make a well-founded assessment of its advantages and disadvantages. After considering the current energy situation and the resulting energy policy requirements, the central technical, economic and ecological aspects of heat pumps are examined. The requirements for different heat sources, the components of a heat pump and different types of heat pumps are systematically analyzed. In addition, environmental and economic aspects are evaluated. Finally, the integration of heat pumps with heat storage tanks in heating systems is discussed.

Module grade calculation
Grade corresponds to the grade of course

Workload
120h
(for details see individual course)

Learning type
Lecture

7.102 Module: High-Voltage Technology [M-ETIT-105060]

Responsible: Dr.-Ing. Rainer Badent

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-110266	High-Voltage Technology	6 CR	Badent

7.103 Module: High-Voltage Test Technique [M-ETIT-100417]

Responsible: Dr.-Ing. Rainer Badent
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-101915	High-Voltage Test Technique	4 CR	Badent

Prerequisites
none

M 7.104 Module: Holistic Approach of Managing Power Plant Operation under Uncertainty and Volatility [M-MACH-107097]

Responsible: Dr. Marcus Seidl
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-112238	Holistic Approach of Managing Power Plant Operation under Uncertainty and Volatility	4 CR	Seidl

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
Students understand the many aspects of power plant operation: the structure of the energy and commodity markets, the regulatory boundary conditions, the energy trading instruments, the principles of fleet management and the requirements of power plant maintenance.

Furthermore, students can develop on their own a suitable strategy for the management of a power plant fleet.

Content
The structure ofelectricity markets

Requirements from network operators

The basics of commodity markets

The impact of regulation on power plant operation

The role of behavioral economics in power plant decision making

Integration of renewable energy sources into the electricity market

Calibration of power plant operation and maintenance to market requirements

Asset management for power plant fleets

Applying financial engineering to optimize asset utilization

Day-to-day decision making for power plant operation

The lecture provides an overview of the many practical aspects of power plant operation. For this purpose, the knowledge of the energy and commodity markets, the regulatory boundary conditions, the energy trading instruments, the principles of fleet management and the requirements of power plant maintenance are required.

For the purpose of an efficient management of a power plant fleet it is explained how a variety of statistical models can be used to determine the optimal combination of resource purchases, outage management, load availability and ask prices.

Module grade calculation
The grade corresponds to the grade of the oral examination.

Workload
120 hours, of which 30 hours attendance and 90 hours self-study

Learning type
Lecture

7.105 Module: Hot Research Topics in AI for Engineering Applications [M-MACH-107089]

Responsible: Prof. Dr.-Ing. Anne Meyer

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-113669	Hot Research Topics in AI for Engineering Applications	4 CR	Meyer

Competence Certificate
See individual course

Prerequisites
None

Competence Goal
After the event, participants will be able to:

- Identify the technical and algorithmic foundations behind the relevant research topics and explain their functionalities
- Identify application possibilities of current research findings and related technologies in an industrial context, as well as the challenges that arise in the process
- Implement solutions proposed in recent publications using existing frameworks and codebases as prototypes
- Structure and execute programming projects in a team
- Clearly present the results of practical projects tailored to the audience

Content
In " Hot Research Topics in AI for Engineering Applications", we explore the applicability of cutting-edge research findings in the fields of Machine Learning and Artificial Intelligence (e.g., LLM agents, Reinforcement Learning) to applications in engineering (e.g., optimization in production and logistics, creation of CAD models). Each year, we offer a different methodological focus (more on the IMI-homepage).

First, we provide the theoretical foundations and then move into a group work phase where students implement and analyze an application prototype. The event is aimed at students with prior knowledge in machine learning and programming.

- Theoretical foundations of the technologies considered in the course (e.g., Deep Learning, Transformers, LLM)
- Application possibilities of modern technologies in an industrial context
- Challenges in making current research findings usable for solving specific engineering problems and productive use
- Implementation of solutions to apply modern technologies to specified engineering problems (usually Python-based, using current frameworks)
- Independent execution of an implementation project with current, thematically relevant content (e.g., LLM agents for interaction with external systems such as robots, for algorithm construction, or for creating 3D CAD models, etc.)
- Technologies and applications are announced at the beginning of each semester

Annotation
Limited number of participants

Workload
120 h
(for details see individual course)

Recommendation
Basic knowledge of artificial intelligence and machine learning, Programming experience, preferably in Python, English proficiency

M 7.106 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	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 CR	Asfour, Spetzger

M 7.107 Module: Human-Machine-Interaction in Anthropomatics: Basics (24100) [M-INFO-100824]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-INFO-101361	Human-Machine-Interaction in Anthropomatics: Basics	3 CR	Beyerer, van de Camp

M 7.108 Module: Humanoid Robots - Seminar [M-INFO-107152]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-INFO-114170	Humanoid Robots - Seminar	3 CR	Asfour

Competence Certificate
See partial Achievements (Teilleistung)

Prerequisites
See partial Achievements (Teilleistung)

Competence Goal
The students choose a topic from the field of humanoid robotics, e.g. robot design, motion generation, perception or learning. 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 a term paper in English in the form of a scientific publication.

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 student gained experience with literature research on a current research topic. He/she explored, understood and compared different approaches to a selected scientific problem. The student is able to write a summary of their literature research in the form of a scientific publication in English and to give a scientific talk on it.

Workload
Seminar with 2 SWS, 3 LP
3 LP corresponds to 90 hours, including
45 hours literature research
25 hours manuscript preparation
10 hours preparation of the presentation
10 hours attendance time

Recommendation
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III – Sensors and Perception in Robotics, Mechano-Informatics and Robotics and Wearable Robotic Technologies is recommended.

M 7.109 Module: Hydrogen and reFuels - Energy Conversion in Combustion Engines [M-MACH-107158]

Responsible: Prof. Dr. Thomas Koch
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-111585	Hydrogen and reFuels - Energy Conversion in Combustion Engines	4 CR	Kubach

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
Students can name and describe the individual phases of the engine process and explain and thermodynamically analyze the overall process. They can name and explain special aspects of alternative fuels.

Content
Introduction

Fundamentals of engine processes

Thermodynamics of the combustion engine

Gas exchange

Flow field

Wall heat losses

Fundamentals and analysis of gasoline engine energy conversion

Fundamentals and analysis of diesel engine energy conversion

Mixture formation, ignition, combustion of hydrogen

Mixture formation, ignition, combustion of reFuels: HVO, methanol, NH3, eFuels, ethanol

Waste heat recovery

Module grade calculation
see individual course

Workload
120h
(for details see individual course)

M 7.110 Module: Industrial Circuitry [M-ETIT-100399]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100716	Industrial Circuitry	3 CR	Liske

Prerequisites
none

Module grade calculation
Die Modulnote ist die Note der mündlichen Prüfung.

M 7.111 Module: Industrial Mobile Robotics Lab [M-MACH-106830]

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

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	pass/fail	Each term	1 term	English	4	1

Mandatory			
T-MACH-113701	Industrial Mobile Robotics Lab	4 CR	Furmans

Competence Certificate
Certificate through colloquium with presentation, documentation of the work results and fulfilment of the attendance requirement.

Prerequisites
None

Competence Goal
Students can:

- Identify and explain the basics of intralogistics systems
- Describe the application of mobile robots in industry
- Explain the basic idea of the VDA 5050 communication standard
- Understand the concept of multi-robot task assignment in intralogistics
- Develop solutions to control mobile robots
- Apply the learned theory to a practical problem
- Evaluate the developed solutions through group discussions and presentations

Content
Hard skills

- Introduction to the basics of intralogistic systems
- Implement the communication in a multi-robot system using uniform JSON messages defined in the VDA 5050 via MQTT
- Design and implement a fleet management system to coordinate a fleet of mobile robots using Python
- Design and implement a robot control to accomplish assigned tasks using Python
- Transfer the solutions from the simulation to real industrial mobile robots

Soft skills

- Presentation of the work results
- Software development in teamwork (including tools such as git, Scrum, ...)

Annotation

- The number of participants is limited to 15 students.
- The selection procedure is based on a letter of motivation in which the following questions should be answered:
    - Why do you want to attend the course?
    - What skills and previous knowledge do you have?

Workload

- Compulsory attendance: approx. 20 hours
- Self study with video lectures: 10 hours
- Group work project: 90 hours

Recommendation
Basic knowledge of Python programming and basic knowledge of technical logistics of advantage.

Learning type
Laboratory

Literature
None

M 7.112 Module: Information Fusion [M-ETIT-103264]

Responsible: Prof. Dr.-Ing. Michael Heizmann

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-106499	Information Fusion	4 CR	Heizmann

Prerequisites
none

M 7.113 Module: Information Processing in Sensor Networks [M-INFO-100895]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck

Organisation: KIT Department of Informatics

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German/English	4	1

Mandatory			
T-INFO-101466	Information Processing in Sensor Networks	6 CR	Hanebeck

M 7.114 Module: Information Systems and Supply Chain Management [M-MACH-105281]

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

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-102128	Information Systems and Supply Chain Management	3 CR	Kilger

Competence Certificate
The assessment consists of an oral exam according to §4 (2), 2 of the examination regulation. It may be a written exam (according to §4 (2), 1 of the examination regulation) in the case of large number of participants.

Prerequisites
none

Competence Goal
Students are able to:

- Describe requirements of logistical processes regarding IT systems,
- Choose information systems to support logistical processes and use them according to the requirements of a supply chain.

Content
1) Overview of logistics systems and processes

2) Basic concepts of information systems and information technology

3) Introduction to IS in logistics: Overview and applications

4) Detailed discussion of selected SAP modules for logistics support

Workload
regular attendance: 21 hours
self-study: 69 hours

Learning type
Lectures

Literature
Stadtler, Kilger: Supply Chain Management and Advanced Planning, Springer, 4th edition 2008

M 7.115 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: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100698	Information Technology in Industrial Automation Systems	3 CR	Bort

Prerequisites
none

M 7.116 Module: Innovation and Project Management in Rail Vehicle Engineering [M-MACH-106514]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	4	2

Mandatory			
T-MACH-113068	Innovation and Project Management in Rail Vehicle Engineering	4 CR	Cichon

Competence Certificate
Graded examination:
2/3 of the examination: 20-minute oral examination on the content of the lecture
1/3 of the examination performance of another type: unit accompanying the lecture as part of a 10-minute presentation and a practical application from innovation and project management

Prerequisites
none

Competence Goal
In this course, students will learn the basics of innovation and project management in the context of rail vehicle development. Creativity techniques are applied to the challenges of the rail system in a practical way, such as aspects of sustainability. Students will also learn about the various organizational, systemic, economic and technological challenges of a project and project management.

Content

- Fundamentals of innovation management
  Challenges and aspects of sustainability in the rail system
  Independent testing of various creativity techniques
  Moderation of creativity workshops
  Techniques for generating and evaluating ideas
  Fundamentals and methods of project management
  Practical challenges in project management
  Creation of tools for project management (work breakdown structure, project controlling, organizational charts)
  Project team organization and role allocation

Annotation
A bibliography is available for students to download from the Ilias platform.

Workload
Attendance time: 21 hours
Preparation / wrap-up: 21 hours
Exam and exam preparation: 78 hours
Total time: 120 hours = 4 LP

Learning type
Lecture

M 7.117 Module: Innovation2Business – Innovation Strategy in the Industrial Corporate Practice [M-MACH-107188]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-112882	Innovation2Business – Innovation Strategy in the Industrial Corporate Practice	4 CR	Albers

Competence Certificate
See partial performance

Prerequisites
None

Competence Goal
Learn....

... the challenges in product development using the example of a corporate group

... what influence (mega) trends have on the product development of a global player

... know and apply selected methods and tools for trend analysis / portfolio strategy / business case evaluation

... what role compliance plays in product development

Content
In this lecture series, learn from the example of Schaeffler how global companies are continuously transforming themselves in order to grow sustainably and maintain a leading position in the global market in the long term through business-oriented innovation.
Together we will go through the most important elements of the innovation and development process and learn about the successes and lessons learned using
illustrative examples from practice.
Take part in the fireside evenings with the speakers to discuss the lecture content and beyond in a relaxed atmosphere.

Module grade calculation
The module grade corresponds to the grade from the partial performance.

Annotation
None

Workload
Attendance: 30h

Self-study: 90h

Recommendation
None

Learning type
Lecture

Literature
None

Base for
None

M 7.118 Module: Innovative Concepts for Programming Industrial Robots (24179) [M-INFO-100791]

Responsible: Prof. Dr.-Ing. Björn Hein
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-INFO-101328	Innovative Concepts for Programming Industrial Robots	4 CR	Hein

M 7.119 Module: Innovative Nuclear Systems [M-MACH-107119]

Responsible: Dr. Aurelian Florin Badea
Prof. Dr.-Ing. Xu Cheng

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105404	Innovative Nuclear Systems	4 CR	Cheng

Competence Certificate
A performance assessment will consist of an oral examination of approx. 20 minutes.

Prerequisites
none

Competence Goal
The objective of the module is the explanation of state-of-the-art development of nuclear systems. Nuclear systems, that are from todays point of view promising will be presented and explained. The main characteristics of such systems and the associated challenges are also part of the lecture.

Content
1. state of the art and development tendencies in nuclear systems
2. advanced concepts in light water cooled systems
3. new developments in fast reactors
4. development tendencies in gas-cooled plants
5. transmutation systems for waste management
6. fusion systems

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h
(for details see individual course)

M 7.120 Module: Integrated Intelligent Sensors [M-ETIT-100457]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100961	Integrated Intelligent Sensors	3 CR	Stork

Competence Certificate
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

M 7.121 Module: Integrated Product Development [M-MACH-107141]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
18	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105401	Integrated Product Development	18 CR	Albers, Düser

Competence Certificate
See partial performance

Prerequisites
None

Competence Goal
The Students are able to ...

- analyze and evaluate product development processes based on examples and their own experiences.
- plan, control and evaluate the working process systematically.
- choose and use suitable methods of product development, system analysis and innovation management under consideration of the particular situation.
- prove their results.
- develop complex technical solutions in a team and to present them to qualified persons as well as non-qualified persons
- to design overall product development processes under consideration of market-, customer- and company- aspects

Content
organizational integration: integrated product engineering model, core team management and simultaneous engineering

informational integration: innovation management, cost management, quality management and knowledge management

personal integration: team coaching and leadership management

invited lectures

Module grade calculation
The module grade corresponds to the grade from the partial performance

Annotation
Registration takes place in the previous summer semester. The lecture starts at the beginning of October.

For organizational reasons, the number of participants for the product development project is limited to 42 people. A selection process will therefore take place. Registration for the selection process takes place via a registration form, which is made available on the IPEK homepage from April to July each year. Subsequently, the selection itself is made in personal selection interviews with Prof. Albers.

Workload
540h:

Attendance: 120h

Self-study/project work: 420h

Recommendation
None

Learning type
Lecture, Workshops, project work

Literature
Klaus Ehrlenspiel - Integrierte Produktentwicklung. Denkabläufe, Methodeneinsatz, Zusammenarbeit, Hanser Verlag, 2009

Base for
None

M 7.122 Module: Integrated Systems and Circuits [M-ETIT-100474]

Responsible: Prof. Dr. Sebastian Kempf

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100972	Integrated Systems and Circuits	4 CR	Kempf

Prerequisites
none

M 7.123 Module: Interdisciplinary Qualifications [M-ETIT-107193]

Responsible: Prof. Dr. Martin Doppelbauer
Prof. Dr.-Ing. Marcus Geimer

Organisation: KIT Department of Electrical Engineering and Information Technology
KIT Department of Mechanical Engineering

Part of: Interdisciplinary Qualifications

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	pass/fail	Each term	1 term	German/English	4	1

Election notes
The module "Interdisciplinary Qualifications" consists of three parts:

- Compulsory: T-MACH-113883 - Introduction to Philosophy of Technology (2 CP)
  Recommanded basis for:
- Compulsory-elective "Engineering Ethics" (2 CP: one of the following components)
  - T-MACH-113884 - Technology Assessment and its Normative Basis
  - T-MACH-113903 - Ethics of Technology
- Compulory-elective "Further Interdisciplinary Qualifications" (4 CP)

In "Further Interdisciplinary Qualifications" for self assignment of taken interdisciplinary qualifications of HoC, FORUM, 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.

All courses are listed with English titles, regardless of the course language.

To see English courses with English titles and German courses with German titles visit the German website**.**

Courses given in English (alphabetically ordered) are listed above the "Self Assignments", the ones in German (alphabetically ordered) below.

Mandatory			
T-MACH-113883	Introduction to Philosophy of Technology	2 CR	Hillerbrand
Engineering Ethics (Election: at least 2 credits)			
T-MACH-113884	Technology Assessment and its Normative Basis	2 CR	Hillerbrand
T-MACH-113903	Ethics of Technology	2 CR	Hillerbrand
Further Interdisciplinary Qualifications (Election: at least 4 credits)			
T-ETIT-111317	Introduction to the Scientific Method (Seminar, Englisch)	1 CR	Nahm
T-ETIT-100814	Seminar Project Management for Engineers	3 CR	Noe
T-ETIT-111688	Self Assignment-HOC-SPZ-FORUM-graded	2 CR	
T-ETIT-111689	Self Assignment-HOC-SPZ-FORUM-graded	2 CR	
T-ETIT-112898	Self Assignment-HOC-SPZ-FORUM-ungraded	2 CR	
T-ETIT-112899	Self Assignment-HOC-SPZ-FORUM-ungraded	2 CR	
T-ETIT-100797	Educational Development for Student Teachers - Basic Level	2 CR	
T-MACH-105721	Engineer's Field of Work	2 CR	Doppelbauer, Geimer
T-WIWI-100796	Industrial Business Administration	3 CR	Fichtner
T-MACH-105442	Intellectual Property Rights and Strategies in Industrial Companies	4 CR	Zacharias
T-ETIT-111316	Introduction to the Scientific Method (Seminar, German)	1 CR	Nahm
T-MACH-106460	Leadership in Interdisciplinary Teams	4 CR	Matthiesen
T-MACH-106738	ProVIL - Product Development in a Virtual Idea Laboratory	4 CR	Albers, Düser
T-ETIT-100754	Seminar Creating a Patent Specification	3 CR	Stork
T-ETIT-108820	Seminar Project Management for Engineers	3 CR	Day, Noe
T-ETIT-111369	Strategy Derivation for Engineers	3 CR	Arndt

Competence Certificate
Depending on the selected offer

Prerequisites
None

Content
Depending on the selected offer

Module grade calculation
ungraded

Workload
Depending on the selected offer

7.124 Module: International Production Engineering [M-MACH-105109]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each term	2 terms	German	4	1

Mandatory			
T-MACH-110334	International Production Engineering A	4 CR	Fleischer
T-MACH-110335	International Production Engineering B	4 CR	Fleischer

Competence Certificate
Alternative test achievement (graded):
- Result of the project work and final presentation with weighting 65%
- Oral exam (ca. 15 min) with weighting 35%

Competence Goal
The students ...

- can develop ideas for technical solutions in the environment of production plants in a team and evaluate their feasibility according to technical and economic criteria,
- are capable of selecting the essential components and modules of a production plant and carrying out the necessary calculations,
- can use FEM simulations to predict and evaluate the static and dynamic behavior of an assembly,
- are able to present, plan and assess their own work and decision-making processes,
- are able to apply basic methods of project management in an international environment.

Content
The module “International Production Engineering” offers a practical insight into the development of production plants in an international environment. A student team works on a current and concrete problem in the field of production engineering, which is introduced into the project by an industrial partner who is operating as well in Germany as in China.

As part of the course "International Production Engineering A", the problem will initially be transferred into work packages. According to the elaborated project plan, ideas and concepts for a solution of the problem will be generated and developed. Based on the concepts, the selected solution approach is elaborated and validated, e.g. through simulation, programming and/or design, but always in the context of production technology. The practical implementation of the developed solution is part of the course "International Production Engineering B" during an eight-week research stay in China.

The project will be carried out by the students under the guidance of scientific staff and in cooperation with the industrial partner. The results of the project will be presented and discussed with the project partner in a final presentation (respectively IPE A and B).

More details about the course are discussed in an information event (always in January/February, the exact date is published on the homepage: www.wbk.kit.edu).

The project offers students …

- the unique opportunity to put the contents of the accompanying lecture into practice in an interdisciplinary and creative context,
- to gain insights into a wide range of development activities relevant for their future careers,
- cooperation with an attractive industrial partner,
- work in a team with other students with competent support from scientific staff,
- first practical experience in project management
- international practical experience.

Workload
IPE A
1. Presence time lecture: 15 * 2 h = 30 h
2. Pre- and post-processing time lecture: 15 * 5 h = 75 h
3. Exam preparation and presence in the same: 15 h

In total: 120 h = 4 LP

IPE B
1. Presence time lecture: 15 * 2 h = 30 h
2. Pre- and post-processing time lecture: 15 * 5 h = 75 h
3. Exam preparation and presence in the same: 15 h

In total: 120 h = 4 LP

M 7.125 Module: Introduction into Energy Economics [M-WIWI-100498]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	German	4	5

Mandatory			
T-WIWI-102746	Introduction to Energy Economics	5 CR	Fichtner

Competence Certificate
The assessment consists of a written exam according to Section 4(2), 1 of the examination regulation.

Prerequisites
None

Competence Goal
The student is able to

- characterize and judge the different energy carriers and their peculiarities,
- understand contexts related to energy economics.

Content
1. Introduction: terms, units, conversions
2. The energy carrier gas (reserves, resources, technologies)
3. The energy carrier oil (reserves, resources, technologies)
4. The energy carrier hard coal (reserves, resources, technologies)
5. The energy carrier lignite (reserves, resources, technologies)
6. The energy carrier uranium (reserves, resources, technologies)
7. The final carrier source electricity
8. The final carrier source heat
9. Other final energy carriers (cooling energy, hydrogen, compressed air)

Workload
The total workload for this course is approximately 165.0 hours. For further information see German version.

M 7.126 Module: Introduction to Automotive and Industrial Lidar Technology [M-ETIT-105461]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-111011	Introduction to Automotive and Industrial Lidar Technology	3 CR	Stork

Competence Certificate
The examination consists of an oral exam and a short oral presentation. The overall impression is rated.

Competence Goal

- The students are able to explain the basic principles of a lidar sensor
- The students can explain all relevant components of a lidar sensor and put them in context
- The students can explain different forms of execution and make a meaningful choice depending on the requirements
- The students can describe lidar sensors theoretically using the lidar equations and explain the interactions based on this theory
- The students are able to assess the eye safety of a system
- The students are able to suggest possible sensor concepts for different applications or to evaluate existing concepts

Content
In this course the functionality of a lidar sensor is explained and then put into context with relevant use cases. Typical criteria for the evaluation of the performance are then presented. In the following the concept of the sensor is presented in detail and all relevant components are introduced individually. Afterwards they are qualitatively related to each other and the whole system is quantitatively examined by means of the lidar equation. Finally, the interaction of the components is further considered to present meaningful combinations and design solutions. The eye safety of lidar sensors is always explicitly considered. The course concludes with a colloquium in which the students will give short presentations on what they have learned. This repetition is intended to repeat and deepen what has been learned and to lead to a discussion of open question

Module grade calculation
The module grade results of the assessment of the oral exam and the short oral presentation. Details will be given during the lecture.

Workload

1. participation in the lectures 12h - 8 dates á 1,5h
2. preparation and postprocessing 14 h (2h for VL dates 1-7)
3. preparation of the short lecture (16h)
4. preparation and participation in the oral exam : 48h

Recommendation
Basics of optics / optical technologies are helpful (e.g. optical engineering, optoelectronic, technical optics)

M 7.127 Module: Introduction to Bionics [M-MACH-106525]

Responsible: apl. Prof. Dr. Hendrik Hölscher
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-111807	Introduction to Bionics	4 CR	Hölscher

Competence Certificate
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.

Learning type
Lecture

Literature
Slides and literature are provided byILIAS.

M 7.128 Module: Introduction to Microsystem Technology I [M-MACH-102691]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-114100	Introduction to Microsystem Technology I	4 CR	Badilita, Korvink

Competence Certificate
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

7.129 Module: Introduction to Microsystem Technology II [M-MACH-102706]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105183	Introduction to Microsystem Technology II	4 CR	Badilita, Korvink

Competence Certificate
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

7.130 Module: Introduction to Nanotechnology [M-MACH-107207]

Responsible: apl. Prof. Dr. Hendrik Hölscher
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-111814	Introduction to Nanotechnology	4 CR	Hölscher

Competence Certificate
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

Annotation
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.

7.131 Module: Introduction to Nuclear Energy [M-MACH-107122]

Responsible: Dr. Aurelian Florin Badea
Prof. Dr.-Ing. Xu Cheng

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105525	Introduction to Nuclear Energy	4 CR	Cheng

Competence Certificate
A performance assessment will consist of an oral examination of approx. 20 minutes.

Prerequisites
none

Competence Goal
The objective of the module is the fundamental knowledge of nuclear energy and nuclear reactors. After the lecture the students understand the principle of the usage of nuclear energy, the structure and operation of nuclear power plants and nuclear safety measures. Furthermore, the students are capable of giving technical assessment of the usage of nuclear energy with respect to its safety and sustainability.

Content
1. Nuclear energy generation
2. Basics of reactor physics
3. Reactor types and structure
4. Reactor safety and heat dissipation
5. Nuclear materials
6. Fuel cycle and waste treatment
7. Radiation protection
8. Economic efficiency
9. Exercises with nuclear power plant simulation

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h
(for details see individual course)

M 7.132 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: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113648	IT/OT-Security Seminar	4 CR	Barth

Competence Certificate
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 perspectiv 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

Recommendation
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 7.133 Module: IT-Fundamentals of Logistics: Opportunities for Digital Transformation [M-MACH-105282]

Responsible: Prof. Dr.-Ing. Kai Furmans
Prof. Dr.-Ing. Frank Thomas

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-MACH-105187	IT-Fundamentals of Logistics	4 CR	Thomas

Competence Certificate
The assessment consists of an oral exam (30 min.) or an written exam (60min.) taking place in the recess period according to § 4 paragraph 2 Nr. 1/2 of the examination regulation.

Prerequisites
none

Competence Goal
The students …

- can describe the business process models from goods-inbound to goods-outbound based on sound basic knowledge, and derive the corresponding analysis models.
- will learn through the modularisation of the business process elements to think in reusable, adaptive IT components.
- will accomplish excellent work as a highly-motivated employee together in interdisciplinary teams (responses from the industry).

Content
The rapid development of information technology influences business processes drastically.
A strategic IT-orientation for an enterprise without a critical appreciation of worldwide IT-development (where the half-life value of IT for logistic systems knowledge is less than 3 years) is dangerous. The pressure of costs is always in focus. For this purpose the contents of this course, as well as the detailed script will be continuously revised, and the influences on business processes will be shown in practical examples.

Focuses:

System architecture in Material Flow Control Systems (MFCS)

A guiding principle for a new system architecture for MFC systems is the consideration of making new standardized, functional groups available for re-usability.

Design and application of innovative Material Flow Control Systems (MFCS)

The most important task of the MFCS is the commissioning of conveying systems with driving commands in a way that optimally utilizes the facility and serves the logistics processes on schedule.

Identification of goods – Application in Logistics

Along with business processes, coded information is the link between the flow of information and the flow of materials, and contributes to error prevention in the communication between people and machines.

Data communication in Intra-logistics

Information describes the content of a message that is of value to the recipient.
The recipient can be both a human and a machine.

Business processes for Intra-logistics – Software follows function!

If the business processes from Goods Incoming to Goods Outgoing are adapted with reusable building blocks then capabilities become visible. Against this background the consideration becomes apparent, how, through an innovative software architecture, a reusable building-block based framework can be made.
Therefore applies: Software follows function. And only if all project requirements are documented in the planing phase, and supported together in an inter-disciplinary team - consisting of logistics planners, the customers (users) and the implementation leader (IL).

Software development in accordance with industrial standards

Today's development of object-oriented software, and the increasing penetration of industrial software production with this technology, makes it possible to create system designs that already offer these opportunities in their facility - both for a high degree of reuse and for easier adaptability.
In software development, object-oriented methods are used to improve the productivity, maintainability and software quality. An important aspect of object-orientation is: the objects used are primarily intended to depict the real world.

Workload
regular attendance: 21 hours
self-study: 69 hours

Learning type
Lectures

M 7.134 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 Area in Mechatronics and Information Technology (Internship/Lab Course)

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

Mandatory			
T-MACH-105341	Lab Computer-Aided Methods for Measurement and Control	4 CR	Merkert, Stiller

Competence Certificate
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

Recommendation
Basic studies and preliminary examination; basic lectures in automatic control

Learning type
Tutorial

Literature
Instructions to the experiments are available on the institute's website

M 7.135 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 Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-100757	Lab Course on Nanoelectronics	6 CR	Kempf

Competence Certificate
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.

Annotation
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

Recommendation
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 7.136 Module: Laboratory Exercise in Energy Technology [M-MACH-107206]

Responsible: Prof. Dr.-Ing. Hans-Jörg Bauer
Prof. Dr. Ulrich Maas

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	pass/fail	Each term	1 term	German/English	4	1

Mandatory			
T-MACH-105331	Laboratory Exercise in Energy Technology	4 CR	Bauer, Maas, Wirbser

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
Learning Objectives:

By participating in the course, students should:

- be able to work on experimental and constructive as well as theoretical tasks within a scientific framework
- correctly evaluate the data obtained
- document results and present them in a scientific context

Content
Information on the institute's website; registration is online.

Registration within the first two weeks of the lecture period on the institute's website: http://www.its.kit.edu

Course content:

- Model gas turbine
- Various measuring sections for investigating heat transfer on components subject to high thermal loads.
- Optimization of components of the internal air and oil system
- Spray jet characterization of atomizer nozzles
- Investigation of pollutant emissions, noise emissions, reliability and material damage in combustion chambers
- Exhaust gas aftertreatment
- Exhaust gas turbocharger
- Cooling tower
- Heat pump
- Vegetable oil cooker
- Heat capacity
- Wood combustion

Module grade calculation
The module is passed with successful assessment of the coursework.

Workload
120 h

(for details see individual course)

M 7.137 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 Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-ETIT-100759	Laboratory FPGA Based Circuit Design	6 CR	Kempf

Prerequisites
none

M 7.138 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: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100681	Laboratory in Software Engineering	6 CR	Sax

Prerequisites
none

M 7.139 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: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German/English	4	1

Mandatory			
T-ETIT-114183	Laboratory Information Systems in Power Engineering	6 CR	Leibfried

Competence Certificate
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

Recommendation
Basic knowledge on high-voltage technology, calculation of electrical networks and energy transmission and network control, computer skills

M 7.140 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 Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German/English	4	1

Mandatory			
T-ETIT-106854	Laboratory Mechatronic Measurement Systems	6 CR	Heizmann

Competence Certificate
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.

Annotation
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

Recommendation
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 7.141 Module: Laboratory Mechatronics [M-MACH-102699]

Responsible: Prof. Dr. Veit Hagenmeyer
Prof. Dr.-Ing. Wolfgang Seemann
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	pass/fail	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-105370	Laboratory Mechatronics	4 CR	Hagenmeyer, Stiller

Competence Certificate
The laboratory course is offered exclusively as ungraded course work. The assessment consists of a group colloquium at the beginning of the individual specialization phases (Part 1). In addition, a robot control system for a pick-and-place task must be successfully implemented in the group phase (Part 2).

Prerequisites
None

Competence Goal
The students are able to put the knowledge from the specialization in mechatronics and microsystems technology into practice on an exemplary mechatronic system, a handling system. The students can create an automated object recognition, calculate kinematic systems and realize a communication between different systems (PC, CAN, USB).

Furthermore, the students can integrate the individual parts of a manipulator in teamwork to a functioning overall system.

Content
Part I
Control, programming and simulation of robots
CAN-Bus communication
Image processing / machine vision
Dynamic simulation of robots in ADAMS

Part II
In a group work, a kinematic system has to be programmed so that it is able to recognize and grip objects fully automatically.

Module grade calculation
The module is not graded. Passing the module is 100% tied to the performance assessment of the partial performance.

Workload

1. Attendance time Lecture: 15 * 2 h = 30h
2. self-study: 15 * 6 h = 90h

Total: 120h = 4 LP

Learning type
Seminar

7.142 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-100765	Laboratory Nanotechnology	6 CR	Lemmer

Competence Certificate
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

Recommendation

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

7.143 Module: Laboratory Optoelectronics [M-ETIT-100477]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-100764	Laboratory Optoelectronics	6 CR	Trampert

Competence Certificate
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

Recommendation
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

7.144 Module: Laboratory Solar Energy [M-ETIT-102350]

Responsible: Prof. Dr. Ulrich Wilhelm Paetzold
Prof. Dr. Bryce Sydney Richards

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-104686	Laboratory Solar Energy	6 CR	Trampert

Competence Certificate
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 solar technology, particularly in the field of photovoltaics, by means of independently conducted 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. Light Beam Induced Current (LBIC) measurement in solar cells
2. Optical and electrical modelling of thin-film solar cells
3. Quantum efficiency measurements on solar cells
4. Outdoor measurements of PV modules

Module grade calculation
Oral examinations and the assessment of written reports 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

Recommendation
Knowledge of the theoretical background of each experiment is recommended. It is strongly recommended that you attend this module after attending the relevant lectures, as knowledge of the theoretical background is important but not strictly necessary.

M 7.145 Module: Leadership in Interdisciplinary Teams [M-MACH-107142]

Responsible: Prof. Dr.-Ing. Sven Matthiesen

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-106460	Leadership in Interdisciplinary Teams	4 CR	Matthiesen

Competence Certificate
See individual course

Prerequisites
None

Competence Goal
After attending the course, students will be able to ...
- Use communication techniques to lead meetings
- Use and apply constructive criticism and reaction in meetings and discussions
- Apply problem and conflict resolution methods to project work in a team
- Identify strengths and weaknesses in the team, take them into account and use the existing strengths in the project
- Explain and apply different leadership styles
- Critically reflect on their own behavior and actions

Content
Communication, communication models, conversation techniques, self-management, formulating goals, delegating tasks, dealing with challenging situations, conflict resolution strategies, constructive criticism/reaction, project management, leadership, leadership tasks, leadership styles, leadership theories, team processes, recommendations for action

Module grade calculation
The module grade corresponds to the grade from the individual course

Annotation
None

Workload
Attendance: 40h
Self-study: 80h

Recommendation
Attendance of the course "Mechatronic Systems and Products" is recommended.

Learning type
Seminar, Workshop

Literature
None

Base for
None

M 7.146 Module: Liberalised Power Markets [M-WIWI-105403]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	3

Mandatory			
T-WIWI-107043	Liberalised Power Markets	6 CR	Fichtner

Competence Certificate
Success is monitored in the form of a written examination.

Prerequisites
See course description.

Competence Goal
The student has extensive knowledge of the new requirements of liberalized energy markets.

Content

1. Power markets in the past, now and in future

2. Designing liberalised power markets

2.1. Unbundling Dimensions of liberalised power markets
2.2. Central dispatch versus markets without central dispatch
2.3. The short-term market model
2.4. The long-term market model
2.5. Market flaws and market failure
2.6. Regulation in liberalised markets

3. The power (sub)markets

3.1 Day-ahead market
3.2 Intraday market
3.3 (Long-term) Forwards and futures markets
3.4 Emission rights market
3.5 Market for ancillary services
3.6 The “market” for renewable energies
3.7 Future market segments

4. Grid operation and congestion management

4.1. Grid operation
4.2. Congestion management

5. Market power

5.1. Defining market power
5.2. Indicators of market power
5.3. Reducing market power

6. Future market structures in the electricity value chain

1. Power markets in the past, now and in future

2. Designing liberalised power markets

2.2. Unbundling Dimensions of liberalised power markets
2.3. Central dispatch versus markets without central dispatch
2.4. The short-term market model
2.5. The long-term market model
2.6. Market flaws and market failure
2.7. Regulation in liberalised markets

3. The power (sub)markets

3.1 Day-ahead market
3.2 Intraday market
3.3 (Long-term) Forwards and futures markets
3.4 Emission rights market
3.5 Market for ancillary services
3.6 The “market” for renewable energies
3.7 Future market segments

4. Grid operation and congestion management

4.1. Grid operation
4.2. Congestion management

5. Market power

5.1. Defining market power
5.2. Indicators of market power
5.3. Reducing market power

6. Future market structures in the electricity value chain

Workload

The total workload for this module is approximately 180 hours.

M 7.147 Module: Lighting Engineering [M-ETIT-100485]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100772	Lighting Engineering	4 CR	Neumann

Prerequisites
none

7.148 Module: Lightweight Engineering Design [M-MACH-102696]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105221	Lightweight Engineering Design	4 CR	Düser, Ott

Competence Certificate
Written examination (90 min)

Prerequisites
none

Competence Goal
The students are able to ...

- evaluate the potential of central lightweight strategies and their application in design processes.
- apply different stiffing methods qualitatively and to evaluate their effectiveness.
- evaluate the potential of computer-aided engineering as well as the related limits and influences on manufacturing.
- reflect the basics of lightweight construction from a system view in the context of the product engineering process.

Content
General aspects of leightweight design, lightweight strategies, construction methods, design principles, lightweight construction, stiffening techniques, lightweight materials, virtual product engineering, bionics, joining techniques, validation, recycling

Additionally, guest speakers from industry will present lightweight design from an practical point of view.

Workload
1. Time of presence lecture: 15 * 2 h = 30 h

2. Prepare/follow-up lecture: 15 * 2 h = 30 h

3. Exam preparation and time of presence: 60 h
Total: 120 h = 4 LP

Literature
Klein, B.: Leichtbau-Konstruktion. Vieweg & Sohn Verlag, 2007

Wiedemann, J.: Leichtbau: Elemente und Konstruktion, Springer Verlag, 2006

Harzheim, L.: Strukturoptimierung. Grundlagen und Anwendungen. Verlag Harri Deutsch, 2008

M 7.149 Module: Localization of Mobile Agents (24613) [M-INFO-100840]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-INFO-101377	Localization of Mobile Agents	6 CR	Hanebeck
T-INFO-114169	Localization of Mobile Agents Pass	0 CR	Hanebeck

M 7.150 Module: Logistics and Supply Chain Management [M-MACH-105298]

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

Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each summer term	1 term	English	4	2

Mandatory			
T-MACH-110771	Logistics and Supply Chain Management	9 CR	Furmans

Competence Certificate
The assessment consists of a 120 minutes written examination (according to §4(2), 1 of the examination regulation).

Prerequisites
None

Competence Goal
The student

- has comprehensive and well-founded knowledge of the central challenges in logistics and supply chain management, an overview of various practical issues and the decision-making requirements and models in supply chains,
- can model supply chains and logistics systems using simple models with sufficient accuracy,
- identifies cause-effect relationships in supply chains,
- is able to evaluate supply chains and logistics systems based on the methods they have mastered.

Content
Logistics and Supply Chain Management provides comprehensive and well-founded fundamentals for the crucial issues in logistics and supply chain management. Within the scope of the lectures, the interaction of different design elements of supply chains is emphasized. For this purpose, qualitative and quantitative description models are used. Methods for mapping and evaluating logistics systems and supply chains are also covered. The lecture contents are enriched by exercises and case studies and partially the comprehension of the contents is provided by case studies. The interacting of the elements will be shown, among other things, in the supply chain of the automotive industry.

Module grade calculation
grade of the module is grades of the exam

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

- lecture: 60 h

independent study:

- preparation and follow-up lectures: 90 h
- preparation of case studies: 60 h
- examination preparation: 60 h

total: 270 h

Recommendation
none

Learning type
Lectures, tutorials, case studies.

Literature
Knut Alicke: Planung und Betrieb von Logistiknetzwerken: Unternehmensübergreifendes Supply Chain Management, 2003

Dieter Arnold et. al.: Handbuch Logistik, 2008

Marc Goetschalkx: Supply Chain Engineering, 2011

M 7.151 Module: Machine Dynamics [M-MACH-102694]

Responsible: Prof. Dr.-Ing. Carsten Proppe
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-105210	Machine Dynamics	5 CR	Proppe

Competence Certificate
Written examination

Prerequisites
none

Competence Goal
Students are able to apply engineering-oriented calculation methods in order to model and to understand dynamic effects in rotating machinery. This includes the investigation of runup, stationary operation of rigid rotors including balancing, transient and stationary behavior of flexible rotors, critical speeds, dynamics of slider-crank mechanisms, torsional oscillations.

Content
1. Introduction

2. Machine as mechatronic system
3. Rigid rotors: equations of motion, transient and stationary motion, balancing
4. Flexible rotors: Laval rotor (equations of motion, transient and stationary behavior, critical speed, secondary effects), refined models)
5. Slider-crank mechanisms: kinematics, equations of motion, mass and power balancing

Workload
Lectures and exercices: 32 h

Studies: 118 h

Learning type
Lecture, tutorial

M 7.152 Module: Machine Learning - Basic Methods [M-INFO-105252]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	English	4	4

Mandatory			
T-INFO-110630	Machine Learning - Basic Methods	5 CR	Neumann

7.153 Module: Machine Learning - Foundations and Algorithms [M-INFO-107169]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-111558	Machine Learning - Foundations and Algorithms	6 CR	Neumann

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-INFO-105252 - Machine Learning - Basic Methods must not have been started.

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 7.154 Module: Machine Learning 1 [M-WIWI-105003]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-WIWI-106340	Machine Learning 1 - Basic Methods	5 CR	Zöllner

Competence Certificate
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.

7.155 Module: Machine Learning 2 [M-WIWI-105006]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-WIWI-106341	Machine Learning 2 – Advanced Methods	5 CR	Zöllner

Competence Certificate
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

M 7.156 Module: Machine Learning and Optimization in Energy Systems [M-WIWI-106604]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-WIWI-113073	Machine Learning and Optimization in Energy Systems	4 CR	Fichtner

Competence Certificate
The assessment of this module is a written examination (60 min) or an oral exam (30 min) depending on the number of participants.

Prerequisites
None.

Competence Goal
Participants know about the most common optimization and machine learning approaches for the application in energy systems. They understand the basic principles of the methods and are able to apply them for solving important problems of future energy systems with high shares of renewable energy sources.

Content
In the beginning, the essential transition of the energy system into a smart grid and the need for methods from the field of optimization and machine learning are explained. The course can be subdivided into an optimization part and a larger machine learning part. In the optimization part, the basics of optimization approaches that are used in energy systems are shown. Further, heuristic methods and approaches from the field of multiobjective optimization are introduced. In the machine learning part, the most important methods from the field of unsupervised learning, supervised learning and reinforcement learning are introduced and their application in future energy systems are investigated.

Amongst the considered applications are power plant dispatch, intelligent heating with heat pumps, charging strategies for electric vehicles, clustering of energy data for energy system models and electricity demand and renewable generation forecasting.

We also offer a voluntary computer exercise that deepens the understanding of the methods and applications covered in the lecture. The students will have the opportunity to solve problems from the energy domain by using optimization and machine learning approaches implemented in the programming language Python.

The course's general focus is on the application of the methods in the energy field and not on the mathematical details of the different approaches.

Module grade calculation
The module grade is the grade of the written or oral exam.

Workload
The total workload for this module is approximately 120 hours:

- Attendance: 30 hours
- Self-study: 45 hours
- Exam preparation: 55 hours

M 7.157 Module: Machine Learning for Robotic Systems 1 [M-MACH-106457]

Responsible: Jun.-Prof. Dr. Rania Rayyes

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-113064	Machine Learning for Robotic Systems 1	5 CR	Rayyes

Competence Certificate
The assessment of this course is a written examination (90 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.

Prerequisites
None

Competence Goal

- Students acquire knowledge of the basic methods and concepts of Machine Learning
- Students can select suitable models and methods for learning problem in robotic systems
- Students can evaluate, compare and judge different machine learning models
- Student can implement and apply Machine Learning methods for Robotic Applications

Content
This lecture provides an overview of essential and current methods and concepts of Machine Learning for different robotic applications. It covers also their underlying mathematical and statistical methods. Important fundamental terminology, concepts and methods are presented for various topics including:

- Model selection, machine learning bias vs. parameter optimization
- Training, test, validation, generalization, overfitting, regularization
- Supervised vs unsupervised learning
- Regression
- Classifications
- Neural Networks
- Gaussian mixtures, Gaussian mixture regression

And other interesting topics

Annotation
None

Workload
150h

- approx 25h lecture attendance
- approx 25h attendance of exercises
- approx 70h studying and completing of the exercise sheets
- approx 30h exam preparation

Recommendation
None

Learning type
Lecture, exercise

Literature
None

M 7.158 Module: Machine Learning for Robotic Systems 2 [M-MACH-106652]

Responsible: Jun.-Prof. Dr. Rania Rayyes
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-113403	Machine Learning for Robotic Systems 2	5 CR	Rayyes

Competence Certificate
The assessment of this course is a written examination (90 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.

Prerequisites
None

Competence Goal
- Students acquire knowledge of the basic methods and concepts of Machine Learning
- Students can select suitable models and methods for learning problems in robotic systems
- Students can evaluate, compare, and judge different machine learning models
- Students can implement and apply Machine Learning methods for Robotic Applications

Content
This lecture provides an overview of current advanced machine learning for different robotic applications. Important fundamental terminology, concepts, and methods are presented for various topics including:
- Active Learning
- Transformers
- Adversarial learning, GANs
- Deep Reinforcement Learning
- Goal-Directed Exploration
- Recurrent Neural Network

And other interesting topics

The course also includes hands-on sessions for programming and implementing the methods.

M 7.159 Module: Machine Tools and Industrial Handling [M-MACH-105107]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-110962	Machine Tools and High-Precision Manufacturing Systems	8 CR	Fleischer

Competence Certificate
Oral exam (40 minutes)

Competence Goal
The students

- are able to assess the use and application of machine tools and high-precision manufacturing systems and to differentiate between them in terms of their characteristics and design.
- can describe and discuss the essential elements of machine tools and high-precision manufacturing systems (frame, main spindle, feed axes, peripheral equipment, control unit).
- are able to select and dimension the essential components of machine tools and high-precision manufacturing systems.
- are capable of selecting and evaluating machine tools and high-precision manufacturing systems according to technical and economic criteria.

Content
The module gives an overview of the construction, use and application of machine tools and high-precision manufacturing systems. In the course of the module a well-founded and practice-oriented knowledge for the selection, design and evaluation of machine tools and high-precision manufacturing systems is conveyed. First, the main components of the systems are systematically explained and their design principles as well as the integral system design are discussed. Subsequently, the use and application of machine tools and high-precision manufacturing systems will be demonstrated using typical machine examples. Based on examples from current research and industrial applications, the latest developments are discussed, especially concerning the implementation of Industry 4.0 and artificial intelligence.
Guest lectures from industry round off the module with insights into practice.

The individual topics are:

- Structural components of dynamic manufacturing Systems
- Feed axes: High-precision positioning
- Spindles of cutting machine Tools
- Peripheral Equipment
- Machine control unit
- Metrological Evaluation
- Maintenance strategies and condition Monitoring
- Process Monitoring
- Development process for machine tools and high-precision manufacturing Systems
- Machine examples

Workload
1. Presence time lecture/exercise: 15 * 6 h = 90 h
2. Pre- and post-processing time lecture/exercise: 15 * 9 h = 135 h
3. Exam preparation and presence in the same: 15 h
In total: 240 h = 8 LP

Learning type
Lecture, exercise, field trip

M 7.160 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: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-105223	Machine Vision	8 CR	Lauer, Stiller

Competence Certificate
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

Learning type
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 7.161 Module: Magnet Technology of Fusion Reactors [M-MACH-107223]

Responsible: Dr. Klaus-Peter Weiss
Dr. Michael Wolf

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German/English	4	1

Mandatory			
T-MACH-105434	Magnet Technology of Fusion Reactors	4 CR	Weiss, Wolf

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
The goal of the lecture is to impart the fundamentals of construction of superconducting magnets. Magnet technology is inherently of multidisciplinary character e.g. material properties at low temperature, high voltage and high current technique. The use of superconductors is mandatory to reach highest magnetic fields with comparable small losses. Examples of magnets from power application, basic research and fusion reactor construction are discussed.

Educational objective: The students know:

- Magnetic plasma confinement principles in connection with fusion machine
- Examples and basic properties of different superconductors
- Basics of formation of superconducting cables and magnet construction
- Generation of low temperature, cryostat construction
- Basics of magnet design and magnet safety
- Material testing and material properties at low temperatures
- High-temperature superconductor use in magnet construction and power application

Content
The lecture will show basic principles for design and construction of such magnets and includes:

- Introduction with examples to nuclear fusion and to magnetic plasma confinement
- Basics of low temperature and high temperature properties and cryotechnique
- Material testing and critical material properties at low temperatures
- Principles of magnet design, construction and safe magnet operation
- Present status and magnet examples from fusion projects ITER, W7-X and JT-60SA
- Application of high temperature superconductors on fusion and power engineering

Lecture Content:

- Basics of nuclear fusion and design aspects of fusion magnets
- Superconductors - basics and stability
- Low temperature cryogenic aspects
- Low temperature and high temperature superconductors
- Cryogenic material testing and properties of fusion materials at low temperatures
- Quench and high voltage aspects for magnets
- Status and magnets of fusion machines ITER, W7-X, JT-60SA & future DEMO
- Impact of high temperature superconductors on fusion and power engineering

Module grade calculation
The module grade is the grade of the oral exam.

Workload
120h
(for details see individual course)

M 7.162 Module: Master's Thesis [M-ETIT-107192]

Responsible: Prof. Dr. Martin Doppelbauer
Prof. Dr.-Ing. Marcus Geimer

Organisation: KIT Department of Electrical Engineering and Information Technology
KIT Department of Mechanical Engineering

Part of: Master's Thesis

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
30	Grade to a tenth	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-114214	Master's Thesis	30 CR	Doppelbauer, Geimer

Competence Certificate
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 Conditions
The following conditions have to be fulfilled:

1. You need to have earned at least 75 credits in the following fields:
    - Elective Area in Mechatronics and Information Technology
    - Field of Specialization in Mechatronics and Information Technology
    - Interdisciplinary Qualifications

Competence Goal
After successful completion of the module, students are able to work independently on a challenging task in the field of mechatronics 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 mechatronics 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 Mechatronics and Information Technology.

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 the KIT Department of Mechanical Engineering or a habilitated member of the two KIT Departments 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)).

7.163 Module: Material Flow in Logistic Systems [M-MACH-104984]

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

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-102151	Material Flow in Logistic Systems	9 CR	Furmans

Competence Certificate
The assessment (Prüfungsleistung anderer Art) consists of the following assignments:

- 40% assessment of the final case study as individual performance,
- 60% semester evaluation which includes working on 5 case studies and defending those (For both assessment types, the best 4 of 5 tries count for the final grade.):
  - 40% assessment of the result of the case studies as group work,
  - 20% assessment of the oral examination during the case study colloquiums as individual performance.

A detailed description of the learning control can be found under Annotations.

Prerequisites
none

Competence Goal
The student

- acquires comprehensive and well-founded knowledge on the main topics of logistics, an overview of different logistic questions in practice and knows the functionality of material handling systems,
- is able to illustrate logistic systems with adequate accuracy by using simple models,
- is able to realize coherences within logistic systems,
- is able to evaluate logistic systems by using the learnt methods.

Content
The module *Material Flow in Logistic Systems* provides comprehensive and well-founded basics for the main topics of logistics. Within the lectures, the interaction between several components of logistic systems will be shown. The module focuses on technical characteristics of material handling systems as well as on methods for illustrating and evaluating logistics systems. To gain a deeper understanding, the course is accompanied by exercises and case studies.

Annotation
Students are divided into groups for this course. Five case studies are carried out in these groups. The results of the group work during the lecture period are presented and evaluated in writing. In the oral examination during the case study colloquiums, the understanding of the result of the group work and the models dealt with in the course is tested. The participation in the oral defenses is compulsory and will be controlled. For the written submission the group receives a common grade, in the oral defense each group member is evaluated individually.

After the lecture period, there is the final case study. This case study contains the curriculum of the whole semester. The students work individually on this case study which takes place at a predefined place and time (duration: 4h).

Recommendation
Recommended elective subject: Probability Theory and Statistics

Learning type
Lecture, tutorial

7.164 Module: Materials for Lightweight Construction [M-MACH-102727]

Responsible: Dr.-Ing. Wilfried Liebig
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105211	Materials of Lightweight Construction	4 CR	Liebig

Competence Certificate
Oral exam, about 25 minutes

Prerequisites
none

Competence Goal
The students are capable to name different lightweight materials and can describe their composition, properties and fields of application. They can describe the hardening mechanisms of lightweight materials and can transfer this knowledge to applied problems.
The students can apply basic mechanical models of composites and can depict differences in the mechanical properties depending on composition and structure. The students can describe the basic principle of hybrid material concepts and can judge their advantages in comparison to bulk materials. The students can name special materials for lightweight design and depict differences to conventional materials. The students have the ability to present applications for different lightweight materials and can balance reasons for their use.

Content
Introduction

Constructive, production-orientied and material aspects of lightweight construction

Aluminium-based alloys
Aluminium wrought alloys
Aluminium cast alloys

Magnesium-based alloys
Magnesium wrought alloys
Magnesium cast alloys

Titanium-based alloys
Titanium wrought alloys
Titanium cast alloys

High-strength steels
High-strength structural steels
Heat-treatable and hardenable steels

Composites - mainly PMC
Matrices
Reinforcements

Workload
The workload for the lecture “Design with Plastics” is 120 h per semester and consists of the presence during the lectures (21 h), preparation and rework time at home (50 h) and preparation time for the oral exam (49 h).

M 7.165 Module: Materials Recycling and Sustainability [M-MACH-107043]

Responsible: Dr.-Ing. Wilfried Liebig
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-110937	Materials Recycling and Sustainability	4 CR	Liebig

Competence Certificate
oral exam (about 25 min.)

Prerequisites
none

Competence Goal
Students are able to reproduce the history of sustainability, classify the limits of recycling, understand the relevance of manufacturing responsibility, enumerate and apply the basic principles of recycling optimised design, define, classify and critically question the concept of obsolescence and examine the interaction between recycling and sustainability. In addition, students will be able to define the basic concepts of recycling, work out the differences between recycling, downcycling and upcycling, mass and waste flows and their origins, name the work processes involved in recycling and apply them to different material classes as well as explain the specific challenges for the respective material class.

Content
The lecture series is organised in two main topics: On the one hand, fundamentals of sustainability are explained and it is shown how to tread more sustainable paths in materials science and mechanical engineering. On the other hand, separation and recycling processes for all common classes of materials are presented and discussed. It is shown how recycling fosters a holistic and sustainable perspective on material processing and use.

1. legal bases and historical background
2. climate change, ecology and material flows
3. sustainability in general
4. product responsibility, recyclable design and planned obsolescence
5. general and legal bases of recycling
6. material separation, sorting and processing
7. recycling of metals
8. recycling of polymers and composites
9. recycling of everyday materials
10. alternative materials and alternative design concepts
11. materials for renewable energy sources

Module grade calculation
The module grade is the grade of the oral examination.

Workload
The workload for the lecture “Materials Recycling and Sustainability” is 120 h per semester:

It consists of the presence during the lectures (21 h), preparation and rework time at home (50 h) and preparation time for the oral exam (49 h).

7.166 Module: Mathematical Methods in Continuum Mechanics [M-MACH-106210]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	3

Mandatory			
T-MACH-110375	Mathematical Methods in Continuum Mechanics	4 CR	Böhlke
T-MACH-110376	Tutorial Mathematical Methods in Continuum Mechanics	2 CR	Böhlke

Prerequisites
M-MACH-106764 must not be started.

M 7.167 Module: Mathematical Methods in Fluid Mechanics [M-MACH-107032]

Responsible: Prof. Dr.-Ing. Bettina Frohnapfel
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German/English	4	1

Mathematical Methods in Fluid Mechanics (Election: at most 6 credits)			
T-MACH-113955	Mathematical Methods in Fluid Mechanics	6 CR	Frohnapfel, Gatti
T-MACH-113956	Mathematical Methods in Fluid Mechanics	6 CR	Frohnapfel, Gatti

Competence Certificate
written exam - 90 minutes

Competence Goal
Students deepen and explain mathematical methods for solving the Navier-Stokes equations. They transfer these to technical problems. They are able to select suitable methods and discuss their application critically.

Content
The students can simplify the Navier-Stokes equations for specific flow problems. They are able to employ mathematical methods in fluid mechanics effectively in order to solve the resulting governing equations analytically, if possible, or to enable simpler numerical solution of the problem. The students can describe the limits of applicability of the assumptions made to model the flow behavior.

The lecture will cover a selection of the following topics:

- Creeping flows (Stokes flow)
- Lubrication theory
- Potential flow theory
- Boundary-layer theory
- Laminar-turbulent transition (linear stability theory)
- Turbulent flows

Module grade calculation
result of exam

Workload
see individual courses

Learning type
Lecture, Tutorial

Literature
Kundu, P.K., Cohen, K.M.: Fluid Mechanics, Elsevier, 4th Edition, 2008

Kuhlmann, H.: Strömungsmechanik, Pearson, 2007

Spurk, J. H.: Strömungslehre, Springer, 2006

Zierep, J., Bühler, K.: Strömungsmechanik, Springer, 1991

Schlichting H., Gersten K., Grenzschichttheorie, Springer, 2006

Kundu, P.K., Cohen, K.M.: Fluid Mechanics, Elsevier, 4th Edition, 2008

Batchelor, G.K.: An Introduction to Fluid Dynamics, Cambridge Mathematical Library, 2000

Pope, S. B.: Turbulent Flows, Cambridge University Press, 2000

Ferziger, H., Peric, M.: Computational Methods for Fluid Dynamics, Springer, 2008

7.168 Module: Mathematical Methods in Hydraulics [M-MACH-107210]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-113912	Mathematical Methods in Hydraulics	4 CR	Geimer
T-MACH-113913	Tutorial Mathematical Methods in Hydraulics	2 CR	Geimer

Competence Certificate
Oral examination, duration approx. 30 minutes

Successful completion of Ilias tests. Details will be announced in the first lecture.

Prerequisites
none

Competence Goal
Students are able to mathematically model hydraulic systems and set up differential equations, e.g. in the form of pressure build-up equations. They recognize and understand the analogies between hydraulic, electrical, mechanical and thermal systems.
In addition, students are able to select and apply suitable mathematical methods for solving hydraulic problems. This includes both analytical and numerical methods for solving the pressure curve over time.
Students are able to describe the dynamic behavior of hydraulic systems and differentiate between various simulation approaches for calculating these systems.
Students are able to apply the mathematical methods they have learned to real hydraulic problems and to critically question and evaluate the results obtained.

Content

- Fundamentals of hydraulics,
- Description of components for converting mechanical energy into hydraulic energy and vice versa (pumps and motors),
- Presentation of components for controlling pressure and volume flow (pressure and flow valves),
- Presentation and description of hydraulic systems,
- Solution methods for the pressure curve over time
- Simulation approaches for hydraulic networks

Module grade calculation
The module grade is the grade of the oral examination.

Workload
The workload includes:

1. attendance time in lectures, exercises (4 SWS): 15*4 h = 60 h

2. preparation/follow-up of the same: 15*4 h = 60 h

3. exam preparation and attendance: 60 h

Total: 180 h = 6 LP

M 7.169 Module: Mechanical Properties of Nanomaterials and Microsystems [M-MACH-107185]

Responsible: Dr. Patric Gruber
Prof. Dr. Christoph Kirchlechner
Dr. Daniel Weygand

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-114018	Mechanical Properties of Nanomaterials and Microsystems	4 CR	Gruber, Kirchlechner, Weygand

Competence Certificate
oral exam ca. 30 minutes

Prerequisites
none

Competence Goal
The students know and understand size and scaling effects in micro- and nanosystems based on the fundamental microstructure mechanisms at play. They can describe the mechanical behavior of nano- and microstructured materials and analyze and explain the origin for the differences compared to classical material behavior. They are able to explain suitable processing routes, experimental characterization techniques and adequate modelling schemes for nano- and microstructured materials. They also understand the relevance of mechanical phenomena in small dimensions and can judge how they determine material processing as well the performance and the design of microsensors and microactuators.

Content
1. Introduction: Application and properties of micro- and nanosystems; Overview on size effects
2. Fundamentals: Dislocation plasticity (definition of a dislocation; dislocation density, mobility, dislocation sources, statistical aspects incl. SSDs and GNDs).
3. Single crystal plasticity: mechanical and microstructure characterization, mechanisms and their size dependence.
4. Interface plasticity: Compatibility, slip transfer mechanisms, expected size effects.
5. Modelling of mechanisms causing size effects in crystals and at grain boundaries, e.g. dislocation dynamics.
6. Thin film materials: synthesis, characterization and mechanical properties.
7. Nanocrystalline materials: Synthesis, outstanding mechanical properties
8. Elektro-mechanical conversion: piezo-resistive, piezo-elektric, elektrostatic, ...
9. Actuation: inverse piezoelectric effect, shape-memory, electromagnetic, …

Module grade calculation
see individual course

Workload
120h
regular attendance: 22,5 hours
self-study: 97,5 hours

Learning type
Lecture

7.170 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-113425	Medical Image Processing for Guidance and Navigation	9 CR	Spadea

Competence Certificate
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.

Annotation
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

Recommendation

- 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

Learning type
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)

7.171 Module: Micro System Simulation [M-MACH-105486]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-108383	Microsystem Simulation	4 CR	Korvink

Competence Certificate
Written exam (120 min)

Competence Goal
Students are able to formulate the finite element method such as needed for mechanics, heat transfer, or transport processes. They are familiar with approximation using functions, and the relation between a finite element CAD model, and the underlying mechanism to solve the equations, an essential basis for modern engineering design.

Content
Microsystems are multiphysical devices. For example, in order to measure infrared radiation, a microsystem might use the Seebeck (thermoelectric) effect, which couples heat to electrical currents – thus radiation, heat flow, and charge transport are coupled in a multiphysical manner.

Because microsystemcomponents are very small (in the micrometre range), often the operational modalities will be described better bystatistical mechanics or evenquantum mechanics, so that we have to take caution to use the right models.

In many cases, commercial tools are unavailable, so that engineers are forcedbuild their own simulation programs to be able to make intelligent designs.

In this lecture you will learn the fundamentals needed to build such a computer program. Because we want to be very efficient in learning, and not re-invent all the wheels or confront computer science issues such as compilation and libraries, you will learn to build your program in the higher level programming environment Mathematica ®.

Annotation
The lecture is aimed at students who wish to learn the basis of numerical modelling and simulation programs, so as to understand the functioning of these most important engineering design tools. Practical examples are taken from microsystems engineering to illustrate the concepts.

Workload
Literature: 20 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Recommendation
There are no requirements for background, however, I recommend that you have at least the following: Basic knowledge in engineering, physics, and mathematics.

Regular attendance is definitely recommended, as well as doing all the exercises.

Literature

The following references are usedby the lecturers to prepare the lecture. Students are not required to access most of these, but of course it does not hurt! Hints for efficient further reading, depending on interest, will be provided during the lecture.

- E. Buckingham, On physically similar systems: illustrations on the use of dimensional equations, Phys. Rev. 4, 345–376 (1914)
- E. Buckingham, Model Experiments and the Forms of Empirical Equations, ASME 263–296 (1915)
- K. Eriksson, D. Estep, P. Hansbo, C. Johnson, Computational Differential Equations, Cambridge University Press, Cambridge (1996)
- Bengt Fornberg, Calculation of Weights in Finite Difference Formulas, SIAM Rev. 40(3) 1998
- Gene H. Golub, Charles F. van Loan, Matrix Computations, John Hopkins University Press 1996
- H. Hanche-Olsen, Buckingham's pi-theorem, Internet (2004)
- Arieh Iserles, A First Course in the Numerical Analysis of Differential Equations, Cambridge University Press, Cambridge (1996)
- Mathematica Help Documentation
- N. Metropolis, A.W. Rosenbluth, M.N. Rosenbluth. A.H. Teller and E. Teller, "Equation of State Calculations by Fast Computing Machines, J. Chem. Phys. 21 (1953) 1087-1092.
- Rick Beatson and Leslie Greengard, A short course on fast multipole methods

M 7.172 Module: Microactuators [M-MACH-100487]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-101910	Microactuators	4 CR	Kohl

Competence Certificate
Written exam: 60 min

Prerequisites
none

Competence Goal
- Knowledge of the actuation principles including pros and cons
- Knowledge of important fabrication technologies
- Explanation of layout and function of the microactuators
- Calculation of important properties (time constants, forces, displacements,
etc.)
- Development of a layout based on specifications

Content
- Basic knowledge in the material science of the actuation principles
- Layout and design optimization
- Fabrication technologies
- Selected developments
- Applications

The lecture includes amongst others the following topics:

- Microelectromechnical systems: linear actuators, microrelais, micromotors
- Medical technology and life sciences: Microvalves, micropumps, microfluidic systems
- Microrobotics: Microgrippers, polymer actuators (smart muscle)
- Information technology: Optical switches, mirror systems, read/write heads

Workload
lTime 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

- Lecture notes
- D. Jendritza, Technischer Einsatz Neuer Aktoren: Grundlagen, Werkstoffe, Designregeln und Anwendungsbeispiele, Expert-Verlag, 3. Auflage, 2008
- M. Kohl, Shape Memory Microactuators, M. Kohl, Springer-Verlag Berlin, 2004
- N.TR. Nguyen, S.T. Wereley, Fundamentals and applications of Microfluidics, Artech House, Inc. 2002
- H. Zappe, Fundamentals of Micro-Optics, Cambride University Press 2010

M 7.173 Module: Microenergy Technologies [M-MACH-102714]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	2

Mandatory			
T-MACH-105557	Microenergy Technologies	4 CR	Kohl, Xu

Competence Certificate
Oral exam: 45 min

Prerequisites
none

Competence Goal
The students can:

- describe the energy conversion principles and exemplify them
- explain the underlying concepts of thermodynamics and materials science
- illustrate the layout, fabrication and function of the treated devices
- calculate important properties (time constants, power output, efficiency, etc.)
- develop a layout based on specifications

Content
- Basic physical principles of energy conversion - Layout and design optimization - Technologies - Selected devices - Applications

The lecture includes amongst others the following topics:

- Micro energy harvesting of vibrations using different conversion principles (piezo, electrostatic, electromagnetic, etc.)
- Thermoelectric energy generation
- Novel thermal energy conversion principles (thermomagnetic, pyroelectric)
- Miniature scale solar devices
- RF energy harvesting
- Miniature scale heat pumping
- Solid-state cooling technologies (magneto-, electro-, mechanocalorics)
- Power management
- Energy storage technologies (microbatteries, supercapacito4rs, fuel cells)

Module grade calculation
Module grade calculation
The module grade is the grade of the written exam.

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
- Lecture notes (overhead transparencies) „Micro Energy Technologies“

- Stephen Beeby, Neil White, Energy Harvesting for Autonomous Systems, Artech House, 2010

- Shashank Priya, Daniel J. Inman, Energy Harvesting Technologies, Springer, 2009

M 7.174 Module: Microsystem Product Design for Young Entrepreneurs [M-MACH-107195]

Responsible: Dr.-Ing. Dario Mager
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	English	4	1

Mandatory			
T-MACH-105814	Microsystem Product Design for Young Entrepreneurs	4 CR	Korvink, Mager

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
- Assessing one's own (technical) strengths and weaknesses, also in direct comparison with team members
- The ability to correctly assess the amount of work involved in solving a problem
- Looking at products not only in terms of their technical benefits, but also considering other aspects such as cost-effectiveness and feasibility.

Content
This event is all about developing your own product as a team and perhaps even founding your own company. Many successful products are manageable in their complexity and can therefore also be developed by small start-ups without a large development department. What is more important is that they hit the nerve of the times and make customers' lives better. Examples of this are products such as the fascia roll (very expensive construction foam) or the stitch healer Heat-it (a clever heater). The latter was developed as part of this course.

The aim of the course is for you to come together as a team and jointly design a product that suits the team. In the course of the semester, the first prototypes are then built and possible market opportunities evaluated. Starting a company is difficult to plan and it always helps to get external feedback, which is why many teams then take part in the VDE's Cosima student competition (cosima-mems.de), where they can measure their product against that of other teams.

You can come to the event as a ready-made team or find yourself here, but since teams (3-5 people) are always needed, it would be great if you could send me a non-binding e-mail (dario.mager@kit.edu) up to one week before the start of the lecture to let me know that you are interested in the event.

Module grade calculation
see individual course

Workload
120h
(for details see individual course)

7.175 Module: Microsystem Technology [M-ETIT-100454]

Responsible: Prof. Dr. Wilhelm Stork

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100752	Microsystem Technology	3 CR	Stork

Competence Certificate
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

M 7.176 Module: Microwave Engineering [M-ETIT-100535]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each term	1 term	German/English	4	1

Mandatory			
T-ETIT-100802	Microwave Engineering	5 CR	Zwick

Competence Certificate
Success control is carried out as part of a written overall examination (120 minutes) of the selected courses, which in total meet the minimum requirement for LP.

Prerequisites
none

Competence Goal
The students have a deep understanding of microwave technology with a focus on passive components of microwave circuit technology. This includes the functioning of the most important microwave components such as waveguides, filters, resonators, couplers, power dividers up to directional lines and circulators. Students are able to understand and describe how these components work. You can transfer this knowledge to other areas of high-frequency technology and use it to analyze and solve high-frequency problems. You are able to apply what you have learned in a practical way.

Content
In-depth lecture on high-frequency technology: The focus of the lecture is the teaching of the functioning of the most important passive microwave components, starting with waveguides, through filters, resonators, power dividers and couplers to directional lines and circulators.

Accompanying the lecture, exercises are given on the lecture material. These are discussed in a large hall exercise and the associated solutions are presented in detail.

Module grade calculation
The module grade is the grade of the written exam.

Annotation
WS: German
SS: English
The exam is in each semester and for every student bilingual.

Workload
The workload includes: Attendance study time lecture / exercise: 45 h Self-study time including exam preparation: 105 h A total of 150 h = 5 LP

Recommendation
Knowledge of the basics of high frequency technology is helpful.

7.177 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 Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	English	4	1

Mandatory			
T-ETIT-113938	Microwave Engineering Lab	6 CR	Zwick

Competence Certificate
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

Recommendation
Knowledge of microwave measurement technology and RF components and systems is helpful.

7.178 Module: Microwaves Measurement Techniques [M-ETIT-100424]

Responsible: Dr.-Ing. Mario Pauli
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology) (Usage until 3/31/2026)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	4

Mandatory			
T-ETIT-100733	Microwaves Measurement Techniques	4 CR	Zwick

Competence Certificate
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 an in-depth knowledge of the structure and functioning of microwave measuring devices (signal generator, power measurement, frequency measurement, spectral analyzer, network analyzer). They understand the special features of measuring powers, frequencies and scattering parameters in the microwave range. You can apply the knowledge you have learned in practice and interpret the measurement results. You can analyze and assess possible sources of error in the measurement. You are able to design measurement setups with given measurement values ??and to carry out the measurements correctly.

Content
This lecture contains all basic areas of today's high-frequency measurement techniques, such as power measurement, frequency measurement, spectral analysis and network analysis. Particular attention is paid to the description of those measurement systems and methods that are used in modern applications.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
The workload includes:

Attendance study time lecture / exercise: 45 h

Self-study time including exam preparation: 75 h

A total of 120 h = 4 LP

Recommendation
Knowledge of the basics of high frequency technology is helpful.

7.179 Module: Microwaves Measurement Techniques [M-ETIT-107007]

Responsible: Dr.-Ing. Mario Pauli
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology) (Usage from 4/1/2026)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-114046	Microwaves Measurement Techniques	4 CR	Zwick

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

Prerequisites
none

Competence Goal
The students have an in-depth knowledge of the structure and functioning of microwave measuring devices (signal generator, power measurement, frequency measurement, spectral analyzer, network analyzer). They understand the special features of measuring power, frequency and scattering parameters in the microwave range. They can apply the knowledge
they have learned in practice and interpret the measurement results. They can analyze and assess possible sources of error in the measurement. They are able to design measurement setups and to carry out measurements correctly.

Content
This lecture contains all basic areas of today's high-frequency measurement techniques, such as power measurement, frequency measurement, spectral analysis and network analysis. Particular attention is paid to the description of those measurement systems and methods that are used in modern applications.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
The workload includes:

Attendance study time lecture / exercise: 45 h

Self-study time including exam preparation: 75 h

A total of 120 h = 4 CR

Recommendation
Knowledge of the basics of high frequency technology is helpful.

M 7.180 Module: Miniaturized Heat Transfer [M-MACH-107063]

Responsible: Prof. Dr.-Ing. Jürgen Brandner
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-108613	Miniaturized Heat Exchangers	4 CR	Brandner

Competence Certificate
See course

Competence Goal
After completing this module, students will be able to calculate, design and define miniaturized heat exchangers and solve basic problems in microfluidics

Content
Advantages and disadvantages of miniaturization, basics of microfluidics; basics of heat transfer, design principles for microstructure heat exchangers, types of heat exchangers, materials and manufacturing methods, sensors and measurement technology, applications

Module grade calculation
The module grade corresponds to the grade of the oral examination

Workload
120h

Learning type
Lecture

Literature
V. Hessel, A. Renken, J.C. Schouten, J. Yoshida: Micro Process Engineering: A comprehensive handbook; Wiley-VCH
H.-O. Demski (ed.): Kompakt-Wärmeübertrager; Publico Publications
W. Wagner: Wärmeübertragung; Vogel Fachbuch - Kamprath-Reihe
W. Wagner: Heat exchangers; Vogel Fachbuch - Kamprath series

M 7.181 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	English	4	1

Mandatory			
T-ETIT-111006	MMIC Design Laboratory	6 CR	Ulusoy

Competence Certificate
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

Recommendation
Radio-Frequency Integrated Circuits and Systems, Modern Radio Systems Engineering, Microwave Engineering, Electromagnetics and Numerical Calculation of Fields

M 7.182 Module: Mobile Machines [M-MACH-107041]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105168	Mobile Machines	8 CR	Geimer

Competence Certificate
The assessment consists of an oral exam (45 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Prerequisites
none

Competence Goal
The student

- knows and understands the basic structure of the machines,
- masters the basic skills required to develop selected machines.

Content

- Introduction of the required components and machines
- Basics of the structure of the whole system
- Practical insight in the development techniques

Knowledge in Fluid Power is required.

Module grade calculation
see individual course

Annotation
It is recommended to attend the course *Fluid Power Systems* [2114093] beforehand.

Workload

- Attendance time: 42 hours
- Self-study: 198 hours

Recommendation
Knowledge in Fluid Power Systems is required. It is recommended to attend the course *Fluid Power Systems* [2114093] beforehand.

M 7.183 Module: Modern Control Concepts I [M-MACH-105308]

Responsible: apl. Prof. Dr. Lutz Groell
apl. Prof. Dr. Jörg Matthes

Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105539	Modern Control Concepts I	4 CR	Groell, Matthes

Competence Certificate
A performance assessment is held in form of a written examination of 60 minutes.

Prerequisites
None

Competence Goal
After attending the lecture, the students are able to

- Analyze linear systems with respect to various properties,
- Identify linear dynamic models,
- Design linear controllers with feedforward control in the time domain and incooperate actuator limits,
- Use Matlab for the realization of the considered concepts and
- Implement controllers in software.

Content

1. Introduction (system classes, nomenclature)
2. Equilibria
3. Linearization (software based, Hartman-Grobman-Theorem)
4. Parameter identification of linear dynamic models (SISO+MIMO)
5. PID-controller (realization, design-hints, Anti-Windup-mechanisms)
6. Conzept of 2DOF-Controllers (structure, reference signal design)
7. State space (geometric view)
8. Controller with state feedback and integrator expansion
   (LQ-design, Eigenvalue placement, decoupling design)
9. Observer (LQG-design, disturbance observer, reduced observer)

Workload

1. Attendance time Lecture: 15 * 1.5h = 22.5h
2. Pre- and postprocessing time Lecture: 15 * 3.5h = 52.5h
3. Exam preparation and attendance exam: 45h

Total: 120h = 4 LP

Recommendation
The attendance of the following lecture is recommended:

- Grundlagen der Mess- und Regelungstechnik

Alternativatly: comparable lectures at „Fakultät für Elektrotechnik und Informationstechnik“

Learning type
Lecture

M 7.184 Module: Modern Control Concepts II [M-MACH-105313]

Responsible: apl. Prof. Dr. Lutz Groell
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-106691	Modern Control Concepts II	4 CR	Groell

Competence Certificate
A performance assessment is held in form of an oral examination of 30 minutes.

Prerequisites
None

Competence Goal
After attending the lectures, the students are able to

- analyze and control multivariable systems,
- analyze and control DAE systems,
- analyze and control time delay systems,
- use Matlab for simulation, analysis and synthesis of the discussed concepts,
- solve linear control problems with more routine.

Content

1. Discrete time systems
2. The role of zeros (different kinds of zeros, zero dynamics, internal model principle, repetitive control, 2Dof structures, controller design via Diophantine equations)
3. Limitations of control systems (existency question, limitations w.r.t. time and frequency domain)
4. Linear multivariable systems (state space with structural invariants, canonical forms in frequency domain, polynomial matrices, matrix fractions)
5. Multivariable control for LTI systems (coprime factorization, relative gain array analysis, decentral and cooperative controls, decoupling controls, tracking controls)
6. Internal model control (internal stability, Youla parametrization, predictive structures, different 2DoF structures)
7. Advanced control loop structures (serial and parallel cascades, multiple controller structures, inferential control, split range control, extremal controls)
8. Differential-algebraic systems of equations
9. Time delay systems
10. Open topic (based on learning progress and interests, the aforementioned topics are deepened or other topics, such as time-varying systems, model order reduction, alternative stability concepts, etc. are discussed.)

Workload

1. Attendance time Lecture: 15 * 1.5h = 22.5h
2. Pre- and postprocessing time Lecture: 15 * 3.5h = 52.5h
3. Exam preparation and attendance exam: 45h

Total: 120h = 4 LP

Recommendation
The attendance of the following lecture is recommended:

- Grundlagen der Mess- und Regelungstechnik
- Moderne Regelungskonzepte I

Alternativatly: comparable lectures at „Fakultät für Elektrotechnik und Informationstechnik“

Learning type
Lecture

Literature

- Aström, K.-J., Murray, R.M.: Feedback Systems, 2012
- Skogestad, S., Postlethwaite, I.: Multivariable Feedback Control, 2001

7.185 Module: Modern Control Concepts III [M-MACH-105314]

Responsible: apl. Prof. Dr. Lutz Groell
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-106692	Modern Control Concepts III	4 CR	Groell

Competence Certificate
A performance assessment is held in form of an oral examination of 30 minutes.

Prerequisites
None

Competence Goal
After attending the lectures, the students are able to

- analyze nonlinear systems and their solutions w.r.t. stability,
- design nonlinear controls with feedforward using different methods.

Content

1. Qualitative theory of ODEs (advanced solution term in ODEs, bifurcation, Poincaré index, equilibria in infinity)
2. Lyapunov stability (definitions, theorems, topological properties of domains of attraction, Barbashin-Krasovskii-LaSalle's theorem, Barbalat's lemma)
3. Feedback linearization
4. Modifications of feedback linearization (zero dynamics, advanced linearization)
5. Flatness-based controller design
6. Lyapunov-based controller design (backstepping desing, nonlinear damping, tracking control)
7. Passivity-based controller design
8. Sliding mode control
9. Alternative linearization concepts
10. Open topic (based on learning progress and interests, the aforementioned topics are deepened or other topics, such as alternative stability concepts, observer design for nonlinear systems, basics in differential geometry, analysis and synthesis of underactuated systems, hybrid systems, Luré-type control or adaptive control.)

Workload

1. Attendance time Lecture: 15 * 1.5h = 22.5h
2. Pre- and postprocessing time Lecture: 15 * 3.5h = 52.5h
3. Exam preparation and attendance exam: 45h

Total: 120h = 4 LP

Recommendation
The attendance of the following lecture is recommended:

- Grundlagen der Mess- und Regelungstechnik
- Moderne Regelungskonzepte I und II

Alternativatly: comparable lectures at „Fakultät für Elektrotechnik und Informationstechnik“

Learning type
Lecture

Literature

- Khalil, H.: Nonlinear Systems, 1991.
- Krstic, M.; Kanellakopoulos, I.; Kokotovic, P.: Nonlinear and Adaptive Control Design, 1995.

7.186 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	English	4	2

Mandatory			
T-ETIT-100735	Modern Radio Systems Engineering	6 CR	Zwick

Competence Certificate
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

Recommendation
Knowledge of the basics of radio frequency technology and communications technology is recommended.

M 7.187 Module: Modern VLSI Technologies [M-ETIT-106921]

Responsible: Prof. Dr. Jasmin Aghassi-Hagmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113864	Modern VLSI Technologies	6 CR	Aghassi-Hagmann

Competence Certificate
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

Recommendation
Previous knowledge from the lectures "Festkörperelektronik und Bauelemente" and "Elektronische Schaltungen" is recommended.

M 7.188 Module: Modules in English Language: [M-ETIT-107301]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of:
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
0	pass/fail	see Annotations	1 term	English	4	1

Annotation
serves as a marker, not selectable

M 7.189 Module: Modules in German Language: [M-ETIT-107300]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of:
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
0	pass/fail	see Annotations	1 term	German	4	1

Annotation
serves as a marker, not selectable

M 7.190 Module: Motion in Human and Machine - Seminar [M-INFO-102555]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	English	4	3

Mandatory			
T-INFO-105140	Motion in Human and Machine - Seminar	3 CR	Asfour

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student knows procedures for modelling human motion, as well as possibilities for its processing and analysis. He/she knows methods for learning motion primitives and mapping human motion to robots that have different kinematics and dynamics and can apply them in new contexts.

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 interdisciplinary block seminar deals with methods of modelling, generating and controlling movements in humans and robot systems. Students get an insight into this interdisciplinary field and learn the basics of biological motion, biomechanical simulation, robotics, and machine learning. In the introduction, motion generation as effect of muscle contraction is discussed. It will be shown how movement patterns can be identified and categorized based on the observation of human movements and how these patterns can be reproduced on a humanoid robot. Finally, methods for the learning of movement primitives from human demonstration will be presented and their application for the generation of motion for humanoid robots will be explained.

Annotation
The block internship is an interdisciplinary event in co-operation with the University of Stuttgart and the University of Heidelberg.

Workload
Seminar with 3 SWS, 3 LP
3 LP corresponds to 90 hours, including
30 hours attendance time
15 hours group work
20 hours literature research
20 hours manuscript preparation
5 hours video creation

Recommendation
Programming experience in C++, Python or Matlab is recommended.
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics, Mechano-Informatics and Robotics and Wearable Robotic Technologies is recommended.

M 7.191 Module: Motor Vehicle Laboratory [M-MACH-102695]

Responsible: Dr.-Ing. Michael Frey
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	4	2

Mandatory			
T-ETIT-114320	Motor Vehicle Labor (graded)	4 CR	Frey

Competence Certificate
After completion of the experiments: written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
None

Competence Goal
The students have deepened their knowledge on motor vehicles acquired in lectures and can apply it practically. They have an overview of the applied measuring technique and can execute and analyse measurements for the handling of given problem definitions. They are ready to analyze and to judge measurement results.

Content
1. Determination of the driving resistances of a passenger vehicle on a roller dynamometer; measurement of the engine performance of the test vehicle

2. Investigation of a twin-tube and a single-tube shock absorber

3. Behavior of car tyres under longitudinal forces and lateral forces

4. Behavior of car tires on wet road surface

5. Rolling resistance, energy dissipation and high-speed strength of car tires

6. Investigation of the moment transient characteristic of a Visco clutch

Module grade calculation
The module grade is the grade of the written examination.

Annotation
The admission is limited to 12 persons per group.

Workload
regular attendance: 31,5 hours
self-study: 103,5 hours

Literature
1. Matschinsky, W: Radführungen der Straßenfahrzeuge, Verlag TÜV Rheinland, 1998

2. Reimpell, J.: Fahrwerktechnik: Fahrzeugmechanik, Vogel Verlag, 1992

3. Gnadler, R.: Documents to the Motor Vehicle Laboratory

M 7.192 Module: Nano- and Quantum Electronics [M-ETIT-105604]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-111232	Nano- and Quantum Electronics	6 CR	Kempf

Competence Certificate
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

Recommendation
Successful completion of the modules "Superconductivity for Engineers" and „Einführung in die Quantentheorie für Elektrotechniker“ is recommended.

7.193 Module: NMR Micro Probe Hardware Conception and Construction [M-MACH-107196]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-108407	NMR Micro Probe Hardware Conception and Construction	4 CR	Korvink

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
The aim of this practical block course is to familiarize the students with magnetic resonance imaging as a substantial non-invasive non-destructive imaging technique that is widely used for medical diagnosis.

It is also to give them hands-on experience on how to build the MRI probe from A to Z including

- Mechanical design
- High frequency electrical circuitry
- Testing on a commercial MRI scanner.

The course includes a concise introduction to the theory of MRI and the hardware of the MRI scanner. This will be followed by a number of work-packages through which the participants will construct and test their own functioning MRI probehead, with which it will be possible to record a proton-MRI image of a sample containing sufficient water. The probehead will be operated inside a Bruker MRI machine at the end of the one week course.

Content
In order to prepare attendees, the following chapters will be offered, spread over the week as lecture units, and accompanying the practical work:

- Theory of magnetic resonance imaging

-The MRI probe and the principle of reciprocity

- RF resonators

- Coaxial cables and cable traps

- Tuning and matching the MRI probe

- Effects of material susceptibility

- The mechanical support of the MRI probe

- Introduction to ParaVision, the MRI imaging software.

Module grade calculation
see individual course

Workload
120 h
(for details see individual course)

7.194 Module: Nonlinear Control Systems [M-ETIT-100371]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100980	Nonlinear Control Systems	3 CR	Kluwe

Prerequisites
none

M 7.195 Module: Nonlinear Optics [M-ETIT-100430]

Responsible: Prof. Dr.-Ing. Christian Koos
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-101906	Nonlinear Optics	6 CR	Koos

Competence Certificate
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 7.196 Module: Novel Actuators and Sensors [M-MACH-105292]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-102152	Novel Actuators and Sensors	4 CR	Kohl, Sommer

Competence Certificate
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

Learning type
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 7.197 Module: Nuclear Power and Reactor Technology [M-MACH-107042]

Responsible: Dr. Aurelian Florin Badea
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-110332	Nuclear Power and Reactor Technology	4 CR	Badea

Competence Certificate
A performance assessment will consist of an oral examination of 30 minutes.

Competence Goal
The objective of the module is the understanding of reactor technology and of the major physical processes in converting nuclear power into electrical energy. The students acquire comprehensive knowledge on the physics of nuclear fission reactors: neutron flux, cross sections, fission, breeding processes, chain reaction, critical size of a nuclear system, moderation, reactor dynamics, transport-and diffusion-equation for the neutron flux distribution, power density distributions in reactor, one-group, two-group and multi-group theories for the neutron spectrum. Students are able to analyze and understand the obtained results. The students are capable of understanding the advantages and disadvantages of different reactor technologies - LWR, heavy water reactors, nuclear power systems of generation IV - by using the delivered knowledge on reactor physics, thermal-hydraulics, reactor design, control, safety and requirements of the front-end and back-end of the fuel cycle. The students are qualified for further training in nuclear energy and safety field and for (also research-related) professional activity in the nuclear industry.

Content

- nuclear fission & fusion,
- radioactive decay, neutron excess, fission, fast and thermal neutrons, fissile and fertile nuclei, enrichment, neutron flux, cross section, reaction rate, mean freepath,
- chain reaction, critical size, moderation,
- reactor dynamics,
- transport- and diffusion-equation for the neutron flux distribution,
- power distributions in reactor,
- one-group and two-group theories,
- light-water reactors,
- reactor safety,
- design of nuclear reactors,
- breeding processes,
- nuclear power systems of generation IV

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h

M 7.198 Module: Nuclear Power Plant Technology [M-MACH-107121]

Responsible: Dr. Aurelian Florin Badea
Prof. Dr.-Ing. Xu Cheng

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105402	Nuclear Power Plant Technology	4 CR	Badea, Cheng

Competence Certificate
A performance assessment will consist of an oral examination of approx. 30 minutes.

Prerequisites
none

Competence Goal
The objective of the module is the qualification for a research-related professional activity in nuclear power plant engineering. The participants can describe the most important components of nuclear power plants and their function. You can design or modify nuclear power plants independently and creatively. They have acquired a broad knowledge of this power plant technology, including specific knowledge of core design, design of primary and secondary systems, and of nuclear safety technologies. Based on the acquired knowledge in thermodynamics and neutron physics, they can describe and analyze the specific behavior of the nuclear power plant components and assess risks. Participants of the lecture have a trained analytical thinking and judgment in the design of nuclear power plants.

Content
Power plants with pressurized water reactors:

Design of the pressurized water reactor
Fuel assemblies
Control rods and drives
Core instrumentation
Reactor pressure vessel and its internals

Components of the primary system
Primary coolant pumps
Pressurizer
Steam generator
Water make-up system

Secondary system
Turbines
Reheater
Feedwater system
Cooling systems

Containment
Containment design
Components of safety systems
Components of residual heat removal systems

Control of a nuclear power plant with PWR

Power plants with boiling water reactors:

Design of the boiling water reactor
Fuel assemblies
Control elements and drives
Reactor pressure vessel and its internals
Containment and components of safety systems

Control of a nuclear power plant with boiling water reactors

Module grade calculation

The module grade is the grade of the oral examination.

Workload

120h

(for details see individual course)

M 7.199 Module: Numerical Fluid Mechanics [M-MACH-107036]

Responsible: Prof. Dr.-Ing. Bettina Frohnapfel
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105338	Numerical Fluid Mechanics	4 CR	Frohnapfel, Gatti

Competence Certificate
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.

Learning type
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 7.200 Module: Numerical Methods [M-MATH-105831]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MATH-111700	Numerical Methods - Exam	5 CR	Kunstmann, Liao, Reichel

Competence Certificate
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 7.201 Module: Numerical Methods with Programming Practice [M-MATH-106972]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of:
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MATH-111700	Numerical Methods - Exam	5 CR	Kunstmann, Liao, Reichel
T-MATH-113937	Numerical Methods - Workshop *This item will not influence the grade calculation of this parent.*	1 CR	Kunstmann, Liao, Reichel

Competence Certificate
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.

Annotation
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 7.202 Module: Optical Design Lab [M-ETIT-100464]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-100756	Optical Design Lab	6 CR	Stork

Competence Certificate
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

Recommendation
Basic knowledge in optics. The participation in the course Optical Engineering is strongly adviced.

M 7.203 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113941	Optical Engineering and Machine Vision	6 CR	Heizmann

Competence Certificate
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

Recommendation
Basic knowledge of systems theory and signal processing (e.g. from the module “Signals and Systems”) as well as optics is helpful.

Learning type
lecture (3 SWS) and exercise (1 SWS)

M 7.204 Module: Optical Transmitters and Receivers [M-ETIT-100436]

Responsible: Prof. Dr. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-100639	Optical Transmitters and Receivers	6 CR	Freude

Competence Certificate
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

Recommendation
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

7.205 Module: Optical Waveguides and Fibers [M-ETIT-100506]

Responsible: Prof. Dr.-Ing. Christian Koos
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-101945	Optical Waveguides and Fibers	4 CR	Koos

Competence Certificate
Type of Examination: Oral exam

Duration of Examination: approx. 20 minutes

Modality of Exam: The written exam is offered continuously upon individual appointment.

Prerequisites
None

Competence Goal
The students

- conceive the basic principles of light-matter-interaction and wave propagation in dielectric media and can explain the origin and the implications of the Lorentz model and of Kramers-Kronig relation,
- are able to quantitatively analyze the dispersive properties of optical media using Sellmeier relations and scientific databases,
- can explain and mathematically describe the working principle of an optical slab waveguide and the formation of guided modes,
- are able to program a mode solver for a slab waveguide in Matlab,
- are familiar with the basic principle of surface plasmon polariton propagation,
- know basic structures of planar integrated waveguides and are able to model special cases with semi-analytical approximations such as the Marcatili method or the effective-index method,
- are familiar with the basic concepts of numerical mode solvers and the associated limitations,
- are familiar with state-of-the-art waveguide technologies in integrated optics and the associated fabrication methods,
- know basic concepts of of step-index fibers, graded-index fibers and microstructured fibers,
- are able to derive and solve basic relations for step-index fibers from Maxwell’s equations,
- are familiar with the concept of hybrid and linearly polarized fiber modes,
- can mathematically describe signal propagation in single-mode fibers design dispersion-compensated transmission links,
- conceive the physical origin of fiber attenuation effects,
- are familiar with state-of-the-art fiber technologies and the associated fabrication methods,
- can derive models for dielectric waveguide structures using the mode expansion method,
- conceive the principles of directional couplers, multi-mode interference couplers, and waveguide gratings,
- can mathematically describe active waveguides and waveguide bends.

Content

1. Introduction: Optical communications
2. Fundamentals of wave propagation in optics: Maxwell´s equations in optical media, wave equation and plane waves, material dispersion, Kramers-Kroig relation and Sellmeier equations, Lorentz and Drude model of refractive index, signal propagation in dispersive media.
3. Slab waveguides: Reflection from a plane dielectric boundary, slab waveguide eigenmodes, radiation modes, inter- and intramodal dispersion, metal-dielectric structures and surface plasmon polariton propagation.
4. Planar integrated waveguides: Basic structures of integrated optical waveguides, guided modes of rectangular waveguides (Marcatili method and effective-index method), basics of numerical methods for mode calculations (finite difference- and finite-element methods), waveguide technologies in integrated optics and associated fabrication methods
5. Optical fibers: Optical fiber basics, step-index fibers (hybrid modes and LP-modes), graded-index fibers (infinitely extended parabolic profile), microstructured fibers and photonic-crystal fibers, fiber technologies and fabrication methods, signal propagation in single-mode fibers, fiber attenuation, dispersion and dispersion compensation
6. Waveguide-based devices: Modeling of dielectric waveguide structures using mode expansion and orthogonality relatons, multimode interference couplers and directional couplers, waveguide gratings, material gain and absorption in optical waveguides, bent waveguides

Module grade calculation
The module grade is the grade of the oral exam.

There is, however, 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
Total 120 h, hereof 45 h contact hours (30 h lecture, 15 h tutorial) and 75 h homework and self-studies.

Recommendation
Solid mathematical and physical background, basic knowledge of electrodynamics

Literature
B.E.A. Saleh, M.C. Teich: Fundamentals of Photonics

G.P. Agrawal: Fiber-optic communication systems

C.-L. Chen: Foundations for guided-wave optics

Katsunari Okamoto: Fundamentals of Optical Waveguides

K. Iizuka: Elements of Photonics

M 7.206 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: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-104594	Optimal Control and Estimation	3 CR	Hohmann

Prerequisites
none

M 7.207 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: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-100685	Optimization of Dynamic Systems	5 CR	Hohmann

Competence Certificate
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.

Annotation
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 7.208 Module: Optoelectronic Measurement Engineering [M-ETIT-100484]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-100771	Optoelectronic Measurement Engineering	3 CR	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

7.209 Module: Organ Support Systems [M-MACH-102702]

Responsible: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-MACH-105228	Organ Support Systems	4 CR	Pylatiuk

Competence Certificate
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

Recommendation
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.

7.210 Module: Pattern Recognition (24675) [M-INFO-100825]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer

Organisation: KIT Department of Informatics

Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-INFO-101362	Pattern Recognition	6 CR	Beyerer, Zander

7.211 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-109173	Photonics and Communications Lab	6 CR	Koos, Randel

Prerequisites
none

M 7.212 Module: Photovoltaics [M-ETIT-100513]

Responsible: Prof. Dr.-Ing. Michael Powalla
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-101939	Photovoltaics	6 CR	Powalla

Prerequisites
Module "M-ETIT-100524 - Solar Energy" must not have started.

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-ETIT-100524 - Solar Energy must not have been started.

M 7.213 Module: Physical Basics of Laser Technology [M-MACH-107064]

Responsible: Dr.-Ing. Johannes Schneider
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-102102	Physical Basics of Laser Technology	5 CR	Schneider

Competence Certificate
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

Recommendation
Basic knowledge of physics, chemistry and material science is assumed.

Learning type
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 7.214 Module: Plasma Sources [M-ETIT-100481]

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

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100768	Plasma Sources	4 CR	Heering, Kling

Prerequisites
none

M 7.215 Module: Polymers in MEMS A: Chemistry, Synthesis and Applications [M-MACH-107183]

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German/English	4	1

Election notes
First part of the lecture series Polymers in MEMS with focus on chemical fundamentals. Lecture forms a good basis for Polymers in MEMS-C, Biopolymers

Mandatory			
T-MACH-102192	Polymers in MEMS A: Chemistry, Synthesis and Applications	4 CR	Worgull

Competence Certificate
Oral examination by arrangement, duration approx. 30 min

Prerequisites
none

Competence Goal
The aim of the lecture is providing mechanical or chemical engineers, as well as interested students from the life or material sciences the basic knowledge required for understanding what polymers are and how they are made, highlighting their importance for modern MEMS systems with a wide view to applications in everyday life.

After attending the lecture the students will be able:

- … to understand the physic/chemical basics of organic chemistry in polymer synthesis.
- … to state the most important polymers and polymer classes and to develop application examples for these.
- … to state the most important polymers in MEMS.
- … to understand the most important techniques for rapid prototyping.
- … to state and to understand the most important resists in MEMS.
- … to understand the chemical synthesis of polymers.
- … to correctly estimate the application scope of the individual classes of polymers.

Content
We all come in contact with numerous polymeric products in everyday life. From water bottles to packaging to the cover of the iPad, many things are made of polymers. Polymers are also important materials for modern microelectromechanical systems (MEMS) allowing cost effective mass market compatible products, e.g., in the life sciences or diagnostics. But polymers are not just cost-effective replacements for more expensive classical materials in MEMS (such as, e.g., silicon) – some polymers have intrinsic properties that make them ideal materials for sensors, actuators or templates for biology and chemistry in MEMS.

This lecture will introduce the basics of organic chemistry required for understanding what polymers are, how they are manufactured and which mechanisms are responsible for their unique properties. The lecture will highlight (in the context of MEMS but also in a wider scope) where and why polymers are applied with a strong focus on their chemical and physical properties (and on their synthesis).

Some of the topics covered are:

- What is the basic chemistry of polymers? What are monomers, what are macromolecules and how are they formed?
- How are polymers produced on industrial scale – but also on the laboratory scale? Numerous examples of how to make (commonly and lesser known) polymers will be discussed including materials such as Plexiglas.
- Why are polymers so important for biochemistry and tissue engineering?
- How do photoresists work and why do some polymers contract when exposed to light?
- What are high-performance polymers and why do they have such a wide application range, e.g., in implants?
- What polymers fuel the household 3D printing community and what materials do 3D printers such as, e.g., the RepRap work with?
- How does 3D printing and rapid prototyping work and which polymers can be employed for which techniques?
- Why does silicone always smell like vinegar and why is this material so important for modern day microfluidics? How do you built fluid-logic devices using silicone?
- How do shape memory polymers remember their shape?
- What are polymer foams and why are they not only important for heat insulation but also for organic chemistry?
- How do glues work? Why are there two-component glues, what is superglue and how can you make glue from potatoes?

Module grade calculation
according to the performance in the oral examination

Annotation
Basic knowledge of organic chemistry is an advantage. A basic understanding of microsystems technology and microsystems technology processes is helpful but not necessary.

Workload
120h

- lecture: 15 * 1.5 h (22 h)
- lecture preparation (before and after lecture): 15 * 2 h (30 h)
- preparation of final exam: approx. 68 h

Recommendation
Basic knowledge of organic chemistry and microsystems technology is advantageous, the effort may be somewhat higher

Learning type
Online lecture, presentations are available as downloads. Individual additional meetings as required

Literature
Literature will be named accordingly in the lecture

Base for
Basis for module "Polymers in MEMS-C", Biopolymers

M 7.216 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	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 CR	Worgull

Competence Certificate
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.

Annotation
The language will depend on the participants present. If interested, an optional laboratory tour on polymer processing can also be offered.

Workload
120 hours

Recommendation
Basics of chemistry and microsystem technology (MST) are beneficial but not requirend

Learning type
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

M 7.217 Module: Polymers in MEMS C: Biopolymers and Bioplastics [M-MACH-107085]

Responsible: Dr.-Ing. Matthias Worgull
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	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 CR	Worgull

Competence Certificate
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

Annotation
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

Recommendation
Attendance of the lectures “Polymers in MEMS A” or “Polymers in MEMS B”, but not a prerequisite

Learning type
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 7.218 Module: Power Electronic Systems in Energy Technology [M-ETIT-106067]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-112286	Power Electronic Systems in Energy Technology	6 CR	Hiller

Prerequisites
none

M 7.219 Module: Power Electronics [M-ETIT-104567]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	6

Mandatory			
T-ETIT-109360	Power Electronics	6 CR	Hiller

Competence Certificate
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 7.220 Module: Power Electronics for Photovoltaics and Wind Energy [M-ETIT-102261]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives) (Usage until 9/30/2025)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology) (Usage until 9/30/2025)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German/English	4	2

Mandatory			
T-ETIT-104569	Power Electronics for Photovoltaics and Wind Energy	3 CR	Hiller

Competence Certificate
Success control takes place in the form of an overall oral examination (20 minutes) on the selected courses, which together fulfill the minimum LP requirement.

Prerequisites
none

Competence Goal
Students will be familiar with the main renewable energy generation systems. They will be able to assess typical inverter circuits and consider their application aspects including grid connections in design, construction and operation. They will be able to estimate the essential system properties in rough calculations.

Content
The lecture explains all the possibilities of regenerative energy generation that are currently being used on a large scale. These include

- wind power
- hydropower
- solar thermal energy
- geothermal energy
- photovoltaics

It also looks at how these systems can be integrated into existing grids and how stand-alone grids can be set up. An overview of energy storage systems is also provided.

This is followed by a detailed look at photovoltaic energy generation.

This topic includes

- PV DC voltage systems
- charge controllers
- MPP trackers
- PV grid couplings
- Inverter circuits
- Grid power control / reactive power control
- Characteristic curves of solar cells
- System efficiencies

are covered and explained in detail.

The lecturer reserves the right to deviate from the content of the current lecture without

deviate from the content given here without special notice.

Module grade calculation
The module grade is the grade of the oral examination.

Annotation
English videos are available for English-speaking students.

- Last offer in SoSe25 -

Workload
7x V à 3 h = 21 h

Exam preparation = 60 h

Total approx. 81 h (corresponds to 3 LP)

Recommendation
Module Power Electronics

7.221 Module: Power System Protection and Automation [M-ETIT-106506]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-113164	Power System Protection and Automation	3 CR	Leibfried

Prerequisites
none

M 7.222 Module: Power Systems and Economy [M-ETIT-100413]

Responsible: Dr.-Ing. Bernd Hoferer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100725	Power Systems and Economy	3 CR	Hoferer

Prerequisites
none

M 7.223 Module: Power Tool Design [M-MACH-107144]

Responsible: Prof. Dr.-Ing. Sven Matthiesen
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105229	Appliance and Power Tool Design	4 CR	Matthiesen

Competence Certificate
See individual course

Prerequisites
The participation in “Power tool design” requires the concurrent project work.

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 sometimes contradictory problems in the interaction between user, device and application and develop innovative solutions based on this with a clear focus on customer benefits.
- are able to name, identify and explain strategies and methodical procedures for the development of mechatronic devices and apply them to new challenges.
- are able to recognize and evaluate the effects of specific boundary conditions on the development task and to interpret and assess their consequences even in unfamiliar contexts.
- are able to understand and reflect on key success factors of product development in interdisciplinary development teams and apply this knowledge to practical examples and new problems in the areas of customer, company and market.

Content
The lecture "Device Design" offers a practice-oriented insight into the development of technical devices using real industrial examples. The focus is on the product development process of mechatronic systems, starting with the analysis of existing products and the identification of potential. Students learn to generate innovative ideas and implement them in prototypes. Particular attention is paid to hand-held devices, which serve as interdisciplinary examples and illustrate engineering work. The lecture comprises theoretical principles, practical exercises and a compulsory project in which the interaction of analysis and synthesis is deepened in small groups.

Module grade calculation
The module grade corresponds to the grade from the individual course

Annotation
None

Workload
Attendance: 30h

Self-study: 90h

Recommendation
None

Learning type
Lecture

Literature
None

Base for
None

7.224 Module: Power Tool Design Project Work [M-MACH-107145]

Responsible: Prof. Dr.-Ing. Sven Matthiesen
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	pass/fail	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-110767	Appliance and Power Tool Design Project Work	8 CR	Matthiesen

Competence Certificate
See partial performance

Prerequisites
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. 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 sometimes contradictory problems in the interaction between user, device and application and develop innovative solutions based on this with a clear focus on customer benefits.
- are able to name, identify and explain strategies and methodical procedures for the development of mechatronic devices and apply them to new challenges.
- are able to recognize and evaluate the effects of specific boundary conditions on the development task and to interpret and assess their consequences even in unfamiliar contexts.
- are able to understand and reflect on key success factors of product development in interdisciplinary development teams and apply this knowledge to practical examples and new problems in the areas of customer, company and market.

Content
The "Power Tool Design" project enables students to apply the knowledge and skills they have acquired in practice as part of a real product development project. Working in small groups, students put the knowledge they have acquired in the lecture into practice by analyzing and further developing various hand-held devices. The project work goes through typical phases of the product development process, starting with the analysis of existing devices and the identification of potential improvements. Based on this, innovative ideas are generated and implemented in prototypes. The focus is on the interplay between analysis and synthesis, which gives students a practical insight into the challenges of device design.

Module grade calculation
The module grade corresponds to the grade from the partial performance

Annotation
None

Workload
Attendance: 60h

Self-study: 180h

Recommendation
None

Learning type
Project work

Literature
None

Base for
None

M 7.225 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: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-ETIT-100711	Practical Aspects of Electrical Drives	4 CR	Doppelbauer

Competence Certificate
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.

Annotation
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)

Recommendation

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"

7.226 Module: Practical Course Polymers in MEMS [M-MACH-107034]

Responsible: Dr.-Ing. Matthias Worgull
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

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

Election notes
The practical course focuses on polymer processing, therefore it is necessary to attend the module "Polymers in MEMS B".

Mandatory			
T-MACH-105556	Practical Course Polymers in MEMS	2 CR	Worgull

Competence Certificate
The practical course will close with an oral examination.There will be only passed and failed results, no grades.

Prerequisites
MACH-107035 must be started

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-MACH-107035 - Polymers in MEMS B: Physics, Microstructuring and Applications must have been started.

Competence Goal
Students gain in-depth insights into plastics processing with a focus on microstructures and microstructured surfaces. The aims of the practical course are

- carrying out a necessary design analysis and selecting a suitable processing method
- the selection of suitable process parameters based on the desired polymer material
- setting up a molding machine (hot embossing)
- the analysis and measurement of a molded component

Content
The practical course provides detailed insights into the molding of plastic components with details in the micro range. To this end, students will carry out practical experiments on nanoimprint systems. In addition, the topic of micro injection molding will be demonstrated and explained in detail.

Module grade calculation
ungraded

Annotation
The practical course will only be held if there is a sufficient number of registrations.

Workload
60 hours

Learning type
Practical course

Literature
Literature on polymers in MEMS-B

M 7.227 Module: Practical Course: Autonomous Driving [M-MACH-107052]

Responsible: Dr.-Ing. Martin Gießler
Kevin Simon

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

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

Mandatory			
T-MACH-113713	Practical Course: Autonomous Driving	6 CR	Frey, Gießler

Competence Certificate
To pass the course it is neccessary to successfully complete the colloquia, the homework and the final demonstration of the driving task.

Prerequisites
none

Competence Goal
The main objective of the event is the practical implementation of the pipeline required for automated/autonomous driving functions with a real test vehicle. This includes recording the environment using various sensors, processing the recorded sensor data (perception), planning driving manoeuvres and the final execution of the manoeuvre by the actuators.

Content
- Sensor data acquisition: Setup and data recording of the sensors on the test vehicle
- Perception: data annotation, segmentation of sensor data, object recognition
- Manoeuvre planning: path and trajectory planning, behaviour generation, etc.
- Manoeuvre execution: vehicle control, implementation of the driving manoeuvre in the real test vehicle using actuators

Module grade calculation
see individual course

Annotation
Limited number of participants with selection procedure, in German language. Please send the application at the end of the previous semester

Workload
120h
(for details see individual course)

7.228 Module: Practical Course: Machine Learning and Intelligent Systems [M-INFO-105958]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-INFO-112104	Practical Course: Machine Learning and Intelligent Systems	8 CR	Fennel, Hanebeck

M 7.229 Module: Practical Course: Smart Energy System [M-INFO-105955]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	English	4	1

Mandatory			
T-INFO-112030	Practical Course: Smart Energy System	6 CR	Waczowicz

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
After successfully completing the course, students will be able to
- be able to explain the structure and objectives of a smart grid using the Energy Lab 2.0 and the Smart Energy System Simulation and Control Centre (SEnSSiCC),
- be able to name and categorise current research issues in the field of innovative, application-oriented information, automation and system technology for sustainable energy systems,
- analyse a problem from the current research questions of SEnSSiCC as part of a project and develop a strategy for a solution together in a team and
- be able to check, analyse and evaluate the feasibility of results in a laboratory.

Content
As part of the preparation for the internship, project topics are derived from the current research questions of the Smart Energy System Simulation and Control Centre of the Energy Lab 2.0 (https://www.iai.kit.edu/RPE.php). The topics are made available to the participating students in advance of the internship as a list, on the basis of which the students can express their preferences for the respective topics. Based on their stated preferences, the students are assigned to the respective project topics.
The two-week internship begins with a joint kick-off event, which includes an introduction and tour of the Energy Lab 2.0 and the SEnSSiCC as well as a brief presentation of all project topics. Students are provided with current scientific papers on their research topic. During the two-week internship, the groups of students work on their project topics under the supervision of the respective scientists. The students use a laboratory set-up to test their concepts and solutions. Particularly promising approaches can be tested on the real system under the supervision of the scientists. The block course ends with a joint final event at which the students present their solutions and work results.

After the internship, the students follow up the project work by preparing a report on the project topic they have worked on, categorising the work results and reflecting on the work process.
Working in a team is another important aspect of all project topics.
The work placement consists of the following sections:
- Familiarisation with the topic
- Selection of a suitable project topic in consultation with the supervising scientists
- Practical realisation of the project topic
- Presentation of the results (colloquium, research report)

Workload
6 credit points corresponds to approx. 180 working hours, of which
- Attendance time / meetings in large and small groups: 10h
- Select and carry out project work: 140h
- Writing a research report and preparing a presentation: 30 hours

Recommendation
- Knowledge of the fundamentals of energy informatics is a prerequisite.
- Knowledge of the fundamentals of electrical engineering and energy technology is required.
- Knowledge of the basics of mechatronics, data analysis and signal processing is helpful.
- Knowledge of power systems or power electronics is helpful.

M 7.230 Module: Practical Course: Software Development and Application of Mobile, Bio-Inspired Robots [M-MACH-106904]

Responsible: Prof. Dr.-Ing. Arne Rönnau

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-113854	Practical Course: Software Development and Application of Mobile, Bio-Inspired Robots	6 CR	Rönnau

Competence Certificate
See partial achievement

Prerequisites
None

Competence Goal
Students are able to understand biologically inspired mobile robots and extend their software.

Content
This module teaches students how to work with and expand biologically inspired mobile robotics. The topics covered include control engineering, computer vision, 3D mapping, navigation and human-machine interaction.

Students work in groups and produce a joint final report and presentation.

Workload
180h

- 30h weekly regular meeting
- 120h preparation and follow-up time
- 30h Presentation and report preparation

Recommendation
See partial achievement

M 7.231 Module: Practical Machine Learning [M-ETIT-106673]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-113426	Practical Machine Learning	6 CR	Heizmann

Competence Certificate
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)

Recommendation
Basic knowledge of mathematics and linear algebra (matrices, vectors, etc.)
as well as basic knowledge of Python.

Learning type
Block lecture (2 SWS) and practical part (by arrangement within the framework of 2 SWS)

M 7.232 Module: Practical Project Robotics and Automation I (Software) [M-INFO-102224]

Responsible: Prof. Dr.-Ing. Björn Hein
Prof. Dr.-Ing. Thomas Längle

Organisation: KIT Department of Informatics

Part of: Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-INFO-104545	Practical Project Robotics and Automation I (Software)	6 CR	Hein, Längle

M 7.233 Module: Practical Project Robotics and Automation II (Hardware) [M-INFO-102230]

Responsible: Prof. Dr.-Ing. Björn Hein
Prof. Dr.-Ing. Thomas Längle

Organisation: KIT Department of Informatics

Part of: Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-INFO-104552	Practical Project Robotics and Automation II (Hardware)	6 CR	Hein, Längle

M 7.234 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: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113628	Practical Tools for Control Engineers	4 CR	Varga

Competence Certificate
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

Recommendation
The contents of the modules “Optimization of Dynamic Systems (ODS)” and “Regelung linearer Mehrgrößensysteme (RLM)” are helpful for the lecture.

M 7.235 Module: Practical Training in Basics of Microsystem Technology [M-MACH-105479]

Responsible: Dr. Arndt Last
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-MACH-102164	Practical Training in Basics of Microsystem Technology	4 CR	Last

Competence Certificate
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.

Annotation
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

Recommendation
Attend at least one of the lectures Micro System Technology I or II.

Read the practical course documents provided as pdf-file!

Learning type
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.

7.236 Module: Principles of Whole Vehicle Engineering I [M-MACH-105289]

Responsible: Prof.Dipl.-Ing. Rolf Frech
Dr.-Ing. Martin Gießler
Dr.-Ing. Hans-Joachim Unrau

Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
2	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-105162	Fundamentals of Automobile Development I	2 CR	Harrer

Competence Certificate
Written exam, duration approximately 90 minutes.

Auxiliary means: none

Competence Goal
The students have an overview of the entire development process of a passenger car. In addition to the chronological sequence of passenger car development, they also know the national and international legal requirements. They have knowledge of the conflict of objectives between aerodynamics, thermal management and design. They will be able to assess conflicting goals in the area of passenger car development and work out possible solutions.

Content

1. Process of automobile development
2. Conceptual dimensioning and design of an automobile
3. Laws and regulations – National and international boundary conditions
4. Aero dynamical dimensioning and design of an automobile I
5. Aero dynamical dimensioning and design of an automobile II
6. Thermo-management in the conflict of objectives between styling, aerodynamic and packaging guidelines I
7. Thermo-management in the conflict of objectives between styling, aerodynamic and packaging guidelines

Workload
The total work load for this module is about 60 Hours (2 Credits). The partition of the work load is carried out according to the credit points of the courses of the module. The work load for courses with 2 credit points is about 60 hours.

Learning type
Lecture

7.237 Module: Principles of Whole Vehicle Engineering II [M-MACH-105290]

Responsible: Prof.Dipl.-Ing. Rolf Frech
Dr.-Ing. Hans-Joachim Unrau

Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
2	Grade to a tenth	Each summer term	1 term	German/English	4	2

Mandatory			
T-MACH-105163	Fundamentals of Automobile Development II	2 CR	Harrer

Competence Certificate
Written exam, duration: approximately 90 minutes.

Auxiliary means: none

Competence Goal
Students are familiar with the selection of suitable materials and with various manufacturing techniques. They have an overview of the acoustics of the vehicle. They are familiar with both the aspects of acoustics in the interior of the vehicle and the aspects of exterior noise. They are familiar with testing the vehicle and assessing the overall vehicle characteristics. They are able to participate competently in the development process of the entire vehicle.

Content

1. Application-oriented material and production technology I
2. Application-oriented material and production technology II
3. Overall vehicle acoustics in the automobile development
4. Drive train acoustics in the automobile development
5. Testing of the complete vehicle
6. Properties of the complete automobile

Workload
The total work load for this module is about 60 Hours (2 Credits). The partition of the work load is carried out according to the credit points of the courses of the module. The work load for courses with 2 credit points is about 60 hours.

Learning type
Lecture

M 7.238 Module: Probabilistic Measurement and Estimation [M-MACH-107087]

Responsible: Prof. Dr.-Ing. Christoph Stiller
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-113873	Probabilistic Measurement and Estimation	4 CR	Stiller

Competence Certificate
written exam

60 min.

Prerequisites
none

Competence Goal
The capabilities of modern sensor technology pave the way for novel applications in engineering. Especially digital measurement techniques may be used even in very complexenvironrnents and this have strong impact on technological progress. Stochastic models of measurement processes form the basis for meaningful information processing and provide a valuable tool for engineering. This interdisciplinary lecture addresses students in mechanical engineering and related subjects. The lecture gives an overview of digital technology and stochastics. These areas form the basics of estimation methods that can be embedded elegantly in the theory of state observers. Applications in signal processing for modern environmental perception (video, Lidar, Radar) illustrate the discussed subjects.

Content
1. Amplifiers
2. Digital technology
3. Stochastic modeling for measurement applications
4. Estimation
5. Kaiman Filter
6. Environmental perception

Workload
In total 120h:

Attendance time: 20 h
Self-study: 100 h

M 7.239 Module: Product- and Production-Concepts for modern Automobiles [M-MACH-105346]

Responsible: Dr. Stefan Kienzle
Dr. Dieter Steegmüller

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-110318	Product- and Production-Concepts for Modern Automobiles	4 CR	Kienzle, Steegmüller

Competence Certificate
Oral Exam (20 min)

Prerequisites
None

Competence Goal
The students …

- are able to name the presented general conditions of vehicle development and are able to discuss their influences on the final product using practical examples.
- are able to name the various lightweight approaches and identify possible areas of application.
- are able to identify the different production processes for manufacturing lightweight structures and explain their functions.
- are able to perform a process selection based on the methods and their characteristics.

Content
The module illuminates the practical challenges of modern automotive engineering. As former leaders of the automotive industry, the lecturers refer to current aspects of automotive product development and production.

The aim is to provide students with an overview of technological trends in the automotive industry. In this context, the course also focuses on changes in requirements due to new vehicle concepts, which may be caused by increased demands for individualisation, digitisation and sustainability. The challenges that arise in this context will be examined from both a production technology and product development perspective and will be illustrated with practical examples thanks to the many years of industrial experience of both lecturers.

The topics covered are:

- General conditions for vehicle and body development
- Integration of new drive technologies
- Functional requirements (crash safety etc.), also for electric vehicles
- Development Process at the Interface Product & Production, CAE/Simulation
- Energy storage and supply infrastructure
- Aluminium and lightweight steel construction
- FRP and hybrid parts
- Battery, fuel cell and electric motor production
- Joining technology in modern car bodies
- Modern factories and production processes, Industry 4.0.

Workload
regular attendance: 25 hours
self-study: 95 hours

Learning type
Lecture

M 7.240 Module: Product Development – Methods of Product Engineering [M-MACH-102718]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering

Part of:
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German/English	4	3

Mandatory			
T-MACH-109192	Methods and Processes of PGE - Product Generation Engineering	6 CR	Albers, Burkardt, Matthiesen

Competence Certificate
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

Learning type
Lecture

Tutorial

Literature
Lecture documents
Pahl, Beitz: Konstruktionslehre, Springer-Verlag 1997
Hering, Triemel, Blank: Qualitätssicherung für Ingenieure; VDI-Verlag, 1993

7.241 Module: Production Techniques Laboratory [M-MACH-102711]

Responsible: Prof. Dr.-Ing. Barbara Deml
Prof. Dr.-Ing. Kai Furmans
Prof. Dr.-Ing. Jivka Ovtcharova
Prof. Dr.-Ing. Volker Schulze

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

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

Mandatory			
T-MACH-105346	Production Techniques Laboratory	4 CR	Deml, Fleischer, Furmans, Ovtcharova

Competence Certificate
A performance assessment (non-graded) is obligatory and can be oral, a written exam, or of another kind.

Prerequisites
None

Competence Goal
The students acquire in the lab profound knowledge about the scientific theories, principles and methods of Production Engineering. Afterwards they are able to evaluate and design complex production systems according to problems of manufacturing and process technologies, materials handling, handling techniques, information engineering as well as production organisation and management.

After completion this lab, the students are able

- to analyse and solve planning and layout problems of the discussed fields,
- to evaluate and configure the quality and efficiency of production, processes and products,
- to plan, control and evaluate the production of a production enterprise,
- to configure and evaluate the IT architecture of a production enterprise,
- to design and evaluate appropriate techniques for conveying, handling and picking within a production system,
- to design and evaluate the part production and the assembly by considering the work processes and the work places.

Content
The production technique laboratory (PTL) is a collaboration of the institutes wbk, IFL, IMI and ifab.

1. Computer Aided Product Development (IMI)
2. Computer communication in factory (IMI)
3. Production of parts with CNC turning machines (wbk)
4. Controlling of production systems using PLCs (wbk)
5. Automated assembly systems (wbk)
6. Optical identification in production and logistics (IFL)
7. RFID identification systems (IFL)
8. Storage and order-picking systems (IFL)
9. Design of workstations (ifab)
10. Time study (ifab)
11. Accomplishment of workplace design (ifab)

Workload
Present time: 20 h

Self study: 100 h

Learning type
Seminar

Literature
Handout and literature online ILIAS.

M 7.242 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: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-ETIT-109148	Project Management in the Development of Products for Safety-Critical Applications	4 CR	Nolle

7.243 Module: Project Workshop: Automotive Engineering [M-MACH-107074]

Responsible: Dr.-Ing. Martin Gießler
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-MACH-102156	Project Workshop: Automotive Engineering	6 CR	Frey, Gießler

Competence Certificate
oral examination, duration approx. 30-40 minutes

Prerequisites
none

Competence Goal
The students are familiar with typical industrial development processes and working style. They are able to apply knowledge gained at the university to a practical task. They are able to analyze and to judge complex relations. They are ready to work self-dependently, to apply different development methods and to work on approaches to solve a problem, to develop practice-oriented products or processes.

Content
During the Project Workshop Automotive Engineering a team of six persons will work on a task given by an German industrial partner using the instruments of project management. The task is relevant for the actual business and the results are intended to be industrialized after the completion of the project workshop.

The team will generate approaches in its own responsibility and will develop solutions for practical application. Coaching will be supplied by both, company and institute.

At the beginning in a start-up meeting goals and structure of the project will be specified. During the project workshop there will be weekly team meetings. Also a milestone meeting will be held together with persons from the industrial company. In a final presentation the project results will be presented to the company management and to institute representatives.

Module grade calculation
see individual course

Workload
120h
(for details see individual course)

Learning type
Steinle, Claus; Bruch, Heike; Lawa, Dieter (Hrsg.), Projektmanagement, Instrument moderner Innovation, FAZ Verlag, Frankfurt a. M., 2001, ISBN 978-3929368277

M 7.244 Module: ProVIL - Product Development in a Virtual Idea Laboratory [M-MACH-105418]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-106738	ProVIL - Product Development in a Virtual Idea Laboratory	4 CR	Albers, Düser

Competence Certificate
Coursework: Final report

Prerequisites
none

Competence Goal
The student

- can model problems of product development including their partial aspects (market, technology, product).
- can systematically design and conduct experiments for the validation of product models and interpret the results in a targeted manner.
- can select development methods specific to the situation and adapt them to realistic tasks.

Content
The course ProVIL is carried out as an innovation project with 4 phases and a realistic task definition. Students develop their own product concepts in a team using the latest hardware and software and execute the following activities:

- Analysis of the existing market and the environment of a product area
- Implementation and application of creativity methods and problem solving techniques
- Modelling of customer and user benefits as product profiles
- Validation of product profiles for target customer markets
- Generation of solution ideas for the technical implementation of the product profiles
- Visualization of user stories based on product videos
- Implementation of the selected ideas in functional prototypes and mock-ups
- Evaluation of the functional prototypes by planning, execution, evaluation and interpretation of suitable tests
- Presentation of the prototypes in a final event

Annotation
none

Workload
1. Time of presence kick-offs, workshops: 18 h

2. Time of presence Pre-Milestones, Milestones: 18 h

3. Project work: 84 h

Total: 120 h = 4 LP

Recommendation
none

Learning type

- Transfer of knowledge in lectures and workshops as block courses
- Project work in small teams
- Presentation of the prototypes in a final event

Literature
none

M 7.245 Module: Python Algorithms for Automotive Engineering [M-MACH-107072]

Responsible: Dr.-Ing. Martin Gießler
Dr.-Ing. Stephan Rhode

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-110796	Python Algorithms for Vehicle Technology	4 CR	Rhode

Competence Certificate
written examination

Competence Goal
The students have an overview of the programming language Python and important Python libraries to solve automotive engineering problems with computer programs. The students know current tools around Python to create algorithms, to apply them and to interpret and visualize their results. Furthermore, the students know
basics in the creation of software to be used in later programming projects in order to develop high-quality software solutions in teamwork. Through practical programming projects (road sign recognition, vehicle state estimation, calibration, data-based modelling), the students can perform future complex tasks from the area of driver assistance systems.

Content

- Introduction to Python and useful tools and libraries for creating algorithms, graphical representation, optimization, symbolic arithmetic and machine learning
  - Anaconda, Pycharm, Jupyter
  - NumPy, Matplotlib, SymPy, Scikit-Learn
- Methods and tools for creating software
  - Version management GitHub, git
  - Testing software pytest, Pylint
  - Documentation Sphinx
  - Continuous Integration (CI) Travis CI
  - Workflows in Open Source and Inner Source, Kanban, Scrum
- Practical programming projects to:
  - Road sign recognition
  - Vehicle state estimation
  - Calibration of vehicle models by mathematical optimization
  - Data-based modelling of the powertrain of an electric vehicle

Module grade calculation
see individual course

Annotation
Lecture language is German, scripts are written in English

Workload
120h
(for details see individual course)

Literature

- A Whirlwind Tour of Python, Jake VanderPlas, Publisher: O'Reilly Media, Inc. Release Date: August 2016, ISBN: 9781492037859 link
- Scientific Computing with Python 3, Olivier Verdier, Jan Erik Solem, Claus Führer, Publisher: Packt Publishing, Release Date: December 2016, ISBN: 9781786463517 link
- Introduction to Machine Learning with Python, Sarah Guido, Andreas C. Müller, Publisher: O'Reilly Media, Inc., Release Date: October 2016, ISBN: 9781449369880, link
- Clean Code, Robert C. Martin, Publisher: Prentice Hall, Release Date: August 2008, ISBN: 9780136083238, link

M 7.246 Module: Quality Management [M-MACH-105332]

Responsible: Prof. Dr.-Ing. Gisela Lanza
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-102107	Quality Management	4 CR	Lanza

Competence Certificate
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

Learning type
Lecture

M 7.247 Module: Quantum Detectors and Sensors [M-ETIT-105606]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-111234	Quantum Detectors and Sensors	6 CR	Kempf

Competence Certificate
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

Recommendation
Successful completion of the module "Superconductivity for Engineers" is recommended.

7.248 Module: Quantum Machines I [M-MACH-107164]

Responsible: Prof. Dr. Marcel Utz
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-113827	Quantum Machines I	4 CR	Utz

Competence Certificate
see individual course

Prerequisites
none

Competence Goal

- be able to explain and apply the fundamental principles and mathematical structure of quantum mechanics
- be able to apply these to concrete engineered systems where quantum effects are an integral part of the operating principles

Content
Quantum Machines I and II are designed to immerse students in the fascinating intersection of quantum mechanics and cutting-edge engineering applications. Aimed at advanced undergraduate and graduate students in mechanical engineering, these courses provide a comprehensive exploration of quantum principles through practical technology examples. In Quantum Machines I, students will build a solid foundation in quantum mechanics, including fundamental concepts such as quantum states, operators, and the uncertainty principle. The course then connects these concepts to real-world engineering systems like MEMS devices, scanning probes, and quantum sensors, making abstract theories tangible and relevant.

Module grade calculation
see individual course

Workload
120h
(for details see individual course)

7.249 Module: Quantum Machines II [M-MACH-107165]

Responsible: Prof. Dr. Marcel Utz
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-113826	Quantum Machines II	4 CR	Utz

Competence Certificate
see individual course

Competence Goal

- be able to explain and apply the principles and mathematical structure of advanced quantum mechanical concepts, in particular symmetry, group theory, and angular momentum
- be able to apply these to the design of engineered systems where quantum effects play a major part; in particular in sensing and measurement, imaging systems and in spectroscopy.

Content
Quantum Machines II delves deeper into advanced topics such as angular momentum, quantum electrodynamics, and quantum information processing. Students will explore sophisticated applications including nuclear magnetic resonance spectroscopy, quantum dots, and atomic clocks. A particular focus is the theory and technology of nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI). The teaching concept integrates theoretical rigor with hands-on examples from modern technology, enabling students to see how quantum effects drive innovation in various fields. Through this approach, complex theoretical concepts are made accessible and engaging, bridging the gap between theory and practice. Registering for both courses will equip students with the knowledge and skills to understand and contribute to the forefront of quantum engineering and technology.

Module grade calculation
see individual course

Workload
120h
(see individual course)

7.250 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113910	Radio-Frequency Electronics	6 CR	Ulusoy

Competence Certificate
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

Recommendation
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 7.251 Module: Rail System Technology [M-MACH-103232]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	4	3

Mandatory			
T-MACH-106424	Rail System Technology	4 CR	Cichon

Competence Certificate
written examination in German language
Duration: 60 minutes
No tools or reference materials may be used during the exam except calculator and dictionary

Prerequisites
none

Competence Goal

- The students understand relations and interdependencies between rail vehicles, infrastructure and operation in a rail system.
- Based on operating requirements and legal framework they derive the requirements concerning a capable infrastructure and suitable concepts of rail vehicles.
- They recognize the impact of alignment, understand the important function of the wheel-rail-contact and estimate the impact of driving dynamics on the operating program.
- They evaluate the impact of operating concepts on safety and capacity of a rail system.
- They know the infrastructure to provide power supply to rail vehicles with different drive systems.

Content

1. Railway System: railway as system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact
2. Operation: Transportation, public transport, regional transport, long-distance transport, freight service, scheduling
3. Infrastructure: rail facilities, track alignment, railway stations, clearance diagram
4. Wheel-rail-contact: carrying of vehicle mass, adhesion, wheel guidance, current return
5. Vehicle dynamics: tractive and brake effort, driving resistance, inertial force, load cycles
6. Signaling and Control: operating procedure, succession of trains, European Train Control System, blocking period, automatic train control
7. Traction power supply: power supply of rail vehicles, comparison electric traction and diesel traction, dc and ac networks, system pantograph and contact wire, filling stations

Annotation
A bibliography is available for download (Ilias-platform).

Workload
Regular attendance: 21 hours

Self-study: 21 hours

Exam and preparation: 78 hours

total: 120 hours = 4 ECTS

Learning type
Lecture

7.252 Module: Rail Vehicle Technology [M-MACH-102683]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	4	3

Mandatory			
T-MACH-105353	Rail Vehicle Technology	4 CR	Cichon

Competence Certificate
written examination in German language
Duration: 60 minutes
No tools or reference materials may be used during the exam except calculator and dictionary

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Prerequisites
none

Competence Goal

- The students learn the role of rail vehicles and understand their classification. They understand the basic structure und know the functions of the main systems. They understand the overall tasks of vehicle system technology.
- They learn functions and requirements of car bodies and jugde advantages and disadvantages of design principles. They know the functions of the car body’s interfaces.
- They know about the basics of running dynamics and bogies.
- The students learn about advantages and disadvantages of different types of traction drives and judge, which one fits best for each application.
- They understand brakes from a vehicular and an operational point of view. They assess the fitness of different brake systems.
- They know the basic setup of train control management system and understand the most important functions.
- They specify and define suitable vehicle concepts based on requirements for modern rail vehicles.

Content

1. Vehicle system technology: structure and main systems of rail vehicles
2. Car body: functions, requirements, design principles, crash elements, coupling, doors and windows
3. Bogies: forces, running gears, bogies, Jakobs-bogies, active components, connection to car body, wheel arrangement
4. Drives: priciples, electric drives (main components, asynchronous traction motor, inverter, with DC supply, with AC supply, without line supply, multisystem vehicles, dual mode vehicles, hybrid vehicles), non-electric drives
5. Brakes: basics, principles (wheel brakes, rail brakes, blending), brake control (requirements and operation modes, pneumatic brake, electropneumatic brake, emergency brake, parking brake)
6. Train control management system: definition of TCMS, bus systems, components, network architectures, examples, future trends
7. Vehicle concepts: trams, metros, regional trains, intercity trains, high speed trains, double deck vehicles, locomotives, freight wagons

Annotation
A bibliography is available for download (Ilias-platform).

Workload
Regular attendance: 21 hours

Self-study: 21 hours

Exam and preparation: 78 hours

total: 120 hours = 4 ECTS

Learning type
Lecture

M 7.253 Module: Railway System Digitalisation [M-MACH-106513]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-113016	Digitization in the Railway System	4 CR	Cichon

Competence Certificate
Examination performance oral
Duration approx. 20 minutes
Auxiliary means: none

Prerequisites
none

Competence Goal
The students have a basic understanding of train control and its technical implementation in Germany, the functioning of the European Train Control System (ETCS) and its planning, Automated Train Operation. They are able to explain the knowledge they have acquired (terms, interrelationships) in context and apply it to issues in practice. Furthermore, the students can classify the operational and technical advantages and disadvantages in the context of the digitalization of the rail network in Germany and take future challenges into account.
The students can discuss the technical aspects and areas of application of ETCS in the different levels and reproduce the main features of balise planning for ETCS Level 2. Digital planning approaches such as PlanPro as well as measurement and test runs are known and can be classified.

Content
1. introduction and motivation: organizational aspects; current developments in Germany, Europe
2. Basics of the railroad system: terminology; interaction of rolling stock, infrastructure and operations
3. Securing train movements: overview of possibilities and areas of application; operational and technical aspects with a focus on Germany
4. Basics of interlockings, control and safety elements: Train protection in Germany with PZB, LZB
5. Safety and security: EN5012x, CENELEC, RAMS
6. European Train Control System (ETCS): specification; system components, braking curves; ETCS level and modes, train integrity; interface between vehicle and infrastructure, data exchange; infrastructure-side ETCS balise planning using the example of ETCS level 2; track surveying, commissioning; digitization of the planning process using the example of PlanPro
7. Automatic Train Operation (ATO), Communication-Based Train Control (CBTC): system architecture, Grade of Automation (GoA); advantages and challenges ATO; differences CTBC to ETCS
8. Future Developments: Future Railway Mobile Communication System (FRMCS) as successor to GSM-R.

Annotation
A bibliography is available for students to download from the Ilias platform.

Workload
Attendance time: 21 hours
Preparation / wrap-up: 21 hours
Exam and exam preparation: 78 hours
Total effort: 120 hours = 4 LP

Learning type
Lecture

Literature

- ETCS for Engineers, Stanley, 2011, ISBN 978-3-96245-034-2
- European Train Control System (ETCS), Schnieder, ISBN 978-3-662-66054-6
- Communications-Based Train Control (CBTC), Schnieder, ISBN 978-3-662-61012-1

M 7.254 Module: Railways in the Transportation Market [M-MACH-107044]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105540	Railways in the Transportation Market	4 CR	Cichon

Competence Certificate
Oral examination
Duration: ca. 20 minutes
No tools or reference materials may be used during the exam.

Prerequisites
none

Competence Goal

- To capture the entrepreneurial perspective on transport companies
- To appraise the intra- and intermodal competition
- To understand the regulative determinant
- To reflect trends in transportation market
- To comprehend strategic challenges, chances and fields of actions of transport companies
- To apply intermodal perspective
- To take important key figures of railways and transportation market
- To realize the relevance of sustainability and digitalization

Content
The lecture gives an overview about perspective, challenges and chances of rail systems in the national and European market. Following items will be discussed:

- Introduction and basics
- Rail reform in Germany
- Overview of Deutsche Bahn
- Regulation of railways
- Financing and development of rail infrastructure
- Group strategy “Strong Rail” and their building blocks:
  (climate, environment, digitalization, “Strong Rail” in Baden-Württemberg)
- Trends in the transportation market
- Field of actions in transport policy
- Intra- and intermodal competition
- Summary

Workload
Regular attendance: 21 hours
Self-study: 21 hours
Exam and preparation: 78 hours
total: 120 hours = 4 ECTS

Learning type
Lecture

Literature
A bibliography is available for download (Ilias-platform).

7.255 Module: Re:Invent - Revolutionary Business Models as the Basis for Product Innovations [M-MACH-106662]

Responsible: Prof. Dr.-Ing. Tobias Düser
Dr.-Ing. Thomas Schneider

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-111888	Re:Invent - Revolutionary Business Models as the Basis for Product Innovations	4 CR	Schneider

Competence Certificate
see individiual course

Prerequisites
None

Competence Goal

- Acquiring skills in innovative business model development: Students acquire the ability to integrate their knowledge of product development into the development of innovative business models.
- Understanding the connection between business models and global challenges: Students learn to understand and describe the connections between business models and current global challenges such as competitive pressure, decarbonisation and data sovereignty.
- Development of technical foundations for servitisation business models: Students develop the necessary technical requirements for the development and introduction of different servitisation business models.
- Ability to build industrial ecosystems: Students will learn to develop and present the fundamentals for building industrial ecosystems within business models.

Content

- Integration of product-service systems: Focus on shaping the change to user-centred product-service systems in the coming decades.
- Case study of TRUMPF machine tools: Discussion and analysis of the first industrial pay-per-part business model.
- Teamwork and idea exploration: students work in teams to explore and develop further ideas.
- Practice-orientated workshop: Conclusion of the lecture with a workshop on product launch in European markets, allowing practical application of what has been learnt.

Module grade calculation
The module grade is the grade of the oral examination.

Annotation
None

Workload
120 hours, including 30 hours attendance

Recommendation
None

Learning type
Lecture, workshop and excursion

Literature
None

Base for
None

7.256 Module: Reactor Physics [M-MACH-107071]

Responsible: Dr. Aurelian Florin Badea
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105550	Energy Systems II: Reactor Physics	4 CR	Badea

Competence Certificate
A performance assessment will consist of an oral examination of approx. 30 minutes.

Prerequisites
none

Competence Goal
The objective of the module is to train the students for the field of nuclear energy using fission reactors. The students acquire comprehensive knowledge on the physics of nuclear fission reactors: neutron flux, cross sections, fission, breeding processes, chain reaction, critical size of a nuclear system, moderation, reactor dynamics, transport- and diffusion-equation for the neutron flux distribution, power density distributions in reactor, one-group, two-group and multi-group theories for the neutron spectrum. Students are able to analyze and understand the obtained results. Based on the reactor physics knowledge, the students are able to understand, compare and evaluate the capabilities of different types of reactors -LWR, heavy water reactors, nuclear power systems of generation IV – as well as their fundamental nuclear safety concepts. The students are qualified for further training in nuclear energy and safety field and for (also research-related) professional activity in the nuclear industry.

Content

- nuclear fi ssion & fusion,
- radioactive decay, neutron excess, fission, fast and
  thermal neutrons, fissile and fertile nuclei, neutron flux, cross section, reaction rate, mean free path,
- chain reaction, critical size, moderation,
- reactor dynamics,
- transport- and diffusion-equation for the neutron flux distribution,
- power distributions in reactor,
- one-group and two-group theories,
- light-water reactors,
- reactor safety,
- design of nuclear reactors,
- breeding processes,
- nuclear power systems of generation IV

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h
(for details see individual course)

M 7.257 Module: Reactor Safety 1: Fundamentals [M-MACH-107116]

Responsible: Dr. Victor Hugo Sanchez-Espinoza
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-105405	Reactor Safety I: Fundamentals	4 CR	Sanchez-Espinoza

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
The student can

- explain the structure and mode of operation of a nuclear power plant and the safety systems
- understand and classify the hazard potential of hypothetical accidents in a nuclear power plant
- explain the basic principles of reactor safety and understand the inherent safety characteristics of reactors
- understand and apply the methods of safety assessment
- explain the sequence of typical accident sequences in nuclear power plants
- get informed about typical numerical tools for safety assessment and can classify the importance of validation of tools
- obtain knowledge of the most important steps for modeling nuclear power plants for safety assessment

Content
The lecture discusses the fundamental principles and concepts of reactor safety including the methodologies for safety assessment and major accidents. It starts with the short description of the reactor systems and their safety functions. Then, the inherent safety features and key thermal hydraulic safety parameters are introduced. The composition of the fuel and amount of radioactive material in the core and it changes during operation are explained for understanding of the radiological risk. The main principles and concepts of reactor safety are discussed such as defense in depth, multi-barrier concept. The initiation and progression of incidents/accidents as well as the methods for the safety evaluation are also treated in the lecture. The approach to model the behavior of nuclear reactors under accidental conditions such as in case of severe accidents is developed including the radiological risk from hypothetical severe accident. Finally, the safety features of innovative reactors such as small modular reactors and liquid-metal fast reactors and molten salt reactors are presented.

Module grade calculation
The module grade is the grade of the oral examination.

Workload
120h
(for details see individual course)

M 7.258 Module: Real Time Control of Electrical Drives [M-ETIT-105916]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-111898	Real Time Control of Electrical Drives	6 CR	Liske

Workload
Jeder Leistungspunkt (Credit Point) entspricht ca. 25-30h Arbeitsaufwand (des Studierenden). Hierbei ist vom durchschnittlichen Studierenden auszugehen, der eine durchschnittliche Leistung erreicht.

56h = 22x V à 2h + 3x Ü à 4h

21h = 21x Nachbereitung von V à 1 h

12h = 3x Vorbereitung von Ü à 4 h

80h = Vorbereitung zur Prüfung

Summe = 169 h (entspricht 6 LP)

M 7.259 Module: Real-Time Systems (24576) [M-INFO-100803]

Responsible: Prof. Dr.-Ing. Thomas Längle

Organisation: KIT Department of Informatics

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-INFO-101340	Real-Time Systems	6 CR	Längle

M 7.260 Module: Reinforcement Learning [M-INFO-105623]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Prof. Dr. Gerhard Neumann

Organisation: KIT Department of Informatics

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	2

Mandatory			
T-INFO-111255	Reinforcement Learning	6 CR	Lioutikov, Neumann

Competence Certificate
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.

Recommendation
• 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.

M 7.261 Module: Reliability and Test Engineering [M-MACH-106050]

Responsible: Dr.-Ing. Thomas Gwosch
Prof. Dr.-Ing. Sven Matthiesen

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-111840	Reliability and Test Engineering	5 CR	Gwosch

Competence Certificate
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.

Annotation
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

Recommendation
We strongly recommend the attendance of the MSuP lectures. Students who have not (yet) attended are recommended to learn the contents in advance.

Learning type
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 7.262 Module: Renewable Energy-Resources, Technologies and Economics [M-WIWI-100500]

Responsible: Prof. Dr. Russell McKenna
Organisation: KIT Department of Economics and Management
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	3

Mandatory			
T-WIWI-100806	Renewable Energy-Resources, Technologies and Economics	4 CR	Jochem

Competence Certificate
The assessment consists of a written exam according to Section 4(2), 1 of the examination regulation.

Prerequisites
None

Competence Goal
The student:

- understands the motivation and the global context of renewable energy resources.
- gains detailed knowledge about the different renewable resources and technologies as well as their potentials.
- understands the systemic context and interactions resulting from the increased share of renewable power generation.
- understands the important economic aspects of renewable energies, including electricity generation costs, political promotion and marketing of renewable electricity.
- is able to characterize and where required calculate these technologies.

Content
1. General introduction: Motivation, Global situation

2. Basics of renewable energies: Energy balance of the earth, potential definition

3. Hydro

4. Wind

5. Solar

6. Biomass

7. Geothermal

8. Other renewable energies

9. Promotion of renewable energies

10. Interactions in systemic context

11. Excursion to the “Energieberg” in Mühlburg

Workload
The total workload for this course is approximately 105.0 hours. For further information see German version.

Literature
Elective literature:

- Kaltschmitt, M., 2006, Erneuerbare Energien : Systemtechnik, Wirtschaftlichkeit, Umweltaspekte, aktualisierte, korrigierte und ergänzte Auflage Berlin, Heidelberg : Springer-Verlag Berlin Heidelberg.
- Kaltschmitt, M., Streicher, W., Wiese, A. (eds.), 2007, Renewable Energy: Technology, Economics and Environment, Springer, Heidelberg.
- Quaschning, V., 2010, Erneuerbare Energien und Klimaschutz : Hintergründe - Techniken - Anlagenplanung – Wirtschaftlichkeit München : Hanser, Ill.2., aktualis. Aufl.
- Harvey, D., 2010, Energy and the New Reality 2: Carbon-Free Energy Supply, Eathscan, London/Washington.
- Boyle, G. (ed.), 2004, Renewable Energy: Power for a Sustainable Future, 2ndEdition, Open University Press, Oxford.

M 7.263 Module: Robotics - Practical Course [M-INFO-107155]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114172	Practical Course: Robotics	6 CR	Asfour

Competence Certificate
See partial Achievements (Teilleistung)

Prerequisites
See partial Achievements (Teilleistung)

Competence Goal
The student knows concrete solutions for different problems in robotics. He/she uses methods of inverse kinematics, grasp and motion planning, and visual perception. The student can implement solutions in the programming languages C++ and Python with the help of suitable software frameworks.

Content
The practical course is offered as an accompanying course to the lectures Robotics I-III. Every week, a small team of students will work on solving a given robotics problem. The list of topics includes robot modeling and simulation, inverse kinematics, robot programming via state charts, collision-free motion planning, grasp planning, robot vision and robot learning.

Workload
Practical course with 4 SWS, 6 LP
6 LP corresponds to 180 hours, including
2 hours introductory event
18 hours initial familiarization with the software framework
120 hours group work
40 hours attendance time

Recommendation
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics and Mechano-Informatics and Robotics is recommended.

M 7.264 Module: Robotics II - Humanoid Robotics [M-INFO-107123]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114152	Robotics II - Humanoid Robotics	3 CR	Asfour

Competence Certificate
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

Recommendation
Having visited the lectures on Robotics I - Introduction to Robotics and Mechano-Informatics and Robotics is recommended.

M 7.265 Module: Robotics III - Sensors and Perception in Robotics (24635) [M-INFO-107130]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114155	Robotics III - Sensors and Perception in Robotics	3 CR	Asfour

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Competence Goal
Students can name the main sensor principles used in robotics.

Students can explain the data flow from physical measurement through digitization to the use of the recorded data for feature extraction, state estimation and semantic scene understanding.

Students are able to propose and justify suitable sensor concepts for common tasks in robotics.

Content
The lecture supplements the lecture Robotics I with a broad overview of sensors used in robotics. The lecture focuses on visual perception, object recognition, semantic scene interpretation, and (inter-)active perception. The lecture is divided into two parts:

In the first part a comprehensive overview of current sensor technologies is given. A basic distinction is made between sensors for the perception of the environment (exteroceptive) and sensors for the perception of the internal state (proprioceptive).

The second part of the lecture concentrates on the use of exteroceptive sensors in robotics. The topics covered include tactile exploration and visual data processing, including advanced topics such as feature extraction, object localization,semantic scene interpretation, and (inter-)active perception.

Workload
Lecture with 2 SWS, 3 LP
3 LP corresponds to 90 hours, including
15 * 2 = 30 hours attendance time
15 * 2 = 30 hours self-study
30 hours preparation for the exam

Recommendation
Attending the lecture Robotics I – Introduction to Robotics is recommended.

7.266 Module: Seamless Engineering [M-MACH-105725]

Responsible: Prof. Dr.-Ing. Kai Furmans
Prof. Dr.-Ing. Eric Sax

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-111401	Seamless Engineering	9 CR	Furmans, Sax

Competence Certificate
Examination of another type. The description of the form of examination can be found in the description of the partial performance.

Prerequisites
None

Competence Goal
After successful completion of the course, the students are able to model and parameterise the requirements and boundary conditions for typical mechatronic systems. In addition, students learn the ability to select the appropriate procedures, processes, methods and tools for the development of a mechatronic system.

Important core competences in the areas of communication, problem solving and self-organisation are further essential components of the workshop, which enable the students to do reflected work independently and in a team.

Content
This module is designed to teach students how to develop a heterogeneous integrated mechatronic system. In the lecture, students are introduced to a system-oriented, higher-level approach to the description, assessment and development of a mechatronic system.

Parallel to this, the contents taught are applied and deepened in the practical part on hardware that is close to industry. The students learn the systematic development in a simulative environment as well as the transition from simulation to real hardware.

To achieve this, important components of software development in the robotics environment are taught. This includes, among other things, the basics of programming (Python) as well as the handling of the framework "Robot Operating System (ROS)". In addition, students gain insights into the use of sensors and actuators, image processing, autonomous navigation of automated guided vehicles and robotic grasping.

Module grade calculation
The evaluation of the colloquia and a final examination are included in the module grade. Further details will be provided at the beginning of the course.

Annotation
None

Workload

1. attendance time lecture and exercise: 45 h
2. interdisciplinary qualification: 45 h
3. group work project: 130 h
4. colloquia and final event: 30 h
5. exam preparation and presence in the same: 20 h

In total: 270 = 9 LP

Recommendation
None

Learning type
Lecture, exercise, project.

Literature
None

M 7.267 Module: Seminar Data-Mining in Production [M-MACH-105477]

Responsible: Prof. Dr.-Ing. Gisela Lanza
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-108737	Seminar Data-Mining in Production	3 CR	Lanza

Competence Certificate
Alternative test achievemen

Prerequisites
None

Competence Goal
The students …

- can name, describe and distinguish between different methods, procedures and techniques of production data analysis.
- can perform basic data analyses with the data mining tool KNIME.
- can analyze and evaluate the results of data analyses in the production environment.
- are able to derive suitable recommendations for action.
- are able to explain and apply the CRISP-DM model.

Content
In the age of Industry 4.0, large amounts of production data are generated by the global production networks and value chains. Their analysis enables valuable conclusions about production and lead to an increasing process efficiency. The aim of the modul is to get to know production data analysis as an important component of future industrial projects. The students get to know the data mining tool KNIME and use it for analyses. A specific industrial use case with real production data enables practical work and offers direct references to industrial applications. The participants learn selected methods of data mining and apply them to the production data. The work within the seminar takes place in small groups on the computer. Subsequently, presentations on specific data mining methods have to be prepared.

Annotation
The number of students is limited to twelve. Dates and deadlines for the seminar will be announced at https://www.wbk.kit.edu/studium-und-lehre.php.

Workload
regular attendance: 10 hours
self-study: 80 hours

Learning type
Seminar

7.268 Module: Seminar Electrocatalysis [M-ETIT-105629]

Responsible: Prof. Dr.-Ing. Ulrike Krewer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-ETIT-111256	Seminar Electrocatalysis	3 CR	Krewer

Prerequisites
none

7.269 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	4	3

Mandatory			
T-ETIT-100753	Seminar Embedded Systems	4 CR	Becker, Sax, Stork

Competence Certificate
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 7.270 Module: Seminar for Rail System Technology [M-MACH-104197]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each term	1 term	German	4	2

Mandatory			
T-MACH-108692	Seminar for Rail System Technology	3 CR	Cichon

Competence Certificate
Examination: Writing an essay (Seminararbeit), final presentation

Prerequisites
None

Competence Goal

- The students become aware of the fundamental relations and interdependencies between rail vehicles, infrastructure and operation in a rail system.
- They overview the technical components of a rail system, in particular rail vehicle technology.
- They are able to use the essential elements of scientific work and present their results in written form and verbal presentation.

Content

1. Railway System: railway as a system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact
2. Operation: Transportation, public transport, regional transport, long-distance transport, freight service, scheduling
3. System structure of railway vehicles: structure and major systems of rail vehicles
4. Scientific working: structuring and writing of scientific papers, literature research, scheduling (mile stones), self-management, presentation skills, using the software Citavi for literature and knowledge management, working with templates in Word, giving and taking feedback
5. The learnt knowledge regarding scientific writing is used to elaborate a Seminararbeit. To this the students create a presentation, train and reflect it and finally present it to an auditorium.

Workload
Regular attendance: 21 hours

Self-study (writing Seminararbeit): 65 hours

Final presentation (including preparation): 4 hours

total: 90 hours = 3 ECTS

Learning type
Essay

M 7.271 Module: Seminar Industrial Process and Plant Engineering [M-ETIT-106970]

Responsible: Prof. Dr.-Ing. Mike Barth
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113932	Seminar Industrial Process and Plant Engineering	4 CR	Barth

Competence Certificate
The examination will be the seminar presentation at the end of the semester. The criteria are:

- Live presentation of the created CAD and simulation models
- Poster design and usage within the presentation
- Answering the questions from the examiners
- Structure of the talk

Prerequisites
none

Competence Goal
The students:

- are able to create (concept and virtual realization) mechatronic plants and production facilities (e.g. robot cells).
- understand the Engineering-Lifecycle of unique production plants, machines and modules.
- are familiar with modern CAX-Engineering Methods.
- know advanced (cloud-based) CAX-Tool-Chains.
- know about advanced computer-aided design principles, e.g. model- and equation-based 3D-Design.
- are familiar with design definitions, patterns and features for semi-automated engineering tasks, e.g. automatic generation of variants.
- know CAX-information models, e.g. asset administration shell (AAS) or Parasolid.
- can implement new software-based Engineering features and interfaces.
- are able to perform the virtual commissioning of complex systems using advanced CAX-features.

Content

- This module is designed to teach students the theoretical and practical aspects of advanced model-based and computer-aided design of unique systems, e.g.
  - Industrial plants,
  - Production cells (e.g. robot),
  - Production modules and machines.
- This includes every lifecycle phase of an engineering project starting from 3D-CAD Design to advanced system simulations and concluding in virtual commissioning and optimization during operations.
- Introduction to advanced cloud-based 3D-Plant-Engineering (e.g. OnShape).
- Principals of model-based system design (3D-Modeling, Drawings, Feature-based Rule Set) including advanced kinematics and simulation.
- Configuration and use of VR-, AR-Setups for virtual commissioning and operator training setups.
- Concept and implementation of software-based feature scripts (e.g. C++, python) for advanced engineering in the used tool chain.
- Concept and implementation of interfaces to external engineering data-sources (e.g. data tables, Asset Administration Shell via REST-API, ROS, MQTT or OPC UA).

Module grade calculation
The module grade is the grade of the final presentation including the aspects named above.

Annotation
The seminar 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' academic progress. Details will be announced on the lecture website.

Workload

1. Attendance in Lecture Blocks for Engineering Theory: 10*2 h = 20 h
2. Guided Seminar Work Block: 80 h
3. Preparation of exam: 20 h

A total of 120 h = 4 CR

Recommendation
Enjoyment and interest in industrial engineering and Computer-aided-X Technologies like e.g. 3D CAD, Robotics, Kinematic Simulations, VR, MR and AR-Technologies.

M 7.272 Module: Seminar Intelligent Industrial Robots [M-INFO-102212]

Responsible: Prof. Dr.-Ing. Björn Hein
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-INFO-104526	Seminar Intelligent Industrial Robots	3 CR	Hein

M 7.273 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: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	4	2

Mandatory			
T-ETIT-100713	Seminar New Components and Systems of Power Electronics	4 CR	Hiller

Prerequisites
none

7.274 Module: Seminar Novel Concepts for Solar Energy Harvesting [M-ETIT-103447]

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

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-108344	Seminar Novel Concepts for Solar Energy Harvesting	3 CR	Richards

Competence Certificate
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
After completion of the seminar, students are able to independently familiarize themselves with a new research topic, recapitulate the corresponding literature and present the topic in the form of a review journal article as well as an oral overview presentation. Besides the exposure to new scientific research topics, the students will develope their know-how in scientific presentations and scientific writing in English which are key competences for their future (e.g. MSc thesis projects and research).

Content
We are offering an advanced seminar on „ Novel Concepts for Solar Energy Harvesting" for students curious in latest research topics on devices, materials and physics of next generation solar energy harvesting. The students will get the opportunity to familiarize themselves with a state-of-the-art research topic of their choice under the guidance of a mentor and present the topic during the seminar. The students must attend the seminar regularly, present the research topic in a 30-min scientific talk and submit a short scientific paper (3-5 pages). The seminar addresses master students from electrical engineering, physics, mechanical engineering, material science, KSOP and related MSc programs.

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.

Workload

1. participation in the seminar lectures: 22,5 h
2. preparation of the seminar presentation: 50 h
3. preparation of the journal article: 47,5 h

Recommendation
Good knowledge of semiconductor components/optoelectronics is desirable.

7.275 Module: Seminar: Bionic Algorithms and Robot Technologies [M-MACH-106902]

Responsible: Prof. Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each term	1 term	English	4	1

Mandatory			
T-MACH-113842	Seminar: Bionic Algorithms and Robot Technologies	3 CR	Rönnau

Competence Certificate
See partial achievement

Prerequisites
None

Competence Goal
The aim is to work independently on a scientific topic in the field of biologically inspired algorithms and robot technologies.

Students are able to independently carry out a literature search on the state of research, summarize external work accurately, relate it to each other and evaluate it.

The results and content can be summerized in a seminar paper and an oral presentation.

Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and apply these guidelines successfully in the preparation of their scientific work.

Content
Biologically inspired robots and their methods and technologies transfer concepts for problem solving from nature to mechanical design, sensor technology, navigation, control and interpretation, among other things. These solution approaches are approximated by technical systems. The spectrum of robotics inspired by biology ranges from multi-legged walking robots, distributed sensor concepts and lightweight construction to machine learning methods and neuromorphic hardware.

Workload
90h workload

- Literature research: 24h
- Elaboration of the seminar paper: 40h
- Preparation of the final presentation: 16h
- Attendance time: Kickoff, presentation and discussion as well as meeting with supervisors: 10h

Recommendation
The visit of the lecture "Biologically Inspired Robots" is helpful.

M 7.276 Module: Sensors [M-ETIT-100378]

Responsible: Dr. Wolfgang Menesklou

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of:
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-101911	Sensors	3 CR	Menesklou

M 7.277 Module: Signal Processing Lab [M-ETIT-106633]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113369	Signal Processing Lab	6 CR	Wahls

Competence Certificate
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.

Annotation
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.

Recommendation
Knowledge of the contents of the modules "Signals and Systems", "Measurement Technology" and "Methods of Signal Processing" is strongly recommended.

7.278 Module: Signal Processing Methods [M-ETIT-106899]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113837	Signal Processing Methods	6 CR	Wahls

Competence Certificate
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

Recommendation
Familiarity with signals and systems (in particular, Fourier transforms) and probability theory at the Bachelor level is assumed.

M 7.279 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 Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113428	Signal Processing with Nonlinear Fourier Transforms and Koopman Operators	6 CR	Wahls

Competence Certificate
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.

Annotation
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

Recommendation
Familiarity with signals and systems at the Bachelor level (Fourier and Laplace transforms, linear systems, etc.) is assumed.

M 7.280 Module: Simulation and Optimization in Robotics and Biomechanics [M-INFO-106504]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-INFO-113123	Simulation and Optimization in Robotics and Biomechanics	6 CR	Mombaur

Competence Certificate
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

Annotation
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

M 7.281 Module: Simulation with Lumped Parameters [M-MACH-107053]

Responsible: Prof. Dr.-Ing. Marcus Geimer

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-113862	Simulation with Lumped Parameters	3 CR	Geimer
T-MACH-113863	Tutorial Simulation with Lumped Parameters	1 CR	Geimer

Competence Certificate
Success is assessed in the form of an oral examination (20 minutes) during the lecture-free period of the semester. The examination is offered every semester and can be repeated at any regular examination date.

Prior registration is required; details will be announced on the website of the *Institute of Vehicle Systems Engineering / Institute of Mobile Machinery*. If there are too many interested students, a selection will be made among all interested students according to qualification.

Prerequisites
see individual course

Competence Goal
After completing this part of the course, students will be able to evaluate how a simulation with concentrated parameters can be used sensibly and which simulation methods are suitable for a given problem. They can create a model for a problem and can explain and implement algorithms for solving a model. You will acquire in-depth knowledge of how a system can be modelled and parameterized with concentrated parameters. You will be able to carry out simulation studies, evaluate simulation results and recognize and avoid errors in the simulation.

Content
The basics of discrete-time modeling are taught using the example of simulation with concentrated parameters. For this purpose, modeling in the disciplines of mechanics, electrics and hydraulics is shown by way of example and analogies are drawn. Furthermore, possibilities for simulation coupling of the disciplines are shown. The students solve exemplary tasks with the help of simulation and briefly summarize the solutions in a report.

Module grade calculation
see individual course

Annotation
Basic knowledge of Matlab/Simulink and hydraulics.

Knowledge of the dynamics of mechanical systems and the fundamentals of electrical engineering is assumed.

Workload

- Attendance time: 21 hours
- Self-study: 99 hours

Recommendation

- Knowledge of ProE (ideally in the current version)
- Basic knowledge of Matlab/Simulink
- Basic knowledge of machine dynamics
- Basic knowledge of hydraulics

M 7.282 Module: Software Engineering [M-ETIT-100450]

Responsible: Dr. Clemens Reichmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	German	4	4

Mandatory			
T-ETIT-108347	Software Engineering	3 CR	Reichmann

Prerequisites
none

M 7.283 Module: Solar Energy [M-ETIT-100524]

Responsible: Prof. Dr. Bryce Sydney Richards
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-100774	Solar Energy	6 CR	Richards

Competence Certificate
Type of Examination: written exam

Duration of Examination: 120 Minutes

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

Prerequisites
Students are not allowed to take „Photovoltaik“ (M-ETIT-100513) in addition to this one.

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-ETIT-100513 - Photovoltaics must not have been started.

Competence Goal
The students:

• understand the basic working principle of pn-junction solar cells,

• learn about the different kinds of solar cells (crystalline and amorphous silicon, CIGS, Cadmium telluride, organic, dye-sensitized solar cells, etc.),

• get an overview over upcoming third-generation photovoltaic concepts,

• receive information on photovoltaic modules and module fabrication,

• develop an understanding of solar cell integration and feeding the electrical power to the grid,

• get insight into solar concentration and tandem solar cells for highly efficient energy conversion,

• compare photovoltaic energy harvesting with solar thermal technologies

• understand the environmental impact of solar energy technologies.

Die Studentinnen und Studenten können in englischer Fachsprache sehr gut kommunizieren.

Content
I. Introduction: The Sun

II. Semiconductor fundamentals

III. Solar cell working principle

IV. First Generation solar cells: silicon wafer based

V. Second Generation solar cells: thin films of amorphous silicon, copper indium gallium diselenide, cadmium telluride, organic photovoltaics and dye sensitized solar cells

V. Third Generation Photovoltaics: high-efficiency device concepts incl. tandem solar cells

VI. Modules and system integration

VII. Cell and module characterization techniques

VIII. Economics, energy pay-back time, environmental impact

IX. Other solar energy harvesting processes, incl. thermal and solar fuels

X. Excursion

Module grade calculation
The module grade is the grade of the written exam.

Workload
Total 180 h, thereof 60h contact hours (45h lecture, 15h problems class), and 120h homework and self-studies

Recommendation
Knowledge of optoelectronics is a prerequisite, e.g. M-ETIT-100480 – Optoelektronik.

Literature
P. Würfel: Physics of Solar Cells

V. Quaschning: Renewable Energy Systems

C. Honsberg and S. Bowden, PV Education CD-ROM and website, http://www.pveducation.org/pvcdrom

M 7.284 Module: Solar Thermal Energy Systems (Sp-STES) [M-MACH-101924]

Responsible: apl. Prof. Dr. Ron Dagan
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	3

Mandatory			
T-MACH-106493	Solar Thermal Energy Systems	4 CR	Dagan

Competence Certificate
oral exam of about 30 minutes

Prerequisites
None

Competence Goal
The students

get familiar with the global energy demand and the role of renewable energies

learn about improved designs for using efficiently the potential of solar energy

gain basic understanding of the main thermal hydraulic phenomena which support the work on future innovative applications

will be able to evaluate quantitatively various aspects of the thermal solar systems

Content
I. Introduction to solar energy: Energy resources, consumption and costs

II. The sun as an energy resource:

Structure of the sun, Black body radiation, solar constant, solar spectral distribution

Sun-Earth geometrical relationship

III. Passive and active solar thermal applications.

IV. Fundamentals of thermodynamics and heat transfer

V. Solar thermal systems - solar collector-types, concentrating collectors, solar towers. Heat losses and efficiency

VII. Energy storage

The course deals with fundamental aspects of solar energy. Starting from a global energy panorama the course deals with the sun as a thermal energy source. In this context, basic issues such as the sun’s structure, blackbody radiation and solar–earth geometrical relationship are discussed. In the next part, the lectures cover passive and active thermal applications and review various solar collector types including concentrating collectors and solar towers and the concept of solar tracking. Further, the collector design parameters determination is elaborated, leading to improved efficiency. This topic is augmented by a review of the main laws of thermodynamics and relevant heat transfer mechanisms.

The course ends with an overview on energy storage concepts which enhance practically the benefits of solar thermal energy systems.

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

Learning type
Lecture, tutorial

Literature

Foster, Ghassemi, cota,; Solar Energy

Duffie and Beckman; Solar engineering of thermal processes

Holman:, Heat transfer

Heinzel; script to solar thermal energy (in German)

M 7.285 Module: Spaceborne Radar Remote Sensing [M-ETIT-103042]

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

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	2

Mandatory			
T-ETIT-112857	Spaceborne Radar Remote Sensing - Exam	4 CR	Moreira, Prats
T-ETIT-112858	Spaceborne Radar Remote Sensing - Workshop	2 CR	Younis

Competence Certificate
The assessment takes place in the form of a written examination lasting 120 min. and in the form of reports (other types of examination). Those reports have to be submitted as part of the SAR computer workshop (approx. a total of five workshops). Details will be given during the lecture.

Prerequisites
"M-ETIT-100426 - Spaceborne SAR Remote Sensing" is not allowed to be started or to be completed.

Competence Goal
The students obtain a sound knowledge on the fundamentals, theory and applications of spaceborne radar systems. They understand the principle and function of synthetic aperture radars (SAR). They are able to explain the theory, techniques, algorithms for data processing and system concepts as well as to report on several application examples.

Content
The lecture is interdisciplinary and well suited for students interested in learning different aspects of the entire end-to-end system chain of spaceborne radar systems. Today, Synthetic Aperture Radar (SAR) systems are generating images of the Earth ´s surface with a resolution better than 1 meter. Due to their ability to produce high-resolution radar images independent of sunlight illumination and weather conditions, SAR systems have demonstrated their outstanding capabilities for numerous applications, ranging from environmental and climate monitoring, generation of three-dimensional maps, hazard and disaster monitoring as well as reconnaissance and security related applications. We have entered a new era of spaceborne and airborne SAR systems. New satellite systems like TerraSAR-X and TanDEM-X provide radar images with a resolution cell of more than a hundred times better than the one of conventional SAR systems. The lecture will cover all aspects of spaceborne radar systems including an overview of new technologies, applications and future developments.

Supporting the main lecture, exercise assignments are distributed to the students. The exercise solutions are presented and discussed in detail during lecture hall exercises. Further dedicated topics are explained to deepen the understanding of the main lecture contents.

The aim of the computer-workshop is to gain practical experience on radar systems using data and parameter simulations which are based on the evaluation of simplified models.

Module grade calculation
The module grade results of the assessment of the exam (4 LP) and the reports (2 LP).

Annotation
Further information can be found at the internet page of the IHE (https://s.kit.edu/ihe-srrs).

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. Workload (for a lecture)

Attendance time in lectures, exercises: 60 h

Present study time computer exercise: 40 h

Self-study time including exam preparation: 80 h

A total of 180 h = 6 LP

Recommendation
Signal processing and radar fundamentals.

Literature
Lecture viewgraphs, reading material, and literature references can be found on ILIAS at https://s.kit.edu/srrs.

M 7.286 Module: Stochastic Information Processing (24113) [M-INFO-100829]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck

Organisation: KIT Department of Informatics

Part of: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-INFO-101366	Stochastic Information Processing	6 CR	Hanebeck

M 7.287 Module: Strategic Product Development - Identification of Potentials of Innovative Products [M-MACH-107140]

Responsible: Prof. Dr.-Ing. Andreas Siebe
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105696	Strategic Product Development - Identification of Potentials of Innovative Products	3 CR	Siebe
T-MACH-110396	Strategic Product Development - Identification of Potentials of Innovative Products - Case Study	1 CR	Albers, Matthiesen, Siebe

Competence Certificate
See individual course

Prerequisites
None

Competence Goal
After attending the lecture, the student will be able to ...

- discuss the importance and objectives of future management in product planning.
- analyze and evaluate different approaches to strategic product planning in context.
- explain the procedure of scenario-based strategic product planning.
- illustrate the scenario-based strategic product planning approach using examples.

Content
Introduction into future management, Development of scenarios, scenariobased strategy development, trendmanagement, strategic early detection, innovation- and technologymanagement, scenarios in product development, from profiles of requirements to new products, examples out of industrial praxis.

Module grade calculation
The module grade corresponds to the grade from the graded individual course

Annotation
None

Workload
Attendance: 20h

Self-study: 100h

Recommendation
None

Learning type
Lecture, Case Study

Literature
None

Base for
None

7.288 Module: Structural Materials [M-MACH-100291]

Responsible: Dr.-Ing. Stefan Guth
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-100293	Structural Materials	6 CR	Guth

Competence Certificate
oral exam about 25 minutes

M 7.289 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: Field of Specialization in Mechatronics and Information Technology / Autonomous Systems and AI (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
15	Grade to a tenth	Each term	2 terms	English	4	2

Mandatory			
T-ETIT-110291	Innovation Lab	9 CR	Hohmann, Nahm, Sax, Stork, Zwick
T-WIWI-102864	Entrepreneurship	3 CR	Terzidis
T-WIWI-110166	SIL Entrepreneurship Project	3 CR	Terzidis

Competence Certificate
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%).

Annotation
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).

Recommendation
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.

Learning type
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)

7.290 Module: Superconducting Magnet Technology [M-ETIT-106684]

Responsible: Prof. Dr. Tabea Arndt
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113440	Superconducting Magnet Technology	4 CR	Arndt

Competence Certificate
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

Recommendation
Having knowledge in “Superconducting Materials” is beneficial, but not mandatory.

M 7.291 Module: Superconducting Power Systems [M-ETIT-106683]

Responsible: Prof. Dr.-Ing. Mathias Noe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113439	Superconducting Power Systems	4 CR	Noe

Competence Certificate
The examination takes place in form of an oral exam (abt. 45 minutes).

Prerequisites
none

Competence Goal

- The students have a solid knowledge of architecture and design aspects of applications in windings and energy technology devices.
- For the most important power system applications the students can apply the state of the art and can reflect the main benefits.
- The students have a clear understanding of opportunities, benefits and limitations of superconducting components and devices.
- 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 focuses on Superconducting Power Systems.

It will provide an overview of the state of the art, will give an insight into the basic setup, the design, the characteristic parameters and the specific operation behaviour of the following applications:

- Power Transmission Cables and Lines
- Motors and Generators
- Transformers
- Fault Current Limiters
- Magnetic Energy Storage
- Basics of Cryo Technology

For each application a design example is shown and the focus is given on the conceptual design of each application.

The lecturers may change the details of the content without further announcement.
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

Recommendation
Having knowledge in „Superconducting Materials“ is beneficial.

Successful participation in „Superconductivity for Engineers“

M 7.292 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: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-114033	Sustainable Product Engineering	4 CR	Ziegahn

Competence Certificate
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.

Annotation
None

Workload
Attendance: 30h

Self-study: 90h

Recommendation
None

Learning type
Lecture

Literature
None

Base for
None

M 7.293 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: Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-112212	System Integration and Communication Structures in Industry 4.0 and IoT	3 CR	Becker

Prerequisites
none

M 7.294 Module: System Integration in Micro- and Nanotechnology [M-MACH-105315]

Responsible: apl. Prof. Dr. Ulrich Gengenbach
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105555	System Integration in Micro- and Nanotechnology	4 CR	Gengenbach

Competence Certificate
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.

Learning type
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

M 7.295 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-110272	System Integration in Micro- and Nanotechnology 2	4 CR	Gengenbach

Competence Certificate
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.

Learning type
Lecture

Literature

- N.-T. Nguyen, Fundamentals and Applications of Microfluidics, Artech House
- G. T. Reed, Silicon Photonics: An Introduction, Wiley

M 7.296 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: Field of Specialization in Mechatronics and Information Technology / Micro System Technology (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100798	System-on-Chip Laboratory	6 CR	Becker, Peric

Competence Certificate
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

Recommendation

- 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 7.297 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: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – Methodical)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Mandatory Electives – General)
Field of Specialization in Mechatronics and Information Technology / Industrial Informatics and Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	English	4	2

Mandatory			
T-ETIT-100675	Systems and Software Engineering	5 CR	Sax

Competence Certificate
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.

Annotation
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

Recommendation
Knowledge in Digital Technology and Information and Automation Technology (e.g. module M-ETIT-102102 and M-ETIT-106336)

M 7.298 Module: Technical Design in Product Development [M-MACH-105318]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-105361	Technical Design in Product Development	4 CR	Albers, Matthiesen, Schmid

Competence Certificate
Written examination; duration approx. 1h

Prerequisites
None

Competence Goal
The students:

- acquire and possess sound design skills for use at the interface between engineer and designer.
- master all relevant human-product requirements, such as demographic/geographic and psychographic characteristics, relevant modes of perception, typical recognition contents as well as ergonomic basics.
- have a command of the procedure for designing a product, product range or product system from the structure, through form, colour and graphic design within the phases of the design process.
- have a command of the functional and structural design as well as the important human-machine interface of interface design, have knowledge of the essential parameters of a good corporate design.

Content
Value relevant parameters of the technical design

Basics Interface Design

Macroergonomics: Planning and concept phase

Microergonomics: Concept and design phase

Microergonomics: development phase

Best practice

Module grade calculation
The module grade is composed of:

1. Grade of the written examination (100%)

Annotation
After attending the module, students will have the knowledge of the essential fundamentals of technically oriented design, as an integral part of methodical product development.

Workload
1. Time of presence lecture: 21 h

2. Prepare/follow-up lecture exam preparation: 99 h

Total: 120 h = 4 LP

Learning type
Tutorial.

Media:

- Beamer
- Models

Literature

Markus Schmid, Thomas Maier
Technisches Interface Design
Anforderungen, Bewertung, Gestaltung.
Springer Vieweg Verlag (http://www.springer.com/de/book/9783662549476)
Hardcover ISBN: 978-3-662-54947-6 / eBook ISBN: 978-3-662-54948-3
2017
Hartmut Seeger
Design technischer Produkte, Produktprogramme und -systeme
Industrial Design Engineering.
2., bearb. und erweiterte Auflage.
Springer-Verlag GmbH (http://www.springer.com/de/book/9783540236535)
ISBN: 3540236538
September 2005 - gebunden - 396 Seiten

M 7.299 Module: Technical Optics [M-ETIT-100538]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-ETIT-100804	Technical Optics	5 CR	Neumann

Prerequisites
none

M 7.300 Module: Thermal Solar Energy [M-MACH-102388]

Responsible: apl. Prof. Dr. Ron Dagan
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	2

Mandatory			
T-MACH-105225	Thermal Solar Energy	4 CR	Dagan

Competence Certificate
A performance assessment is obligatory; oral exam about 30 minutes

Prerequisites
none

Competence Goal
Based on the elaboration of the basic physics knowledge of the solar irradiation, heat radiation, optics and thermal-hydraulics, the student will be able to

- select solar thermal components such as mirrors, glasses, selective absorbers and insulation materials and their manufacturing processes and to calculate and assess their performance,
- identify different collector types and to indicate their potential field of application,
- characterize the entire solar thermal collector system with respect to its performance and derive from the collector characteristics its suitability for different types of use,
- embed collectors into a technical overall system for heat (household, process heat, heat storage networks) or electricity generation (power plant), to calculate the system efficiency and independently develop the basics of its optimization.
- identify adequate thermal storage types for the temporal separation of generation and consumption, to dimension them appropriately and to integrate them into a system concept,
- evaluate solar thermal systems in their entirety (capacity, estimation of system dynamics, response behavior, efficiency) and know options for integration into networks (heat, cold, electricity).

Content
Fundamentals of thermal solar energy from solar irradiation (influence of time and place, modifications in the atmosphere) and their implementation in a collector to integration into a technical overall system. In detail:

1. introduction to the energy demand and evaluation of the application potential of solar thermal energy.

2. primary energy source SUN: Sun, solar constant, solar radiation (scattering, absorption in the atmosphere, direct-diffuse radiation, angular influences, radiation balance).

3. solar collectors: basic design of a collector, basics of determining the efficiency, significance of concentration and its limitations, solar thermal collector types (designs, efficiency, system technology).

4. passive mechanisms of solar thermal energy: heat conduction in solids and gases, radiation heat transport in transparent and opaque bodies Design requirements and physical principles of solar thermal glasses, mirrors and selective absorbers. Goal oriented selection of materials and manufacturing processes.

5. momentum and heat transport: basic equations of single- and multi-phase transport, basic ideas of local and system engineering calculation methods, stability limits.

Optional

6. solar thermal low-temperature systems: collector variants, methods for system simulation, planning and dimensioning of systems, system-related system design and stagnation scenarios and their handling.

7. solar thermal high-temperature systems: solar thermal power plants (classification of system components, loss mechanisms, upwind power plants), coupling of collector with energy generation process.

At the end:

8. Thermal energy storage: Explanation of terms (energy contents, storage forms and materials, potentials ...), storage concepts (system structure, design ratio), system integration.

9. Solar air conditioning: Determination of cooling capacity, indoor climate, solar cooling methods and evaluation of air conditioning.

Module grade calculation
The module grade is the grade of the oral examination.

Workload
regular lecture attendance: 30 h
self-study: 60 h (incl. supplementary searches)

exam preparation 30 h

Recommendation
desirable are reliable knowledge in physics in optics and thermodynamics

Basics in heat and mass transfer, material science, energy technology and fluid mechanics

Learning type
Präsentation complemented by printouts

Literature
supply of lecture material in printed and electronic form

Stieglitz & Heinzel; Thermische Solarenergie -Grundlagen-Technologie- Anwendungen. Springer Vieweg Verlag. 711 Seiten. ISBN 978-3-642-29474-7

M 7.301 Module: Thermal Turbomachines I [M-MACH-107219]

Responsible: Prof. Dr.-Ing. Hans-Jörg Bauer
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-114052	Thermal Turbomachines I	8 CR	Bauer

Competence Certificate
see individual course

Prerequisites
none

Competence Goal
Students will be able to explain the structure and function of thermal turbomachinery in detail and assess the areas of application of these machines. They will be able to describe and analyze the tasks of the individual components and assemblies. Students are able to assess and evaluate the influence of physical, economic and ecological boundary conditions.

Content
- General principles of thermal turbomachinery
- Steam turbine system analysis
- Gas turbine system analysis
- Combined cycle power plants and combined heat and power plants
- Mode of operation of turbomachinery: General overview
- Working principle of turbines: Energy transfer in the stage
- Types and design examples of turbines
- Flat straight blade grids
- Spatial flow in the turbine and radial equilibrium
- Compressor stages and outlook
- Calculation principles and corelation approaches for turbine and compressor design, stage characteristics

Module grade calculation
The module grade is the grade of the oral exam.

Workload
240h
(for details see individual course)

Recommendation
Recommended in combination with the lecture 'Thermal Turbomachinery II'.

Literature
Lecture notes (available on the Internet)
Bohl, W.: Strömungsmaschinen, Bd. I, II; Vogel Verlag, 1990, 1991
Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993
Traupel, W.: Thermische Turbomaschinen Bd. I, II, Springer-Verlag, 1977, 1982

7.302 Module: Thermal-Fluid-Dynamics [M-MACH-107112]

Responsible: Dr. Sebastian Ruck
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-106372	Thermal-Fluid-Dynamics	4 CR	Ruck

Competence Certificate
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 7.303 Module: Tires and Wheel Development for Passenger Cars [M-MACH-107070]

Responsible: Dr.-Ing. Martin Gießler
Prof. Dr.-Ing. Günter Leister

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-102207	Tires and Wheel Development for Passenger Cars	4 CR	Leister

Competence Certificate
oral examination, duration: approximately 30 minutes

Prerequisites
none

Competence Goal
The students are informed about the interactions of tires, wheels and chassis. They have an overview of the processes regarding the tire and wheel development. They have knowledge of the physical relationships.

Content

1. The role of the tires and wheels in a vehicle
2. Geometrie of Wheel and tire, Package, load capacity and endurance, Book of requirement
3. Mobility strategy, Minispare, runflat systems and repair kit.
4. Project management: Costs, weight, planning, documentation
5. Tire testing and tire properties
6. Wheel technology incuding Design and manifacturing methods, Wheeltesting
7. Tire presssure: Indirect and direct measuring systems
8. Tire testing subjective and objective

Module grade calculation
The module grade corresponds to the grade of the examination in the course.

Workload
120h

M 7.304 Module: Tractors [M-MACH-107058]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105423	Tractors	4 CR	Geimer, Kremmer

Competence Certificate
The assessment consists of an written exam taking place in the recess period (90 min).

Prerequisites
none

Content
Tractors are one of the most underestimated vehicles in regard to performance und technics. Almost none vehicle is as multifunctional and fullfilled with high-tec as a tractor. Automatic guidance, special chassis suspension or special concepts of power trains are one of the topics where tractors are in leading position in technologies

During the lecture an overview about the design and construction and application area is given. A close look will be taken on the historical backround, legal requirements, ways of development, agricultural organizations and the proces of development itself.

In detail the following topics will be dealt with:

- agricultural organization / legal requirements
- history of tractors
- tractor engineering
- tractor mechanics
- chassis suspension
- combustion engine
- transmission
- interfaces
- hydraulics
- wheels and tyres
- cabin
- electrics and electronics

basic knowledge in mechanical engineering

Module grade calculation
see individual course

Workload
Attendance time: 28 hours
Self-study: 92 hours

Literature

- K.T. Renius: Traktoren - Technik und ihre Anwendung; DLG Verlag (Frankfurt), 1985
- E. Schilling: Landmaschinen - Lehr- und Handbuch für den Landmaschinenbau; Schilling-Verlag (Köln), 1960

7.305 Module: Ubiquitous Computing (24146) [M-INFO-107161]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-INFO-114188	Ubiquitous Computing	5 CR	Beigl

Competence Certificate
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 7.306 Module: Validation of Technical Systems [M-MACH-107143]

Responsible: Prof. Dr.-Ing. Tobias Düser
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MACH-113982	Validation of Technical Systems	4 CR	Düser

Competence Certificate
See individual course

Prerequisites
None

Competence Goal
Learn …

- How validation environments in complex cyber-physical system fields look like
- How to plan and operationalize the validation of complex cyber-physical systems
- How to conceptualize and design test benches on a mechanical and electrical level, using different sensors, actuators and models
- How to use simulations in combination with the real system on a test bench
- How to validate an automated driving system with a practical example

Content

- Discussion and analysis of various validation environments from technical areas such as automotive, medical technology, device technology (focus on automotive)
- Teaching methodological aspects of how validation of complex cyber-physical systems is planned and operationalized
- Learning content on power test benches with their mechanical and electrical design, as well as measurement and control technology, actuators and modeling
- Understanding the use of simulations, their scaling and connection to the real system
- Application of theoretical knowledge in the context of a leading example in the field of automated driving
- Outlook on the role of large language models and gamification in validation

Module grade calculation
The module grade corresponds to the grade from the individual course.

Annotation
None

Workload
Attendance: 30h

Self-study: 90h

Recommendation
None

Learning type
Lecture

Literature
None

Base for
None

7.307 Module: Vehicle Drive Technology [M-MACH-107056]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-113997	Vehicle Drive Technology	4 CR	Geimer

Competence Certificate
Success is assessed in the form of an oral examination (20 minutes) during the lecture-free period of the semester. The examination is offered every semester and can be repeated at any regular examination date.

Prerequisites
none

Competence Goal
Students will be able to explain the structure and function of all the drive trains of mobile machinery discussed. They will be able to analyze complex gearbox schematics as well as calculate simple gearbox functions using rough calculations.

Content
This lecture presents and discusses the possible variations of the traction drive trains of mobile machinery. The focus of the lecture is as follows:

-Mechanical transmissions

-Hydrodynamic converters

-Hydrostatic drives

-Power-split transmissions

-Electric drives

-Hybrid drives

-axles

-Terra mechanics (wheel-ground effects)

Module grade calculation
see individual course

Workload
120h (attendance time: 21h, self-study: 99h)

M 7.308 Module: Vehicle Lightweight Design - Strategies, Concepts, Materials [M-MACH-102703]

Responsible: Prof. Dr.-Ing. Frank Henning

Organisation: KIT Department of Mechanical Engineering

Lightweight Design

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105237	Vehicle Lightweight Design - Strategies, Concepts, Materials	4 CR	Henning

Competence Certificate
Written exam; Duration approx. 90 min

Prerequisites
none

Competence Goal
Students learn that lightweight design is a process of realizing a demanded function by using the smallest possible mass. They understand lightweight construction as a complex optimization problem with multiple boundary conditions, involving competences from methods, materials and production.

Students learn the established lightweight strategies and ways of construction. They know the metallic materials used in lightweight construction and understand the relation between material and vehicle body.

Content
Strategies in lightweight design
Shape optimization, light weight materials, multi-materials and concepts for lightweight design

Construction methods
Differential, integral, sandwich, modular, bionic

body construction
Shell, space-frame, monocoque

metalic materials
Steel, aluminium, magnesium, titan

Workload
1. Attendance of lectures: 21 h

2. Preparation and attendance of examination: 99 h

Total: 120 h = 4 LP

Learning type
Lecture

Literature
[1] E. Moeller, *Handbuch Konstruktionswerkstoffe : Auswahl, Eigenschaften, Anwendung*. München: Hanser, 2008.

[2] H.-J. Bargel, *et al.*, *Werkstoffkunde*, 10., bearb. Aufl. ed. Berlin: Springer, 2008.

[3] C. Kammer, *Aluminium-Taschenbuch : Grundlagen und Werkstoffe*, 16. Aufl. ed. Düsseldorf: Aluminium-Verl., 2002.

[4] K. U. Kainer, "Magnesium - Eigenschaften, Anwendungen, Potentiale ", Weinheim [u.a.], 2000, pp. VIII, 320 S.

[5] A. Beck and H. Altwicker, *Magnesium und seine Legierungen*, 2. Aufl., Nachdr. d. Ausg. 1939 ed. Berlin: Springer, 2001.

[6] M. Peters, *Titan und Titanlegierungen*, [3., völlig neu bearb. Aufl.] ed. Weinheim [u.a.]: Wiley-VCH, 2002.

[7] H. Domininghaus and P. Elsner, *Kunststoffe : Eigenschaften und Anwendungen; 240 Tab*, 7., neu bearb. u. erw. Aufl. ed. Berlin: Springer, 2008.

M 7.309 Module: Vehicle Systems for Urban Mobility [M-MACH-106515]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Vehicle Systems Engineering (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-MACH-113069	Vehicle Systems for Urban Mobility	4 CR	Cichon

Competence Certificate
Oral exam
Duration approx. 20 minutes
Auxiliary means: none

Prerequisites
none

Competence Goal
Students will gain a basic understanding of the essential traffic, transport policy and technological contexts of urban mobility. On the basis of this basic understanding, different vehicle concepts of public transport in urban and regional environments will be analyzed, compared
and the optimal range of applications will be discussed. In addition to the established public transport systems, special attention will be paid to innovative mobility solutions. In particular, an understanding of how sustainable, systemic mobility solutions should be designed depending on the individual use case is to be created
.

Content

- Definitions of urban mobility and public transport services
- Comparison and performance parameters of different vehicle concepts
- Rail-bound vehicle systems
- Bus systems and alternative propulsion systems
- Definition of an "innovative vehicle concept for public transport".
- Historical innovative urban vehicle concepts and analysis of why they did not succeed
- Future innovative urban vehicle concepts and discussion of their market opportunities
- Comparison of urban mobility solutions under the aspects of sustainability, resource conservation, resilience and economic efficiency
- Presentations by external experts

Annotation
A bibliography is available for students to download from the Ilias platform.

Workload
Attendance time: 21 hours
Preparation / wrap-up: 21 hours
Exam and exam preparation: 78 hours
Total time: 120 hours = 4 LP

Learning type
Lecture

M 7.310 Module: Virtual Engineering 1 [M-MACH-105293]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation:
Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-102123	Virtual Engineering I	4 CR	Ovtcharova

Competence Certificate
Writen exam, graded, 90 min.

Competence Goal
After successful attendance of the course, students can:

- conceptualize complex systems with the methods of virtual engineering and continue the product development in different domains
- model the digital product with regard to planning, design, manufacturing, assembly and maintenance.
- use validation systems to validate product and production in an exemplary manner.
- Describe AI methods along the product creation process.

Content

- Conception of the product (system approaches, requirements, definitions, structure)
- Generation of domain-specific product data (CAD, ECAD, software, ...) and AI methods
- Validation of product properties and production processes through simulation
- Digital twin for optimization of products and processes using AI methods

Module grade calculation
Examination result "Virtual Engineering 1" 100%

Workload
120 h

Recommendation
None

Learning type
Lecture and exercises

Literature
Lecture slides

M 7.311 Module: Virtual Engineering A (WW4INGMB29) [M-MACH-101283]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	2 terms	German	4	7

Mandatory			
T-MACH-102123	Virtual Engineering I	4 CR	Ovtcharova
Virtual Engineering A (Election: at least 5 credits)			
T-MACH-113857	CAD Engineering Project for Intelligent Systems	3 CR	Rönnau
T-MACH-102185	CATIA CAD Training Course	2 CR	Ovtcharova
T-MACH-105312	CATIA Advanced	4 CR	Ovtcharova
T-MACH-113669	Hot Research Topics in AI for Engineering Applications	4 CR	Meyer
T-MACH-102209	Information Engineering	3 CR	Meyer, Ovtcharova
T-MACH-106743	IoT Platform for Engineering	4 CR	Ovtcharova
T-MACH-113956	Mathematical Methods in Fluid Mechanics	6 CR	Frohnapfel, Gatti
T-MACH-102181	PLM for Product Development in Mechatronics	4 CR	Eigner
T-MACH-106740	Virtual Engineering Lab	4 CR	Ovtcharova

Competence Certificate
The assessment is carried out as partial exams (according to Section 4 (2), 1-3 SPO) of the core course and further single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module separately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None

Competence Goal
The students should:

- have basic knowledge about the industrial application of Information Technology in product development,
- have understanding about current and future application of information systems in product development processes in the context of Product Lifecycle Management and Virtual Engineering,
- be able to operate current CAx- and PLM-systems in the product development process
- understands demands and relevance of interconnected IT-systems and respective methods for product development

Content
The Module Virtual Engineering A gives an overview about product development processes, beginning with requirement engineering, verification of manufacturing feasibility and virtual operation in the scope of Digital Factory. The guest-lectures contained in this module complete the content of the lecture with introducing current product development processes focusing.

Workload

- regular attendance: 140 hours
- Preparation and reworking: 20 hours
- Exam and exam revision/preparation: 110 hours

Learning type
Lecture, exercise

M 7.312 Module: Virtual Engineering Lab [M-MACH-105475]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization in Mechatronics and Information Technology / Automation, Control, and Robotics (Internship/Lab Course)
Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Internship/Lab Course)
Elective Area in Mechatronics and Information Technology (Internship/Lab Course)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-106740	Virtual Engineering Lab	4 CR	Ovtcharova

Competence Certificate
Alternative exam assessment.

Prerequisites
None

Competence Goal
Students are able to design and implement a complex task in teamwork using VR/MR/AR hardware and software.

Content
VR/AR/MR basics (hardware, software), tools and applications

Module grade calculation
Alternative exam assessment.

Workload
120 hours

Learning type
Project work in the team

7.313 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: Field of Specialization in Mechatronics and Information Technology / Design of Mechatronic Systems (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114145	Wearable Robotic Technologies	4 CR	Asfour, Beigl

Competence Certificate
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

Recommendation
Attendance of the lecture Mechano-Informatics in Robotics is recommended.

M 7.314 Module: Windpower [M-MACH-105732]

Responsible: Dr. Balazs Pritz

Organisation: KIT Department of Mechanical Engineering
Institute of Thermal Turbomachinery

Part of: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105234	Windpower	4 CR	Lewald

Competence Certificate
Written exam.

Duration: 80 min

Prerequisites
none

Competence Goal
The students are familiar with the elementary basics of using wind power.
The focus of the lecture is on the general principles of using wind power to generate electricity, supplemented by the historical development, general knowledge of wind and alternative, renewable energies.

Content
Due to the broad basic knowledge, the lecture is aimed at students from all faculties and all semesters.
Based on an overview of alternative, renewable energy technologies and general energy data, the entry into wind energy is made by means of an overview of the historical development of wind power.
Since wind provides the driving energy as indirect solar energy, a separate chapter is devoted to the global and local wind systems and their measurement and energy content.
Based on this, the aerodynamic basics and relationships of wind turbines and their profiles are explained.

Another focus is the electrical system of the wind turbines. Beginning with basic generator technology over the control and management of the energy output.
After the focus on aerodynamics and electrical system, the other components of wind turbines and their special features are explained in context.
Finally, the current economic, ecological and legislative boundary conditions for the operation of wind turbines are examined.
In addition to wind turbines for generating electricity, the lecture also briefly discusses alternative uses such as pump systems.
The conclusion is an overview of current developments such as supergrids or future visions of wind energy use.

Module grade calculation
The module grade is the grade of the written examination.

Workload
Attendance time: 28 hours
Self study: 60 hours

Exam preparation: 30 hours

Learning type
Lecture in presence, course material is provided via ILIAS.

7.315 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: Field of Specialization in Mechatronics and Information Technology / Energy Technology (Additive Electives)
Elective Area in Mechatronics and Information Technology (Elective Area in Mechatronics and Information Technology)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-114166	Workshop Finite Element Method in Electromagnetics	3 CR	Doppelbauer

Competence Certificate
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

Recommendation
Knowledge from the modules "Elektrische Maschinen und Stromrichter" and "Entwurf elektrischer Maschinen" is desired.

8 Courses

T 8.1 Course: Actuators and Sensors in Nanotechnology [T-MACH-105238]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102698 - Actuators and Sensors in Nanotechnology

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Competence Certificate
oral exam

Prerequisites
none

T 8.2 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2313724	Adaptive Optics	2 SWS	Lecture / 🗣	Gladysz

Legend: 🖥 Online, ✱ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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.

Recommendation
Basic knowledge of statistics.

Workload
90 hours

T 8.3 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 scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	1

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites
None.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-112768 - Advanced Artificial Intelligence must not have been started.

T 8.4 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 scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	1

Competence Certificate
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 8.5 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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 8.6 Course: Analysis Tools for Combustion Diagnostics [T-MACH-105167]

Responsible: Jürgen Pfeil
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107031 - Analysis Tools for Combustion Diagnostics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2134134	Analysis tools for combustion diagnostics	2 SWS	Lecture / 🗣	Pfeil

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral examination, Duration: 25 min., no auxiliary means

Prerequisites
none

8.7 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 scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each winter term	1 terms	1

Competence Certificate
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

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

T 8.8 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-107144 - Power Tool Design

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	4

Events					
ST 2025	2145164	Power Tool Design	2 SWS	Lecture / 🗣	Matthiesen

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Competence Certificate
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 Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-110767 - Appliance and Power Tool Design Project Work must have been started.

Recommendation
None

Annotation
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.

Workload
120 hours

T 8.9 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-107145 - Power Tool Design Project Work

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	8	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

Competence Certificate
The Appliance and Power Tool Design Project Work will be examined in conjunction with the concurrent lecture.

Prerequisites
None

Recommendation
None

Annotation
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.

Workload
240 hours

T 8.10 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 scale	Recurrence	Version
Oral examination	6	Grade to a third	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

Competence Certificate
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 8.11 Course: Artificial Intelligence in Production [T-MACH-112115]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105968 - Artificial Intelligence in Production

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2149921	Artificial Intelligence in Production	2 SWS	Lecture / 🗣	Fleischer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
Written Exam (90 min)

Prerequisites
none

Workload
120 hours

T 8.12 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 scale	Recurrence	Version
Written examination	6	Grade to a third	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

T 8.13 Course: Automotive Engineering I [T-MACH-100092]

Responsible: Dr.-Ing. Martin Gießler
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100501 - Automotive Engineering I

Type	Credits	Grading scale	Recurrence	Expansion	Language	Version
Written examination	8	Grade to a third	Each winter term	1 terms		3

Events					
WT 24/25	2113805	Automotive Engineering I	4 SWS	Lecture / 🗣	Gießler
WT 24/25	2113809	Automotive Engineering I	4 SWS	Lecture / 🗣	Gießler

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination

Duration: 120 minutes

Auxiliary means: none

Prerequisites
The brick "T-MACH-102203 - Automotive Engineering I" is not started or finished. The bricks "T-MACH-100092 - Grundlagen der Fahrzeugtechnik I" and "T-MACH-102203 - Automotive Engineering I" can not be combined.

Workload
240 hours

T 8.14 Course: Automotive Engineering II [T-MACH-102117]

Responsible: Dr.-Ing. Martin Gießler
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100502 - Automotive Engineering II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2114835	Automotive Engineering II	2 SWS	Lecture / 🗣	Gießler
ST 2025	2114855	Automotive Engineering II	2 SWS	Lecture / 🗣	Gießler

Legend: 🖥 Online, ❁ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written Examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
none

Workload
120 hours

T 8.15 Course: Automotive Vision [T-MACH-105218]

Responsible: Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102693 - Automotive Vision

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	3

Events					
ST 2025	2138340	Automotive Vision	3 SWS	Lecture / 🗣	Lauer, Bätz

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Type of Examination: written exam

Duration of Examination: 60 minutes

Prerequisites
none

Workload
180 hours

T 8.16 Course: Automotive Vision [T-MACH-114149]

Responsible: Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107148 - Automotive Vision

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	2

Events					
ST 2025	2138340	Automotive Vision	3 SWS	Lecture / 🗣	Lauer, Bätz

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Type of Examination: written exam

Duration of Examination: 60 minutes

Prerequisites
none

Workload
180 hours

T 8.17 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	Each summer term	1

Events					
ST 2025	2306330	Basics of Converter Control	2 SWS	Lecture / 🗣	Liske

Legend: 🖥 Online, ❆ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Prerequisites
none

T 8.18 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 scale	Recurrence	Version
Written examination	6	Grade to a third	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

Competence Certificate
The assessment consists of a written exam (60 min.) according to § 4 paragraph 2 Nr. 1 of the examination regulation.

Prerequisites
none

Recommendation
Knowledge of the basics of technical mechanics and out of "Basic of Technical Logstics I" (T-MACH-109919) preconditioned.

Workload
150 hours

T 8.19 Course: Batteries and Fuel Cells [T-ETIT-100983]

Responsible: Prof. Dr.-Ing. Ulrike Krewer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100532 - Batteries and Fuel Cells

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each winter term	3

Events					
WT 24/25	2304207	Batteries and Fuel Cells	2 SWS	Lecture / 🗘	Krewer
WT 24/25	2304213	Batteries and Fuel Cells (Exercise to 2304207)	1 SWS	Practice / 🗣	Krewer, Sonder

Legend: 🖥 Online, 🗘 Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Prerequisites
none

8.20 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each winter term	1

Events					
WT 24/25	2304235	Batteries and Fuel Cells Laboratory	4 SWS	Practical course / 🗣	Weber

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.21 Course: Battery and Fuel Cells Systems [T-ETIT-100704]

Responsible: Dr.-Ing. Andre Weber
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100377 - Battery and Fuel Cells Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Each summer term	1

Events					
ST 2025	2304214	Batterie- und Brennstoffzellensysteme	2 SWS	Lecture / 🗣	Weber

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.22 Course: Bioelectric Signals [T-ETIT-101956]

Responsible: Dr.-Ing. Axel Loewe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100549 - Bioelectric Signals

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	2

Events					
ST 2025	2305264	Bioelectric Signals	2 SWS	Lecture / 🗣	Loewe

Legend: 🖥 Online, ♲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The examination is a written examination with a duration of 90 minutes.

Prerequisites
none

T 8.23 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 scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	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

Competence Certificate
Success is assessed in the form of an oral examination (approx. 15-20 minutes)

Prerequisites
none

Recommendation
It is recommended to listen to the course "Robotics I" beforehand .

Annotation
none

Workload
90 hours

T 8.24 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 scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each winter term	1 terms	2

Competence Certificate
oral exam (appr. 20 Min.)

Prerequisites
none

Workload
120 hours

T 8.25 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Competence Certificate
written exam (75 Min.)

Prerequisites
none

Workload
120 hours

T 8.26 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Competence Certificate
Written exam (75 Min.)

Prerequisites
none

Workload
120 hours

T 8.27 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Competence Certificate
Written exam (75 Min.)

Prerequisites
none

Workload
120 hours

8.28 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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	/ ✕	Guber, Ahrens, Länge, Doll

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral examination (45 Min.)

Prerequisites
none

Workload
120 hours

8.29 Course: CAD Engineering Project for Intelligent Systems [T-MACH-113857]

Responsible: Prof. Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-101283 - Virtual Engineering A
M-MACH-106905 - CAD Engineering Project for Intelligent Systems

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	3	Grade to a third	Each term	1 terms	1

Events					
ST 2025	2122331	CAD Engineering Project for Intelligent Systems	4 SWS	Project (P / 🗣	Rönnau

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Examination of a different kind. Design project as well as written elaboration in a team and a final presentation. Grading: Design project 3/5, written paper 1/5 and presentation 1/5.

Prerequisites
none

Workload
90 hours

T 8.30 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 scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	2

Events					
WT 24/25	2147175	CAE-Workshop	3 SWS	Block / 🗣	Düser
ST 2025	2147175	CAE-Workshop	3 SWS	Block / 🗣	Düser

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written test (with practical part on the computer), duration 60 min.

Prerequisites
None

Annotation
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.

Workload
120 hours

T 8.31 Course: CATIA Advanced [T-MACH-105312]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101283 - Virtual Engineering A

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	1

Events					
WT 24/25	2123380	Advanced CATIA	3 SWS	Project (P /	Rönnau, Mitarbeiter

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Assessment of another type. Design project and written documentation in team work and final presentation. Grading: Project work 3/5, documentation 1/5 and presentation 1/5.

Prerequisites
none

Workload
120 hours

T 8.32 Course: CATIA CAD Training Course [T-MACH-102185]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101283 - Virtual Engineering A

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (practical)	2	pass/fail	Each term	2

Events					
WT 24/25	2123358	CATIA CAD training course	2 SWS	Practical course / 🔀	Rönnau, Mitarbeiter

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Practical examination on CAD computer, duration: 60 min.

Prerequisites
None

Recommendation
Dealing with technical drawings is required.

Annotation
For the practical course attendance is compulsory.

Workload
60 hours

T 8.33 Course: CFD for Power Engineering [T-MACH-114187]

Responsible: Dr. Ivan Otic
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107157 - Computational Fluid Dynamics (CFD) for Energy Technologies

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2130910	CFD for Power Engineering	2 SWS	Lecture / ⯐	Otic

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
Oral exam, approx. 30 min

Prerequisites
none

Workload
120 hours

T 8.34 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 scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Each summer term	1 terms	1

Events					
ST 2025	2310546	Channel Coding: Algebraic Methods for Communications and Storage	2 SWS	Lecture / Blended	Schmalen

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
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

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

T 8.35 Course: CO2-Neutral Combustion Engines and their Fuels I [T-MACH-111550]

Responsible: Prof. Dr. Thomas Koch
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107060 - CO2-Neutral Combustion Engines and their Fuels I

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each winter term	1 terms	2

Events					
WT 24/25	2133113	CO2-neutral combustion engines and their fuels I	3 SWS	Lecture / Practice (/ 🗣	Koch

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral examination, Duration: 25 min., no auxiliary means

Prerequisites
none

Workload
120 hours

T 8.36 Course: CO2-Neutral Combustion Engines and their Fuels II [T-MACH-111560]

Responsible: Prof. Dr. Thomas Koch
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107180 - CO2-Neutral Combustion Engines and their Fuels II

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each summer term	1

Events					
ST 2025	2134151	CO2-neutral combustion engines and their fuels II	3 SWS	Lecture / Practice (/ 🗣	Koch

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Competence Certificate
oral examination, duration: 25 minutes, no auxiliary means

Prerequisites
none

Recommendation
Fundamentals of Combustion Engines II helpful

Workload
150 hours

T 8.37 Course: Cognitive Automobiles - Laboratory [T-MACH-105378]

Responsible: Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106744 - Cognitive Automobiles - Laboratory

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each summer term	1

Events					
ST 2025	2138341	Cogitive Automobiles - Laboratory	3 SWS	/ 🗣	Stiller, Lauer, Blumberg

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam

30 minutes

Prerequisites
none

Annotation
The number of participants is limited. A registration is mandatory, the details are announced on the webpages of the institute of measurement and control systems (mrt). In case of too many interested students a subset will be selected (see website).

Workload
180 hours

T 8.38 Course: Combined Cycle Power Plants [T-MACH-105444]

Responsible: Prof. Dr.-Ing. Daniel Banuti
Hon.-Prof. Dr. Thomas Schulenberg

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107062 - Combined Cycle Power Plants

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2170490	Combined Cycle Power Plants	2 SWS	Lecture / 🗣	Banuti, Schulenberg

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam ca. 30 min

Prerequisites
none

Recommendation
We recommend to combine the lecture with the Simulator Exercises for Combined Cycle Power Plants (T-MACH-105445).

Workload
120 hours

T 8.39 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 scale	Recurrence	Version
Written examination	5	Grade to a third	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 8.40 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
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

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

T 8.41 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	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

Competence Certificate
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

8.42 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 scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2105016	Computational Intelligence	2 SWS	Lecture / Blended	Mikut, Reischl, Meisenbacher

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Written exam (Duration: 1h)

Prerequisites
none

Workload
120 hours

T 8.43 Course: Continuum Mechanics of Solids and Fluids [T-MACH-110377]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Prof. Dr.-Ing. Bettina Frohnapfel

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105180 - Continuum Mechanics

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each winter term	1 terms	6

Events					
WT 24/25	2161252	Continuum mechanics of solids and fluids	2 SWS	Lecture / 🗣	Böhlke, Frohnapfel

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination (90 min). Additives as announced

Prerequisites
Coursework in *Tutorial Continuum Mechanics of Solids and Fluids* (T-MACH-110333) must be passed

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-110333 - Tutorial Continuum Mechanics of Solids and Fluids must have been passed.

Annotation
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) and students of the bachelor's degree program in material science and material technology 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 8.44 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 scale	Recurrence	Version
Written examination	6	Grade to a third	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

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

Prerequisites
none

Recommendation
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 8.45 Course: Control of Mobile Machines [T-MACH-111821]

Responsible: Simon Becker
Prof. Dr.-Ing. Marcus Geimer

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106468 - Control of Mobile Machines

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	3

Competence Certificate
The assessment consists of an oral exam (20 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Prerequisites
A prerequisite for participation in the examination is the preparation of a semester report. T-MACH-111820 must be passed.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-111820 - Control of Mobile Machines – Prerequisites must have been passed.

Workload
120 hours

T 8.46 Course: Control of Mobile Machines – Prerequisites [T-MACH-111820]

Responsible: Simon Becker
Prof. Dr.-Ing. Marcus Geimer

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106468 - Control of Mobile Machines

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	0	pass/fail	Each summer term	1

Competence Certificate
Preparation of a report on the completion of the semester task

Prerequisites
none

T 8.47 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 scale	Recurrence	Version
Written examination	6	Grade to a third	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 8.48 Course: Control Technology [T-MACH-105185]

Responsible: Hon.-Prof. Dr. Christoph Gönnheimer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105348 - Control Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	2

Events					
ST 2025	2150683	Control Technology	2 SWS	Lecture / 🗣	Gönnheimer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
Written Exam (60 min)

Prerequisites
none

Workload
120 hours

T 8.49 Course: Control Theory Laboratory [T-ETIT-111009]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105467 - Control Theory Laboratory

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	6	Grade to a third	Each term	1 terms	1

Events					
WT 24/25	2303169	Control Theory Laboratory	4 SWS	Block / 🗣	Hohmann
ST 2025	2303169	Control Theory Laboratory	4 SWS	Practical course / 🗣	Kluwe, Illerhaus

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.50 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 scale	Recurrence	Version
Examination of another type	4	Grade to a third	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

Competence Certificate
active participation and own presentation (30 Min.)

Prerequisites
none

Workload
120 hours

T 8.51 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 scale	Version
Written examination	6	Grade to a third	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

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-ETIT-112223 - Cyber Physical Production Systems must not have been started.

T 8.52 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 scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	2

Events					
ST 2025	2106014	Data Analytics for Engineers	3 SWS	Lecture / Practice (/	Mikut, Reischl, Meisenbacher

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Written exam (Duration: 1h)

Prerequisites
none

Workload
150 hours

T 8.53 Course: Data-Driven Algorithms in Vehicle Technology [T-MACH-112126]

Responsible: Dr. Stefan Scheubner
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107151 - Data-Driven Algorithms in Vehicle Technology

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each winter term	1 terms	1

Events					
WT 24/25	2113840	Data-Driven Algorithms in Vehicle Technology	2 SWS	Lecture / 🔀	Scheubner

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written Examination

Duration: 90 minutes

Workload
120 hours

T 8.54 Course: Decision-Making and Motion Planning for Automated Driving [T-MACH-113597]

Responsible: Dr.-Ing. Maximilian Naumann
apl. Prof. Dr. Moritz Werling

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106926 - Decision-Making and Motion Planning for Automated Driving

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	1

Events					
WT 24/25	2137401	Decision-Making and Motion Planning for Automated Driving	3 SWS	Lecture /	Naumann, Werling

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
written examination, duration 60 min.

Simple calculators are allowed, programmable or graphical ones are prohibited.

Prerequisites
none

Annotation
Basic knowledge of control engineering and systems theory should be available from "Measurement and Control Systems" or from other lectures.

Workload
180 hours

T 8.55 Course: Deep Learning and Neural Networks [T-INFO-114219]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107197 - Deep Learning and Neural Networks

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	1

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites
T-INFO-101383 - Neural networks must not be started.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-109124 - Deep Learning and Neural Networks must not have been started.

Recommendation
Prior successful completion of the core module "Cognitive Systems" is recommended.

T 8.56 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 scale	Recurrence	Version
Written examination	3	Grade to a third	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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Prerequisites
None.

Recommendation
Basic knowledge of pattern recognition as taught in the module Cognitive Systems, is expected.

Annotation
The course is partially given in German and English.

T 8.57 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 scale	Recurrence	Version
Written examination	3	Grade to a third	Each winter term	2

Events					
WT 24/25	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 8.58 Course: Deep Learning for Engineers [T-MACH-113882]

Responsible: Prof. Dr.-Ing. Christoph Stiller
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107088 - Deep Learning for Engineers

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	6	Grade to a third	Each summer term	1 terms	2

Events					
ST 2025	2138335	Deep Learning for Engineers	2 SWS	Lecture / 🗣	Stiller, Lauer, Pauls
ST 2025	2138337	Deep Learning for Engineers (Tutorial)	1 SWS	Practice / 🗣	Stiller, Lauer, Pauls

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam

60 min

Prerequisites
none

Workload
180 hours

T 8.59 Course: Design and Development of Mobile Machines [T-MACH-105311]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107055 - Design and Development of Mobile Machines

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2113079	Design and Development of Mobile Machines	2 SWS	Lecture / 🗣	Geimer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of an oral exam (20 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

A registration is mandatory, the details will be announced on the webpages of the *Institute of Vehicle System Technology / Institute of Mobile Machines.* In case of too many applications, attendance will be granted based on pre-qualification.

The course will be replenished by interestung lectures of professionals from leading hydraulic companies.

Prerequisites
Required for the participation in the examination is the preparation of a report during the semester. T-MACH-108887 must have been passed.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-108887 - Design and Development of Mobile Machines - Advance must have been passed.

Recommendation
Knowledge in Fluid Power Systems

Annotation
After completion of the lecture, studens can:

- design working and travel drive train hydraulics of mobile machines and can derive characteristic key factors.
- choose and apply suitable state of the art designing methods succesfully
- analyse a mobile machines and break its structure down from a complex system to subsystems with reduced complexity
- identify and desrcibe interactions and links between subsystems of a mobile maschine
- present and document solutions of a technical problem according to R&D standards

The number of participants is limited.

Conent:

The working scenario of a mobile machine depends strongly on the machine itself. Highly specialised machines, e.g. pavers are also as common as universal machines with a wide range of applications, e.g. hydraulic excavators. In general, all mobile machines are required to do their intended work in an optimal way and satisfy various critera at the same time. This makes designing mobile machines to a great and interesting challenge. Nevertheless, usually key factors can be derived for every mobile machine, which affect all other machine parameters. During this lecture, those key factors and designing mobile machines accordingly will be adressed. To do so, an exemplary mobile machine will be discussed and designed in the lecture an as a semester project.

Literature:

See german recommendations

Workload
120 hours

T 8.60 Course: Design and Development of Mobile Machines - Advance [T-MACH-108887]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Jan Siebert

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107055 - Design and Development of Mobile Machines

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	0	pass/fail	Each term	1

Competence Certificate
Preparation of semester report

Prerequisites
none

T 8.61 Course: Design and Optimization of Conventional and Electrified Automotive Transmissions [T-MACH-110958]

Responsible: Dr.-Ing. Hartmut Faust
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107082 - Design and Optimization of Conventional and Electrified Automotive Transmissions

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2146208	Design and Optimization of Conventional and Electrified Automotive Transmissions	2 SWS	Lecture / 🗣	Faust

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam (20 min)

Prerequisites
none

Workload
120 hours

T 8.62 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 scale	Recurrence	Version
Written examination	5	Grade to a third	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

Recommendation
Modul: Elektrische Maschinen und Stromrichter

T 8.63 Course: Design with Plastics [T-MACH-105330]

Responsible: Dipl.-Ing. Markus Liedel
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102712 - Design with Plastics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2174571	Design with Plastics	2 SWS	Block / 🗣	Liedel

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral exam, about 20 minutes

Prerequisites
none

Recommendation
Poly I

Workload
120 hours

T 8.64 Course: Development of Hybrid Drivetrains [T-MACH-110817]

Responsible: Prof. Dr. Thomas Koch
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107078 - Development of Hybrid Powertrains

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2134155	Development of Hybrid Powertrains	2 SWS	Lecture / 🗣	Koch, Doppelbauer

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam, 1 hour

Prerequisites
None

Workload
120 hours

T 8.65 Course: Development of Oil-Hydraulic Powertrain Systems [T-MACH-105441]

Responsible: Dr.-Ing. Gerhard Geerling
Prof. Dr.-Ing. Marcus Geimer

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107059 - Development of Oil-Hydraulic Powertrain Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2113072	Development of Oil-Hydraulic Powertrain Systems	2 SWS	Block / 🗣	Geerling

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam (approx. 20 min)

Prerequisites
none

Workload
120 hours

T 8.66 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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.)

Recommendation
Basics of signal processing and radar techniques are useful.

T 8.67 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2312683	Digital Circuit Design	2 SWS	Lecture /	Peric
ST 2025	2312685	Practice to Digital Circuit Design	1 SWS	Practice /	Peric

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

T 8.68 Course: Digital Control [T-MACH-105317]

Responsible: Prof. Dr.-Ing. Michael Knoop
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107045 - Digital Control

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2137309	Digital Control	2 SWS	Lecture / 🗣	Knoop, Rack

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam

60 min.

Prerequisites
none

Workload
120 hours

8.69 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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

Competence Certificate
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 Conditions
The following conditions have to be fulfilled:

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

Recommendation
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.

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

T 8.70 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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, ✕ Cancelled

Prerequisites
none

Modeled Conditions
The following conditions have to be fulfilled:

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

T 8.71 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 scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2301486	Digital Twin Engineering	2 SWS	Lecture / 🗣	Barth, Witucki

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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 8.72 Course: Digitalization of Products, Services & Production [T-MACH-108491]

Responsible: Dr.-Ing. Bernd Pätzold
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105476 - Digitalization of Products, Services & Production

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	2

Competence Certificate
Assessment of another type. Two presentations in team work and two written compositions. Grading: each composition 1/6 and each presentation 2/3.

Prerequisites
none

Workload
120 hours

T 8.73 Course: Digitization in the Railway System [T-MACH-113016]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-106513 - Railway System Digitalisation

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each winter term	1 terms	2

Events					
WT 24/25	2115920	Railway System Digitalisation	2 SWS	Lecture / 🗣	Jost, Cichon

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral examination
Duration: approx. 20 minutes
No tools or reference material may be used during the exam.

Workload
120 hours

T 8.74 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 scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2302106	Distributed Discrete Event Systems	2 SWS	Lecture /	Heizmann
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 8.75 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 scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each winter term	1 terms	2

Competence Certificate
written examination: 90 min duration

Prerequisites
Mutual exclusion with T-MACH-113981 (combined course/ exam) and T-MACH-105216 (German variant)

Recommendation
None

Annotation
None

Workload
120 hours

T 8.76 Course: Drive Train of Mobile Machines [T-MACH-105307]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105800 - Drive Train of Mobile Machines

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2113077	Drive Train of Mobile Machines	2 SWS	Lecture / 🗣	Geimer
WT 24/25	2113078	Exercise Drivetrain of Mobile Machines	1 SWS	Practice / 🗣	Geimer, Bargen-Herzog

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The final assessment will be an oral examination (20 min) taking place during the recess period. The examination will be offered in ervery semester and can be repeated at any regular examination date.

Prerequisites
none

Recommendation

- General principles of mechanicals engineering
- Basic knowledge of hydraulics
- Interest in mobile machinery

Annotation
At the end of the lecture, participants can explain the structure and function of all discussed drive trains of mobile machines. They can analyze complex gearbox schematics and synthesize simple transmission functions using rough calculations.

Content:

In this course the different drive trains of mobile machinery will be discussed. The focus of this course is:

- mechanical gears
- torque converter
- hydrostatic drives
- power split drives
- electrical drives
- hybrid drives
- axles
- terra mechanics

Media: projector presentation

Literature: Download of lecture slides from ILIAS. Further literature recommendations during lectures.

Workload
120 hours

T 8.77 Course: Dynamics of Electro-Mechanical Systems [T-MACH-111260]

Responsible: Philipp Altoé
Prof. Dr.-Ing. Alexander Fidlin

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105612 - Dynamics of Electro-Mechanical Systems

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	5	Grade to a third	Each summer term	1 terms	2

Competence Certificate
Written exam, 180 minutes

Prerequisites
None

Workload
150 hours

T 8.78 Course: Dynamics of the Automotive Drive Train [T-MACH-105226]

Responsible: Prof. Dr.-Ing. Alexander Fidlin
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102700 - Dynamics of the Automotive Drive Train

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	3

Competence Certificate
Oral examination, 30 min.

Prerequisites
none

Recommendation
Powertrain Systems Technology A: Automotive SystemsMachine DynamicsVibration Theory

Workload
120 hours

8.79 Course: Educational Development for Student Teachers - Basic Level [T-ETIT-100797]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	2	pass/fail	Each term	1

Events					
WT 24/25	2411802	Tutorenschulung „Start in die Lehre“ (PEBA)		Others (sons	Heß

Competence Certificate

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.

T 8.80 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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

Competence Certificate
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 8.81 Course: Electric Drives for E-Mobility [T-ETIT-113936]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106971 - Electric Drives for E-Mobility

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2306500	Electric Drives for E-Mobility	2 SWS	Lecture /	Doppelbauer
ST 2025	2306501	Practice to 2306500 Electric Drives for E-Mobility	1 SWS	Practice /	Doppelbauer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The success control takes place in the form of an oral examination of approximately 30 minutes.

Prerequisites
none

Recommendation
Basic knowledge in the field of electric machines and drives is helpful, for example by attending the course “Elektrische Maschinen und Stromrichter (EMS)” in the KIT-Bachelor.

Basic knowledge in the field of hybrid and electric vehicles is helpful, for example by attending the course “Hybridelektrische Fahrzeuge HEF)” in the KIT-Bachelor.

T 8.82 Course: Electric Power Transmission & Grid Control [T-ETIT-110883]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105394 - Electric Power Transmission & Grid Control

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	6	Grade to a third	Each summer term	1 terms	2

Events					
WT 24/25	2307376	Electric Power Transmission & Grid Control	2 SWS	Lecture / ✕	Leibfried
ST 2025	2307376	Electric Power Transmission & Grid Control	2 SWS	Lecture / 🗣	Leibfried
ST 2025	2307377	Tutorial for 2307376 Electric Power Transmission & Grid Control	2 SWS	Practice / 🗣	Weber

Legend: 🖥 Online, ✣ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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 8.83 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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

Competence Certificate
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

Recommendation
Participation in the courses Elektrische Maschinen and Stromrichter and Elektroenergiesysteme (bachelor courses)

Annotation
Joint event of the IEH and the ETI.

T 8.84 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 scale	Recurrence	Version
Written examination	5	Grade to a third	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

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

T 8.85 Course: Elements and Systems of Technical Logistics [T-MACH-102159]

Responsible: Georg Fischer
Dr.-Ing. Martin Mittwollen

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102688 - Elements of Technical Logistics
M-MACH-105015 - Elements of Technical Logistics incl. Project

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Competence Certificate
The assessment consists of an oral exam (20min) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

Prerequisites
none

Recommendation
Knowledge out of "Basics of Technical Logistics I" (T-MACH-109919) preconditioned.

Workload
120 hours

T 8.86 Course: Elements and Systems of Technical Logistics - Project [T-MACH-108946]

Responsible: Georg Fischer
Dr.-Ing. Martin Mittwollen

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105015 - Elements of Technical Logistics incl. Project

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	2	Grade to a third	Each winter term	1

Competence Certificate
Presentation of performed project and defense (30min) according to $4 (2), No. 3 of the examination regulation

Prerequisites
T-MACH-102159 (Elements and Systems of Technical Logistics) must have been started

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-102159 - Elements and Systems of Technical Logistics must have been started.

Recommendation
Knowledge out of "Basics of Technical Logistics I" (T-MACH-109919) preconditioned.

Workload
60 hours

T 8.87 Course: Energy Storage and Network Integration [T-ETIT-104644]

Responsible: Prof. Dr.-Ing. Mathias Noe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-101969 - Energy Storage and Network Integration

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	2

Events					
WT 24/25	2312687	Energy Storage and Network Integration	2 SWS	Lecture / 🗣	Grilli, De Carne
WT 24/25	2312689	Tutorial for 2312687 Energy Storage and Network Integration	1 SWS	Practice / 🗣	De Carne, Grilli

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed in an overall oral examination (30 minutes).

Prerequisites
The course "T-MACH-105952 – Energiespeicher und Netzintegration" must not have started.

Recommendation
Basic knowledge in the fields of Electrical Engineering and Thermodynamics is helpful.

Annotation
Exam and Lecture will be held in English.

T 8.88 Course: Energy Systems I: Renewable Energy [T-MACH-105408]

Responsible: apl. Prof. Dr. Ron Dagan
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107139 - Energy Systems I - Renewable Energy

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	2

Events					
WT 24/25	2129901	Energy Systems I - Renewable Energy	2 SWS	Lecture / 🗣	Dagan

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam, approx. 1/2 hour

Prerequisites
none

Workload
120 hours

T 8.89 Course: Energy Systems II: Reactor Physics [T-MACH-105550]

Responsible: Dr. Aurelian Florin Badea
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107071 - Reactor Physics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2130929	Energy systems II: Reactor Physics	2 SWS	Lecture / 🗣	Badea

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam, 20 min

Prerequisites
none

Workload
120 hours

T 8.90 Course: Energy Topology and Resilience [T-MACH-112755]

Responsible: Dr. Sadeeb Simon Ottenburger
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107061 - Energy Topology and Resilience

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2153446	Energy Topology and Resilience	2 SWS	Lecture / 🗣	Ottenburger

Legend: 🖥 Online, ✿ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral

Duration: approx. 30 minutes

No auxiliary meand

Prerequisites
none

Workload
140 hours

T 8.91 Course: Engine Measurement Techniques [T-MACH-105169]

Responsible: Dr.-Ing. Sören Bernhardt
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107160 - Engine Measurement Techniques

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2134137	Engine measurement techniques	2 SWS	Lecture / 🗣	Bernhardt

Legend: 🖥 Online, ♲ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
oral examination, Duration: 0,5 hours, no auxiliary means

Prerequisites
none

Recommendation
T-MACH-102194 Combustion Engines I

Workload
120 hours

T 8.92 Course: Engineering Materials for the Energy Transition [T-MACH-112691]

Responsible: Prof. Dr. Hans Jürgen Seifert
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107066 - Engineering Materials for the Energy Transition

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2193008	Engineering Materials for the Energy Transition	2 SWS	Lecture / 🗣	Seifert, Ziebert

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam; about 30 minutes

Prerequisites
T-MACH-108688 - The energetics of engineering materials for the energy transition must not have been started.

Recommendation
Knowledge of Materials Science.

Workload
120 hours

T 8.93 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-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (written)	2	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

Competence Certificate
written test

Duration: 60 minutes

result: passed / not passed

No tools or reference materials may be used during the exam.

Prerequisites
none

Workload
60 hours

T 8.94 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 scale	Recurrence	Version
Written examination	3	Grade to a third	Each term	1

Events					
WT 24/25	2545001	Entrepreneurship	2 SWS	Lecture / Blended	Terzidis, Dang
ST 2025	2545001	Entrepreneurship	2 SWS	Lecture / Blended	Terzidis, Dang

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Competence Certificate
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

Recommendation
None

8.95 Course: Ethics of Technology [T-MACH-113903]

Responsible: Prof. Dr. Dr. Rafaela Hillerbrand
Organisation: KIT Department of Mechanical Engineering
Part of: M-ETIT-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	2	pass/fail	Each summer term	1 terms	2

Events					
ST 2025	9003014	Energy Ethics		Seminar / 🗣	Frigo, Calidori, Gruba

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Academic achievements in the form of written assignments and/or oral performances.

Prerequisites
none

Workload
60 hours

T 8.96 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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

Competence Certificate
Oral examination, 20 minutes

Prerequisites
none

Workload
120 hours

T 8.97 Course: Field Propagation and Coherence [T-ETIT-100976]

Responsible: Prof. Dr. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100566 - Field Propagation and Coherence

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	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 8.98 Course: Flows and Heat Transfer in Energy Technology [T-MACH-105403]

Responsible: Prof. Dr.-Ing. Xu Cheng
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107120 - Flows and Heat Transfer in Energy Technology

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2189910	Flows and Heat Transfer in Energy Technology	2 SWS	Lecture / 🗣	Cheng
WT 24/25	2189911	Tutorial 'Flows and Heat Transfer in Energy Technology '	1 SWS	Practice / 🗣	Cheng, Mitarbeiter

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam, 20 min

Prerequisites
none

Workload
120 hours

8.99 Course: Fundamentals in the Development of Commercial Vehicles [T-MACH-111389]

Responsible: Christof Weber
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105824 - Fundamentals in the Development of Commercial Vehicles

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	see Annotations	2

Events					
WT 24/25	2113812	Fundamentals in the Development of Commercial Vehicles I	1 SWS	Lecture / 🗣	Weber
ST 2025	2114844	Fundamentals in the Development of Commercial Vehicles II	1 SWS	Lecture / 🗣	Weber

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral group examination

Duration: appr. 30 minutes

Auxiliary means: none

Prerequisites
none

Annotation
Fundamentals in the Development of Commercial Vehicles I, WT

Fundamentals in the Development of Commercial Vehicles II, ST

Workload
120 hours

T 8.100 Course: Fundamentals of Automobile Development I [T-MACH-105162]

Responsible: Dr. Manfred Harrer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105289 - Principles of Whole Vehicle Engineering I

Type	Credits	Grading scale	Recurrence	Version
Written examination	2	Grade to a third	Each winter term	1

Events					
WT 24/25	2113810	Fundamentals of Automobile Development I	1 SWS	Lecture / 🗣	Harrer
WT 24/25	2113851	Principles of Whole Vehicle Engineering I	1 SWS	Lecture / 🗣	Harrer

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
none

Workload
60 hours

T 8.101 Course: Fundamentals of Automobile Development II [T-MACH-105163]

Responsible: Dr. Manfred Harrer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105290 - Principles of Whole Vehicle Engineering II

Type	Credits	Grading scale	Recurrence	Version
Written examination	2	Grade to a third	Each summer term	2

Events					
ST 2025	2114842	Principles of Whole Vehicle Engineering II	1 SWS	Block / 🗣	Harrer
ST 2025	2114860	Principles of Whole Vehicle Engineering II	1 SWS	/ 🗣	Harrer

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
none

Workload
60 hours

T 8.102 Course: Fundamentals of Combustion I [T-MACH-105213]

Responsible: Prof. Dr. Ulrich Maas
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102707 - Fundamentals of Combustion I

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	3

Events					
WT 24/25	2165515	Fundamentals of Combustion I	2 SWS	Lecture / 🗣	Maas, Shrotriya
WT 24/25	2165517	Fundamentals of Combustion I (Tutorial)	1 SWS	Practice / 🗣	Bykov
WT 24/25	3165016	Fundamentals of Combustion I	2 SWS	Lecture / 🗣	Maas
WT 24/25	3165017	Fundamentals of Combustion I (Tutorial)	1 SWS	Practice / 🗣	Bykov

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written exam, approx. 3 hours

Prerequisites
T-MACH-114043 and T-MACH-113998 must not have started

Workload
120 hours

T 8.103 Course: Fundamentals of Combustion II [T-MACH-114044]

Responsible: Dr. Viatcheslav Bykov
Prof. Dr. Ulrich Maas

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107117 - Fundamentals of Combustion II

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	2

Events					
ST 2025	3166550	Fundamentals of Combustion II	2 SWS	Lecture / 🗣	Maas, Shrotriya, Bykov
ST 2025	3166551	Fundamentals of Combustion II (Tutorial)	1 SWS	Practice / 🗣	Maas, Bykov, Shrotriya

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam

Prerequisites
T-MACH-105325 and T-MACH-113998 must not be started

Workload
120 hours

T 8.104 Course: Fundamentals of Energy Technology [T-MACH-105220]

Responsible: Dr. Aurelian Florin Badea
Prof. Dr.-Ing. Xu Cheng
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102690 - Fundamentals of Energy Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Each summer term	1

Events					
ST 2025	2130927	Fundamentals of Energy Technology	3 SWS	Lecture / 🗣	Cheng, Badea
ST 2025	3190923	Fundamentals of Energy Technology	3 SWS	Lecture / 🗣	Badea

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination, 90 min

Prerequisites
none

Workload
240 hours

T 8.105 Course: Fundamentals of Reactor Safety for the Operation and Dismantling of Nuclear Power Pants [T-MACH-105530]

Responsible: Dr. Victor Hugo Sanchez-Espinoza

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107150 - Fundamentals of Reactor Safety for the Operation and Dismantling of Nuclear Power Plants

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Competence Certificate
oral exam about 30 minutes

Prerequisites
none

Workload
120 hours

T 8.106 Course: Fusion Technology A [T-MACH-105411]

Responsible: Dr. Sara Perez Martin
Dr. Klaus-Peter Weiss

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107124 - Fusion Technology A

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	2

Events					
WT 24/25	2169483	Fusion Technology A	2 SWS	Lecture / Practice (/ 🗣	Weiss, Perez Martin
WT 24/25	2169484	Exercise Fusion Technology A	2 SWS	Practice / 🗣	Weiss, Perez Martin

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam of about 30 minutes

Prerequisites
T-MACH-113977 must not have been started.

Recommendation
appreciated is knowldege in heat ans mass transfer as well as in electrical engineering,

basic knowledge in fluid mechanics, material sciences and physics

Workload
120 hours

T 8.107 Course: Fusion Technology B [T-MACH-105433]

Responsible: Dr. Sara Perez Martin
Dr. Michael Rieth

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107154 - Fusion Technology B

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2190492	Fusion Technology B	2 SWS	Lecture / 🗣	Perez Martin, Rieth
ST 2025	2190493	Exercise Fusion Technology B	2 SWS	Practice / 🖥	Perez Martin, Rieth

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam of about 30 minutes

Prerequisites
none

Recommendation
attendance of fusion technology A lecture

reliable capability to use fundamental knowledge communicated in the bachelor study in physics, material sciences , electrical engineering and engineering design

Annotation
none

Workload
120 hours

T 8.108 Course: Handling Characteristics of Motor Vehicles I [T-MACH-105152]

Responsible: Dr.-Ing. Hans-Joachim Unrau
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105288 - Handling Characteristics of Motor Vehicles I

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2113807	Handling Characteristics of Motor Vehicles I	2 SWS	Lecture / 🖥	Unrau

Legend: 🖥 Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Competence Certificate
Verbally

Duration: 30 up to 40 minutes

Auxiliary means: none

Prerequisites
none

Workload
120 hours

T 8.109 Course: Handling Characteristics of Motor Vehicles II [T-MACH-105153]

Responsible: Dr.-Ing. Hans-Joachim Unrau
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107073 - Handling Characteristics of Motor Vehicles II

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2114838	Handling Characteristics of Motor Vehicles II	2 SWS	Lecture / 🖥	Unrau

Legend: 🖥 Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Prerequisites
none

Workload
120 hours

T 8.110 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

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

Prerequisites
none

T 8.111 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 scale	Recurrence	Version
Oral examination	6	Grade to a third	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, x Cancelled

Competence Certificate
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 8.112 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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

Competence Certificate
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

T 8.113 Course: Heat and Mass Transfer [T-MACH-105292]

Responsible: Prof. Dr. Ulrich Maas
Dr.-Ing. Chunkan Yu

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102717 - Heat and Mass Transfer

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each term	1

Events					
WT 24/25	2165512	Heat and mass transfer	2 SWS	Lecture / 🗣	Yu, Maas
WT 24/25	2165513	Heat and Mass Transfer (Tutorial)	2 SWS	Practice / 🗣	Yu, Maas, Bykov
ST 2025	3122512	Heat and Mass Transfer	2 SWS	Lecture / 🗣	Maas

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written exam, approx. 3 h

Prerequisites
none

Workload
120 hours

T 8.114 Course: Heatpumps [T-MACH-105430]

Responsible: Prof. Dr. Ulrich Maas
Dr. Heiner Wirbser

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107075 - Heat Pumps

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
WT 24/25	2166534	Heatpumps	2 SWS	Lecture / 🗣	Wirbser
ST 2025	2166534	Heatpumps	2 SWS	Lecture / 🗣	Wirbser

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral exam (20 min)

Prerequisites
none

Workload
120 hours

T 8.115 Course: High-Voltage Technology [T-ETIT-110266]

Responsible: Dr.-Ing. Rainer Badent
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105060 - High-Voltage Technology

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	6	Grade to a third	Each winter term	1 terms	1

Events					
WT 24/25	2307360	High-Voltage Technology	2 SWS	Lecture / 🗣	Badent
WT 24/25	2307362	Tutorial for 2307362High-Voltage Technology	1 SWS	Practice / 🗣	Badent, Zajadatz

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.116 Course: High-Voltage Test Technique [T-ETIT-101915]

Responsible: Dr.-Ing. Rainer Badent
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100417 - High-Voltage Test Technique

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2307392	High-Voltage Test Technique	2 SWS	Lecture / 🗣	Badent
WT 24/25	2307394	Tutorial for 2307392 High-Voltage Test Technique	2 SWS	Practice / 🗣	Gielnik

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.117 Course: Holistic Approach of Managing Power Plant Operation under Uncertainty and Volatility [T-MACH-112238]

Responsible: Dr. Marcus Seidl
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107097 - Holistic Approach of Managing Power Plant Operation under Uncertainty and Volatility

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each term	1

Events					
WT 24/25	2189405	Holistic approach of managing power plant operation under uncertainty and volatility	2 SWS	Lecture / 🖥	Seidl

Legend: 🖥 Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Competence Certificate
oral exam of about 30 minutes

Prerequisites
none

Annotation
none

Workload
120 hours

T 8.118 Course: Hot Research Topics in AI for Engineering Applications [T-MACH-113669]

Responsible: Prof. Dr.-Ing. Anne Meyer
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-101283 - Virtual Engineering A
M-MACH-107089 - Hot Research Topics in AI for Engineering Applications

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	4	Grade to a third	Each winter term	1 terms	1

Events					
WT 24/25	2121341	Hot Research Topics in AI for Engineering Applications	3 SWS	Project (P / 🗣	Meyer, Dörr

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The grade is determined by an examination of another type. This consists of an individual knowledge check after the lecture part, the continuous assessment of teamwork during the implementation task and a final presentation. The overall impression is assessed; in addition to the implementation task, the knowledge test and the final presentation are also taken into account.

Prerequisites
none

Recommendation
Basic knowledge of artificial intelligence and machine learning, Programming experience, preferably in Python, English proficiency

Annotation
Limited number of participants.

Workload
120 hours

T 8.119 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 scale	Recurrence	Version
Written examination	3	Grade to a third	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

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.120 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 scale	Recurrence	Version
Written examination	3	Grade to a third	Each winter term	4

Events					
WT 24/25	2424100	Human-Machine-Interaction in Anthropomatics: Basics	2 SWS	Lecture / Blended	van de Camp

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

T 8.121 Course: Humanoid Robots - Seminar [T-INFO-114170]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-107152 - Humanoid Robots - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). It includes a presentation at the end of the term and a term paper.

Prerequisites
None.

Recommendation
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III – Sensors and Perception in Robotics, Mechano-Informatics and Robotics and Wearable Robotic Technologies is recommended.

T 8.122 Course: Hydrogen and reFuels - Energy Conversion in Combustion Engines [T-MACH-111585]

Responsible: Dr.-Ing. Heiko Kubach
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107158 - Hydrogen and reFuels - Energy Conversion in Combustion Engines

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each winter term	1 terms	2

Events					
WT 24/25	2134155	Hydrogen and reFuels - Energy Conversion in Combustion Engines	2 SWS	Lecture / 🗣	Koch

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam, appr. 25 minutes, no auxillary means

Prerequisites
T-MACH-113979 must not have been started.

Workload
120 hours

T 8.123 Course: Industrial Business Administration [T-WIWI-100796]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-ETIT-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (written)	3	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

Competence Certificate
The assessment of this course is a ungraded written examination (60 min).

Prerequisites
None

T 8.124 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	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

T 8.125 Course: Industrial Mobile Robotics Lab [T-MACH-113701]

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

Part of: M-MACH-106830 - Industrial Mobile Robotics Lab

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each term	2

Events					
WT 24/25	2117073	Industrial Mobile Robotics Lab	2 SWS	Practical course / 🗣	Enke, Furmans
ST 2025	2117073	Industrial Mobile Robotics Lab	2 SWS	Practical course / 🗣	Furmans, Enke

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Certificate through colloquium with presentation, documentation of the work results and fulfilment of the attendance requirement.

Prerequisites
T-MACH-105230 must not be started.

Recommendation
Basic knowledge of Python programming and basic knowledge of technical logistics of advantage.

Annotation
The number of participants is limited to 15 students.
The selection procedure is based on a letter of motivation in which the following questions should be answered:

- Why do you want to attend the course?
  What skills and previous knowledge do you have?

Workload
120 hours

T 8.126 Course: Information Engineering [T-MACH-102209]

Responsible: Prof. Dr.-Ing. Anne Meyer
Prof. Dr.-Ing. Jivka Ovtcharova

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101283 - Virtual Engineering A

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	2

Events					
WT 24/25	2121355	Information Engineering	2 SWS	Seminar / 🧩	Meyer, Rönnau
ST 2025	2122014	Information Engineering	2 SWS	Seminar / 🧩	Meyer, Rönnau

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative exam assessment (written composition and speech)

Prerequisites
None

Workload
90 hours

T 8.127 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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, x Cancelled

Prerequisites
none

8.128 Course: Information Processing in Sensor Networks [T-INFO-101466]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: M-INFO-100895 - Information Processing in Sensor Networks

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each winter term	1

T 8.129 Course: Information Systems and Supply Chain Management [T-MACH-102128]

Responsible: Dr.-Ing. Christoph Kilger

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105281 - Information Systems and Supply Chain Management

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	3

Competence Certificate

The success control takes place in form of a written examination (60 min) during the semester break (according to §4(2), 1 SPO). If the number of participants is low, an oral examination (according to §4 (2), 2 SPO) may also be offered.

Prerequisites

none

Workload

90 hours

T 8.130 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	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

8.131 Course: Innovation and Project Management in Rail Vehicle Engineering [T-MACH-113068]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106514 - Innovation and Project Management in Rail Vehicle Engineering

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	5

Events					
WT 24/25	2115921	Innovation and Project Management in Rail Vehicle Engineering	2 SWS	Lecture / 🗣	Lang, Cichon
ST 2025	2115921	Innovation and Project Management in Rail Vehicle Engineering	2 SWS	Lecture / 🗣	Lang, Cichon

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Graded examination:
2/3 of the examination: 20-minute oral examination on the content of the lecture
1/3 of the examination performance of another type: unit accompanying the lecture as part of a 10-minute presentation and a practical application from innovation and project management

Workload
120 hours

T 8.132 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 scale	Recurrence	Expansion	Version
Examination of another type	9	Grade to a third	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

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
see module description

T 8.133 Course: Innovation2Business – Innovation Strategy in the Industrial Corporate Practice [T-MACH-112882]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107188 - Innovation2Business – Innovation Strategy in the Industrial Corporate Practice

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each winter term	1 terms	1

Events					
WT 24/25	2145182	Innovation2Business – Innovation Strategy in the Industrial Corporate Practice	2 SWS	Lecture / 🗣	Albers

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written exam based on the lecture handout and materials, duration 90 minutes

Prerequisites
none

Recommendation
None

Workload
120 hours

T 8.134 Course: Innovative Concepts for Programming Industrial Robots [T-INFO-101328]

Responsible: Prof. Dr.-Ing. Björn Hein
Organisation: KIT Department of Informatics
Part of: M-INFO-100791 - Innovative Concepts for Programming Industrial Robots

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each summer term	2

Events					
ST 2025	24179	Innovative Concepts for Programming Industrial Robots	2 SWS	Lecture / 🗣	Hein

Legend: 🖥 Online, ♲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.135 Course: Innovative Nuclear Systems [T-MACH-105404]

Responsible: Prof. Dr.-Ing. Xu Cheng
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107119 - Innovative Nuclear Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2130973	Innovative Nuclear Systems	2 SWS	/ 🗣	Cheng

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam, 20 min

Prerequisites
none

Workload
120 hours

T 8.136 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	Each summer term	1

Events					
ST 2025	2311630	Integrated Intelligent Sensors	2 SWS	Lecture / 🗣	Stork

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

T 8.137 Course: Integrated Product Development [T-MACH-105401]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Tobias Düser

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107141 - Integrated Product Development

Type	Credits	Grading scale	Recurrence	Version
Oral examination	18	Grade to a third	Each winter term	3

Events					
WT 24/25	2145156	Lecture: IP – Integrated Product Development	4 SWS	Lecture / 🗣	Albers
WT 24/25	2145157	Workshop: IP – Integrated Product Development	4 SWS	Practice / 🗣	Albers
WT 24/25	2145300	Project Work: IP - Integrated Product Development	2 SWS	Others (sons / 🗣	Albers

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral examination (approx. 60 minutes)

Prerequisites
none

Annotation
Due to organizational reasons, the number of participants is limited. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK hompage from April to July. The selection itself is made by the course's responsible in personal interviews. The criterion for selection is the progress of studies. In the event of equal progress, the decision is made by lot.

Workload
480 hours

T 8.138 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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 8.139 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-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	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

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam (ca. 20 min)

Prerequisites
none

Recommendation
None

Workload
120 hours

T 8.140 Course: International Production Engineering A [T-MACH-110334]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105109 - International Production Engineering

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each summer term	4

Events					
ST 2025	2150600	International Production Engineering A	2 SWS	Lecture / 🧩	Fleischer

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative test achievement (graded):
- Result of the project work and final presentation with weighting 65%
- Oral exam (ca. 15 min) with weighting 35%

Prerequisites
One of the following courses must be started:

- T-MACH-108844 - Automated Manufacturing Systems
- T-MACH-110962 - Machine Tools and High-Precision Manufacturing Systems

Modeled Conditions
You have to fulfill one of 2 conditions:

1. The course T-MACH-108844 - Automated Manufacturing Systems must have been started.
2. The course T-MACH-110962 - Machine Tools and High-Precision Manufacturing Systems must have been started.

Recommendation
This course should be attended in combination with International Production Engineering B in the next winter semester.

Workload
120 hours

T 8.141 Course: International Production Engineering B [T-MACH-110335]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105109 - International Production Engineering

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each winter term	4

Events					
WT 24/25	2149620	International Production Engineering B	2 SWS	Lecture / 🧩	Fleischer

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative test achievement (graded):
- Result of the project work and final presentation with weighting 65%
- Oral exam (ca. 15 min) with weighting 35%

Prerequisites
The following course must be startet:

- T-MACH-110334 - International Production Engineering A

Furthermore successful completion of one of the following courses:

- T-MACH-108844 - Automated Manufacturing Systems
- T-MACH-110962 - Machine Tools and High-Precision Manufacturing Systems

Modeled Conditions
The following conditions have to be fulfilled:

1. You have to fulfill one of 2 conditions:
   1. The course T-MACH-108844 - Automated Manufacturing Systems must have been passed.
   2. The course T-MACH-110962 - Machine Tools and High-Precision Manufacturing Systems must have been passed.
2. The course T-MACH-110334 - International Production Engineering A must have been started.

Workload
120 hours

T 8.142 Course: Introduction to Automotive and Industrial Lidar Technology [T-ETIT-111011]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105461 - Introduction to Automotive and Industrial Lidar Technology

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	3	Grade to a third	Each winter term	1 terms	2

Events					
WT 24/25	2311604	Introduction to automotive and industrial Lidar technology	2 SWS	Lecture /	Stork, Heußner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

T 8.143 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Competence Certificate
written exam (duration: 60 minutes)

Prerequisites
none

Annotation
Brick T-MACH-102172 may not be started

T 8.144 Course: Introduction to Energy Economics [T-WIWI-102746]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-100498 - Introduction into Energy Economics

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	7

Events					
ST 2025	2581010	Introduction to Energy Economics	2 SWS	Lecture / 🗣	Fichtner
ST 2025	2581011	Übungen zu Einführung in die Energiewirtschaft	2 SWS	Practice / 🗣	Sandmeier, Fichtner, Scharnhorst

Legend: 🖥 Online, ✿ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (90 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

Prerequisites
None.

T 8.145 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Competence Certificate
written examination (60 min)

Prerequisites
T-MACH-114035 and T-MACH-105182 must not have started

Workload
120 hours

T 8.146 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Competence Certificate
written examination (60 min)

Prerequisites
T-MACH-114035 and T-MACH-114101 must not have started

Workload
120 hours

T 8.147 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 scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	2

Events					
ST 2025	2142152	Introduction to Nanotechnology	2 SWS	Lecture / 🗣	Hölscher

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam 90 min

Prerequisites
none

Annotation
Brick T-MACH-111814 may not be started

Workload
120 hours

T 8.148 Course: Introduction to Nuclear Energy [T-MACH-105525]

Responsible: Prof. Dr.-Ing. Xu Cheng
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107122 - Introduction to Nuclear Energy

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2189903	Introduction to Nuclear Energy	2 SWS	Lecture / 🗣	Cheng

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam, 30 min

Prerequisites
none

Workload
120 hours

T 8.149 Course: Introduction to Philosophy of Technology [T-MACH-113883]

Responsible: Prof. Dr. Dr. Rafaela Hillerbrand
Organisation: KIT Department of Mechanical Engineering
Part of: M-ETIT-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	2	pass/fail	Each winter term	1 terms	2

Events					
WT 24/25	5000046	Philosophical Foundations of Technology Assessment: An Introduction to Philosophy of Technology	2 SWS	Seminar / 🗣	Hillerbrand, Frigo

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Competence Certificate
Academic achievements in the form of written assignments and/or oral performances.

Prerequisites
none

Workload
60 hours

T 8.150 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-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	1	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

Competence Certificate
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

Annotation
Detailled information on contents, competence goals, and work load at:

M-ETIT-105665 – Introduction to the Scientific Method (Seminar)

T 8.151 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-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	1	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 8.152 Course: IoT Platform for Engineering [T-MACH-106743]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101283 - Virtual Engineering A

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	2

Events					
WT 24/25	2123352	IoT platform for engineering	3 SWS	Project (P / 🗣	Meyer, Maier, Rönnau
ST 2025	2123352	IoT platform for engineering	3 SWS	Project (P / 🗣	Meyer, Maier

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Assessment of another type (graded), Group teaching project on Industry 4.0 consisting of: Conception, implementation, accompanying documentation and final presentation.

T 8.153 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 scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each winter term	1 terms	1

Events					
WT 24/25	2303201	IT/OT-Security Seminar	2 SWS	Seminar / ⯐	Barth, Madsen

Legend: 🖥 Online, ⯐ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The examination takes place in the form of an oral examination.

The module grade is the grade of the oral exam.

Prerequisites
none

T 8.154 Course: IT-Fundamentals of Logistics [T-MACH-105187]

Responsible: Prof. Dr.-Ing. Frank Thomas
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105282 - IT-Fundamentals of Logistics: Opportunities for Digital Transformation

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	4

Competence Certificate
The assessment consists of an oral exam (20 min.) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

Prerequisites
none

Workload
120 hours

T 8.155 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 scale	Recurrence	Version
Completed coursework	4	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

Competence Certificate
Colloquia

Prerequisites
none

Workload
120 hours

T 8.156 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.157 Course: Laboratory Exercise in Energy Technology [T-MACH-105331]

Responsible: Prof. Dr.-Ing. Hans-Jörg Bauer
Prof. Dr. Ulrich Maas
Dr.-Ing. Heinrich Wirbser

Organisation: KIT Department of Mechanical Engineering

Institute of Thermal Turbomachinery

Part of: M-MACH-107206 - Laboratory Exercise in Energy Technology

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each term	1

Events					
WT 24/25	2171487	Laboratory Exercise in Energy Technology	3 SWS	Practical course / 🗣	Bauer, Maas, Bykov
ST 2025	2171487	Laboratory Exercise in Energy Technology	3 SWS	Practical course / 🗣	Bauer, Maas, Bykov, Schießl

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
1 report, approx. 12 pages

Discussion of the documented results with the assistents

Prerequisites
none

Workload
120 hours

T 8.158 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.159 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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 8.160 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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, x Cancelled

Competence Certificate
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 8.161 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 scale	Recurrence	Version
Written examination	6	Grade to a third	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

Competence Certificate
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

Recommendation
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.

Annotation
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.

8.162 Course: Laboratory Mechatronics [T-MACH-105370]

Responsible: Prof. Dr. Veit Hagenmeyer
Prof. Dr.-Ing. Christoph Stiller

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102699 - Laboratory Mechatronics

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each winter term	4

Events					
WT 24/25	2105014	Laboratory mechatronics	3 SWS	Practical course / 🗣	Hagenmeyer, Stiller, Chen, Orth

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The laboratory course is offered exclusively as ungraded course work. The assessment consists of a group colloquium at the beginning of the individual specialization phases (Part 1). In addition, a robot control system for a pick-and-place task must be successfully implemented in the group phase (Part 2).

Prerequisites
None

Workload
120 hours

8.163 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.164 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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 8.165 Course: Laboratory Solar Energy [T-ETIT-104686]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-102350 - Laboratory Solar Energy

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

Events					
WT 24/25	2313716	Laboratory Solar Energy	4 SWS	Practical course / 🗣	Richards, Trampert, Paetzold
ST 2025	2313708	Laboratory Solar Energy	4 SWS	Practical course / 🗣	Trampert, Paetzold, Richards

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.166 Course: Leadership in Interdisciplinary Teams [T-MACH-106460]

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

Part of: M-ETIT-107193 - Interdisciplinary Qualifications
M-MACH-107142 - Leadership in Interdisciplinary Teams

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each winter term	1

Events					
WT 24/25	2145189	Leadership in interdisciplinary teams	2 SWS	Others (sons / Blended	Matthiesen

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
oral colloquium, ungraded

Prerequisites
none

Annotation
NwT students attend only part of the lecture

Workload
120 hours

T 8.167 Course: Liberalised Power Markets [T-WIWI-107043]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105403 - Liberalised Power Markets

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	3

Events					
WT 24/25	2581998	Liberalised Power Markets	2 SWS	Lecture / 🗣	Fichtner
WT 24/25	2581999	Übungen zu Liberalised Power Markets	2 SWS	Practice / 🗣	Signer, Fichtner, Beranek

Legend: 🖥 Online, ❋ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

Recommendation
None

Workload
180 hours

T 8.168 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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

8.169 Course: Lightweight Engineering Design [T-MACH-105221]

Responsible: Prof. Dr.-Ing. Tobias Düser
Sascha Ott

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102696 - Lightweight Engineering Design

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	2

Events					
ST 2025	2146190	Lightweight Engineering Design	2 SWS	Lecture / 🗣	Ott

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
Written examination (90 min)

Prerequisites
None

Workload
120 hours

8.170 Course: Localization of Mobile Agents [T-INFO-101377]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: M-INFO-100840 - Localization of Mobile Agents

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each summer term	2

Events					
ST 2025	24613	Localization of Mobile Agents	3 SWS	Lecture / 🗣	Hanebeck, Frisch

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment takes the form of an oral examination, usually lasting 15 minutes in accordance with Section 4 (2) No. 2 of the SPO.

It will be announced six weeks before the examination (§ 6 Para. 3 SPO) whether the performance assessment

- 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.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-114169 - Localization of Mobile Agents Pass must have been started.

Recommendation
Basic knowledge of linear algebra and stochastics is helpful.

T 8.171 Course: Localization of Mobile Agents Pass [T-INFO-114169]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: M-INFO-100840 - Localization of Mobile Agents

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	0	pass/fail	Each summer term	1

Competence Certificate
The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO).

The assessment is carried out in digital form. There are ILIAS tests with individual, randomized tasks that can be solved by hand or with a small numerical program. User input is automatically assessed and there is instant feedback. There is no limit on retakes. All tests must be passed; learning progress is displayed in ILIAS.

Prerequisites
None.

Recommendation
Basic knowledge of linear algebra and stochastics is helpful.

T 8.172 Course: Logistics and Supply Chain Management [T-MACH-110771]

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

Part of: M-MACH-105298 - Logistics and Supply Chain Management

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	9	Grade to a third	Each summer term	5

Events					
ST 2025	2118078	Logistics and Supply Chain Management	4 SWS	Lecture / 🗣	Furmans, Alicke

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The success control takes place in the form of an examination performance of a different kind. This is composed as follows:

- 50% assessment of a written examination (60 min) during the semester break
- 50% assessment of an oral examination (20 min) during the semester break

To pass the examination, both examination performances must be passed.

Prerequisites
None

Annotation
The brick cannot be taken if one of the bricks "T-MACH-102089 – Logistics - Organisation, Design and Control of Logistic Systems" and "T-MACH-105181 – Supply Chain Management" has been taken.

Workload
270 hours

8.173 Course: Machine Dynamics [T-MACH-105210]

Responsible: Prof. Dr.-Ing. Carsten Proppe
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102694 - Machine Dynamics

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	1

Events					
WT 24/25	2161224	Machine Dynamics	2 SWS	Lecture / 🖥	Proppe
ST 2025	2161224	Machine Dynamics	2 SWS	Lecture / 🗣	Proppe
ST 2025	2161225	Machine Dynamics (Tutorial)	1 SWS	Practice / 🗣	Proppe, Kaupp, Fischer

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam, 180 min.

Prerequisites
none

Workload
150 hours

T 8.174 Course: Machine Learning - Basic Methods [T-INFO-110630]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-105252 - Machine Learning - Basic Methods

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each winter term	2

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-WIWI-106340 - Machine Learning 1 - Basic Methods must not have been started.

T 8.175 Course: Machine Learning - Foundations and Algorithms [T-INFO-111558]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-107169 - Machine Learning - Foundations and Algorithms

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	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

Competence Certificate
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 Conditions
The following conditions have to be fulfilled:

1. The course T-WIWI-106340 - Machine Learning 1 - Basic Methods must not have been started.
2. The course T-INFO-110630 - Machine Learning - Basic Methods must not have been started.

Recommendation
- 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 8.176 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 scale	Recurrence	Version
Written examination	5	Grade to a third	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

Competence Certificate
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 8.177 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 scale	Recurrence	Version
Written examination	5	Grade to a third	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

Competence Certificate
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 8.178 Course: Machine Learning and Optimization in Energy Systems [T-WIWI-113073]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106604 - Machine Learning and Optimization in Energy Systems

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	4

Events					
WT 24/25	2581050	Machine Learning and Optimization in Energy Systems	3 SWS	Lecture / Practice (/ 🗣	Dengiz, Yilmaz

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
The assessment of this course is a written examination (60 min) or an oral exam (30 min) depending on the number of participants. A bonus can be acquired through successful participation in the computer exercise. 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 exact criteria for awarding a bonus will be announced at the beginning of the exercises.

Workload
120 hours

T 8.179 Course: Machine Learning for Robotic Systems 1 [T-MACH-113064]

Responsible: Jun.-Prof. Dr. Rania Rayyes

Organisation: KIT Department of Electrical Engineering and Information Technology

KIT Department of Mechanical Engineering

Part of: M-MACH-106457 - Machine Learning for Robotic Systems 1

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each winter term	1

Events					
WT 24/25	2117055	Machine Learning for Robotic Systems 1	4 SWS	Lecture / Practice (/ 🗣	Rayyes

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of this course is a written examination (90 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.

Prerequisites
None

Recommendation

- The course assumes basic knowledge in mathematics. e.g., particular (conditional) probabilities, the exponential function, basic linear algebra etc.
- programming skills in one programming language is recommended.
- Attendance of the lectures Robotics 1.
- Some knowledge in statistics is useful.

Workload
150 hours

T 8.180 Course: Machine Learning for Robotic Systems 2 [T-MACH-113403]

Responsible: Jun.-Prof. Dr. Rania Rayyes

Organisation: KIT Department of Electrical Engineering and Information Technology

KIT Department of Mechanical Engineering

Part of: M-MACH-106652 - Machine Learning for Robotic Systems 2

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	5	Grade to a third	Each summer term	1 terms	1

Events					
ST 2025	2100015	Machine Learning for Robotic Systems 2	4 SWS	Lecture / Practice (/ 🗣	Rayyes

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of this course is a written examination (90 min) according to §4(2), 1 of the examination regulation or an oral exam (approx. 20 min) following §4, Abs. 2, 2 of the examination regulation.

Prerequisites
None

Recommendation

- The course assumes basic knowledge in mathematics. e.g., particular (conditional) probabilities, the exponential function, basic linear algebra etc.
- programming skills in one programming language is recommended.
- Attendance of the lecture Machine Learning for Robotic Systems 1
- Attendance of the lectures Robotics 1.
- Some knowledge in statistics is useful.

Workload
150 hours

T 8.181 Course: Machine Tools and High-Precision Manufacturing Systems [T-MACH-110962]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105107 - Machine Tools and Industrial Handling

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Each winter term	1

Events					
WT 24/25	2149910	Machine Tools and High-Precision Manufacturing Systems	6 SWS	Lecture / Practice (/ 🗣	Fleischer

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral exam (40 minutes)

Prerequisites
T-MACH-102158 - Machine Tools and Industrial Handling must not be commenced.
T-MACH-109055 - Machine Tools and Industrial Handling must not be commenced.
T-MACH-110963 - Machine Tools and High-Precision Manufacturing Systems must not be commenced.

Workload
240 hours

T 8.182 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 scale	Recurrence	Version
Written examination	8	Grade to a third	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

Competence Certificate
Type of Examination: written exam

Duration of Examination: 60 minutes

Prerequisites
None

Workload
240 hours

T 8.183 Course: Magnet Technology of Fusion Reactors [T-MACH-105434]

Responsible: Dr. Klaus-Peter Weiss
Dr. Michael Wolf

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107223 - Magnet Technology of Fusion Reactors

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2190496	Magnet Technology of Fusion Reactors	2 SWS	Lecture / 🗣	Weiss, Wolf

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral examination of about 30 minutes

Prerequisites
none

Annotation
none

Workload
120 hours

T 8.184 Course: Master's Thesis [T-ETIT-114214]

Responsible: Prof. Dr. Martin Doppelbauer
Prof. Dr.-Ing. Marcus Geimer

Organisation: KIT Department of Electrical Engineering and Information Technology
KIT Department of Mechanical Engineering

Part of: M-ETIT-107192 - Master's Thesis

Type	Credits	Grading scale	Recurrence	Version
Final Thesis	30	Grade to a third	Each term	1

Competence Certificate
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.

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 8.185 Course: Material Flow in Logistic Systems [T-MACH-102151]

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

Part of: M-MACH-104984 - Material Flow in Logistic Systems

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	9	Grade to a third	Each winter term	3

Competence Certificate
The assessment (Prüfungsleistung anderer Art) consists of the following assignments:

- 40% assessment of the final case study as individual performance,
- 60% semester evaluation which includes working on 5 case studies and defending those (For both assessment types, the best 4 of 5 tries count for the final grade.):
    - 40% assessment of the result of the case studies as group work,
    - 20% assessment of the oral examination during the case study colloquiums as individual performance.

A detailed description of the learning control can be found under Annotations.

Prerequisites
none

Recommendation
Recommended elective subject: Probability Theory and Statistics

Annotation
Students are divided into groups for this course. Five case studies are carried out in these groups. The results of the group work during the lecture period are presented and evaluated in writing. In the oral examination during the case study colloquiums, the understanding of the result of the group work and the models dealt with in the course is tested. The participation in the oral defenses is compulsory and will be controlled. For the written submission the group receives a common grade, in the oral defense each group member is evaluated individually.

After the lecture period, there is the final case study. This case study contains the curriculum of the whole semester. The students work individually on this case study which takes place at a predefined place and time (duration: 4h).

Workload
270 hours

T 8.186 Course: Materials of Lightweight Construction [T-MACH-105211]

Responsible: Dr.-Ing. Wilfried Liebig
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102727 - Materials for Lightweight Construction

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	2

Events					
ST 2025	2174574	Materials of Lightweight Construction	2 SWS	Lecture / 🗣	Liebig

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral exam, about 25 minutes

Prerequisites
T-MACH-114012 must not have been started.

Recommendation
Materials Science I/II

Workload
120 hours

T 8.187 Course: Materials Recycling and Sustainability [T-MACH-110937]

Responsible: Dr.-Ing. Wilfried Liebig
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107043 - Materials Recycling and Sustainability

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	3

Events					
ST 2025	2173520	Materials Recycling and Sustainability	2 SWS	Lecture / 🗣	Liebig

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam (about 25 min.)

Prerequisites
T-MACH-114012 must not have been started.

Workload
120 hours

T 8.188 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 scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	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

Competence Certificate
written exam (90 min). Additives as announced.

Prerequisites
Passing the Tutorial to Mathematical Methods of Continuum Mechanics (T-MACH-110376)

Modeled Conditions
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 8.189 Course: Mathematical Methods in Fluid Mechanics [T-MACH-113955]

Responsible: Prof. Dr.-Ing. Bettina Frohnapfel
Dr.-Ing. Davide Gatti

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107032 - Mathematical Methods in Fluid Mechanics

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	1

Competence Certificate
written examination - 90 minutes

Prerequisites
none

Recommendation
Basic Knowledge about Fluid Mechanics

Workload
180 hours

T 8.190 Course: Mathematical Methods in Fluid Mechanics [T-MACH-113956]

Responsible: Prof. Dr.-Ing. Bettina Frohnapfel
Dr.-Ing. Davide Gatti

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101283 - Virtual Engineering A
M-MACH-107032 - Mathematical Methods in Fluid Mechanics

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	2

Events					
ST 2025	2154540	Mathematical Methods in Fluid Mechanics	4 SWS	Lecture / Practice (/ 🗣	Gatti, Frohnapfel

Legend: Online, Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
written examination - 90 minutes

Prerequisites
T-MACH-105295 must not be started.

Recommendation
Basic Knowledge about Fluid Mechanics

Workload
180 hours

T 8.191 Course: Mathematical Methods in Hydraulics [T-MACH-113912]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107210 - Mathematical Methods in Hydraulics

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each winter term	1 terms	1

Competence Certificate
Oral examination, duration approx. 30 minutes

Prerequisites
T-MACH-113913 must be passed.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-113913 - Tutorial Mathematical Methods in Hydraulics must have been passed.

Workload
120 hours

8.192 Course: Mechanical Properties of Nanomaterials and Microsystems [T-MACH-114018]

Responsible: Dr. Patric Gruber
Prof. Dr. Christoph Kirchlechner
Dr. Daniel Weygand

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107185 - Mechanical Properties of Nanomaterials and Microsystems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2178420	Mechanical Properties of Nanomaterials and Microsystems	2 SWS	Lecture / 🗣	Kirchlechner, Gruber, Weygand

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam ca. 30 minutes

Prerequisites
Mutual exclusion with T-MACH-114071

Workload
120 hours

T 8.193 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 scale	Recurrence	Version
Oral examination	9	Grade to a third	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

Competence Certificate
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 8.194 Course: Methods and Processes of PGE - Product Generation Engineering [T-MACH-109192]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Norbert Burkardt
Prof. Dr.-Ing. Sven Matthiesen

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102718 - Product Development – Methods of Product Engineering

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	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, ✕ Cancelled

Competence Certificate
Written exam (processing time: 120 min + 10 min reading time)

Auxiliaries:

- Calculator
- German dictionary (books only)

Prerequisites
None

Annotation
This lecture is the basis for the main subject Integrated Product Development, which is offered as a specialisation.

Workload
180 hours

T 8.195 Course: Microactuators [T-MACH-101910]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100487 - Microactuators

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	3

Events					
ST 2025	2142881	Microactuators	2 SWS	Lecture / 🗣	Kohl

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam, 60 min.

Prerequisites
T-MACH-114036 must not be started

Workload
120 hours

T 8.196 Course: Microenergy Technologies [T-MACH-105557]

Responsible: Prof. Dr. Manfred Kohl
Dr. Jingyuan Xu

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102714 - Microenergy Technologies

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2142897	Microenergy Technologies	2 SWS	Lecture / 🗣	Xu

Legend: 🖥 Online, ❄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral examination (30 Min.)

Prerequisites
none

Workload
120 hours

T 8.197 Course: Microsystem Product Design for Young Entrepreneurs [T-MACH-105814]

Responsible: Prof. Dr. Jan Gerrit Korvink
Dr.-Ing. Dario Mager

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107195 - Microsystem Product Design for Young Entrepreneurs

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	2

Events					
WT 24/25	2141503	Microsystem product design for young entrepreneurs	4 SWS	Practical course / 🧩	Korvink, Mager
ST 2025	2141503	Microsystem product design for young entrepreneurs	4 SWS	Practical course / 🧩	Korvink, Mager

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The class is a laboratory course that is taken in groups, hence the active and productive participation in the team effort is evaluated. To check the individual performance, there will be weekly discussions about the project. To evaluate each group's progress, there will be 2 presentation during the duration of the course. The final mark is determined from the marks obtained in the presentation and an oral group examination of 1 hour.

Prerequisites
T-MACH-114218 must not have been started.

Workload
120 hours

T 8.198 Course: Microsystem Simulation [T-MACH-108383]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105486 - Micro System Simulation

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	2

Competence Certificate
written exam

Prerequisites
T-MACH-114072 must not be started.

Workload
120 hours

T 8.199 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2311625	Microsystem Technology	2 SWS	Lecture /	Stork

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

T 8.200 Course: Microwave Engineering [T-ETIT-100802]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100535 - Microwave Engineering

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each term	1

Events					
WT 24/25	2308407	Microwave Engineering	2 SWS	Lecture / 🗣	Pauli
WT 24/25	2308409	Tutorial for 2308407 Microwave Engineering	1 SWS	Practice / 🗣	Bhutani
ST 2025	2308407	Microwave Engineering	2 SWS	Lecture / ✕	Pauli
ST 2025	2308409	Tutorial for 2308407 Microwave Engineering	1 SWS	Practice / ✕	Nuß

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

Annotation
WS: german

SS: english

The exam is in each semester and for every student bilingual.

T 8.201 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

Events					
WT 24/25	2308415	Microwave Engineering Lab	4 SWS	Practical course / On-Site	Pauli
ST 2025	2308415	Microwave Engineering Lab	4 SWS	Practical course / On-Site	Pauli

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
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

Recommendation
Knowledge of microwave measurement technology and RF components and systems is helpful.

T 8.202 Course: Microwaves Measurement Techniques [T-ETIT-100733]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100424 - Microwaves Measurement Techniques

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	4

Events					
ST 2025	2308420	Microwaves Measurement Techniques	2 SWS	Lecture / 🗣	Pauli
ST 2025	2308422	Übungen zu 2308420 Mikrowellenmesstechnik	1 SWS	Practice / 🗣	Pauli

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.203 Course: Microwaves Measurement Techniques [T-ETIT-114046]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107007 - Microwaves Measurement Techniques

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2308420	Microwaves Measurement Techniques	2 SWS	Lecture / 🗣	Pauli
ST 2025	2308422	Übungen zu 2308420 Mikrowellenmesstechnik	1 SWS	Practice / 🗣	Pauli

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

The module grade is the grade of the oral exam.

Prerequisites
none

T 8.204 Course: Miniaturized Heat Exchangers [T-MACH-108613]

Responsible: Prof. Dr.-Ing. Jürgen Brandner
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107063 - Miniaturized Heat Transfer

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2142880	Miniaturized Heat Exchangers	2 SWS	Lecture / 🗣	Brandner

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam, 20 min.

Prerequisites
none

Workload
120 hours

T 8.205 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 scale	Recurrence	Expansion	Version
Examination of another type	6	Grade to a third	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

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The written report and the oral presentation are used to mark the course. The overall impression is assessed.

T 8.206 Course: Mobile Machines [T-MACH-105168]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107041 - Mobile Machines

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Each summer term	2

Events					
ST 2025	2114073	Mobile Machines	4 SWS	Lecture / 🗣	Geimer, Kazenwadel

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
The assessment consists of an oral exam (45 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Prerequisites
none

Recommendation
Knowledge in Fluid Power Systems is required. It is recommended to attend the course *Fluid Power Systems* [2114093] beforehand.

Annotation
Learning objectives:

After successful participation in the course:

- the student will be able to name the wide range of mobile machinery
- know the possible applications and operating sequences of the most important mobile machines
- be able to describe selected subsystems and components

Content:

- Presentation of the components used and the most important mobile machines
- Basics and structure of the machines
- Practical insights into the development of the machines

Media:

Downloadable set of slides for the lecture

Book "Grundlagen mobiler Arbeitsmaschinen", Karlsruhe series of publications on vehicle systems technology, Volume 22, KIT Scientific Publishing

Workload
240 hours

T 8.207 Course: Modern Control Concepts I [T-MACH-105539]

Responsible: apl. Prof. Dr. Lutz Groell
apl. Prof. Dr. Jörg Matthes

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105308 - Modern Control Concepts I

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2105024	Modern Control Concepts I	2 SWS	Lecture / Blended	Matthes, Groell
ST 2025	2106020	Tutorial on Modern Control Concepts I	2 SWS	Practice / Online	Matthes

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Written exam (Duration: 1 h)

Prerequisites
none

Workload
120 hours

T 8.208 Course: Modern Control Concepts II [T-MACH-106691]

Responsible: apl. Prof. Dr. Lutz Groell
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105313 - Modern Control Concepts II

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2106032	Modern Control Concepts II	2 SWS	Lecture / 🗣	Groell

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam (Duration: 30min)

Prerequisites
none

Workload
120 hours

T 8.209 Course: Modern Control Concepts III [T-MACH-106692]

Responsible: apl. Prof. Dr. Lutz Groell
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105314 - Modern Control Concepts III

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2106035	Modern Control Concepts III	2 SWS	Lecture / 🗣	Groell

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam (Duration: 30min)

Prerequisites
none

Workload
120 hours

T 8.210 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 scale	Recurrence	Version
Oral examination	6	Grade to a third	Each term	2

Events					
ST 2025	2308430	Modern Radio Systems Engineering	3 SWS	Lecture / 🗣	Zwick
ST 2025	2308431	Tutorial to 2308430 Modern Radio Systems Engineering	1 SWS	Practice / 🗣	Bhutani

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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 8.211 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 scale	Recurrence	Version
Oral examination	6	Grade to a third	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

Competence Certificate
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.

8.212 Course: Motion in Human and Machine - Seminar [T-INFO-105140]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-102555 - Motion in Human and Machine - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	3

Events					
ST 2025	2400063	Motion in Human and Machine	3 SWS	Seminar / 🗣	Asfour

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). It includes a term paper and a final presentation.

Prerequisites
None.

Recommendation
Programming experience in C++, Python or Matlab is recommended.
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics, Mechano-Informatics and Robotics and Wearable Robotic Technologies is recommended.

Annotation
The block internship is an interdisciplinary event in co-operation with the University of Stuttgart and the University of Heidelberg.

T 8.213 Course: Motor Vehicle Labor (graded) [T-ETIT-114320]

Responsible: Dr.-Ing. Michael Frey

Organisation: KIT Department of Electrical Engineering and Information Technology
KIT Department of Mechanical Engineering

Part of: M-MACH-102695 - Motor Vehicle Laboratory

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each term	1

Competence Certificate
Colloquium before each experiment

After completion of the experiments: written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
none

Workload
120 hours

8.214 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 scale	Recurrence	Expansion	Version
Written examination	6	Grade to a third	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

Competence Certificate
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

Recommendation
Successful completion of the modules "Superconductivity for Engineers" and „Einführung in die Quantentheorie für Elektrotechniker“ is recommended.

T 8.215 Course: NMR Micro Probe Hardware Conception and Construction [T-MACH-108407]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107196 - NMR Micro Probe Hardware Conception and Construction

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each summer term	1

Events					
ST 2025	2142551	NMR Micro Probe Hardware Conception and Construction	2 SWS	Practical course / 🧩	Korvink, Jouda

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Successful participation.

Prerequisites
none

Workload
120 hours

T 8.216 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 scale	Recurrence	Version
Written examination	3	Grade to a third	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 8.217 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 scale	Recurrence	Version
Oral examination	6	Grade to a third	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 8.218 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Competence Certificate
written exam, 60 minutes

Prerequisites
T-MACH-114036 must not be started

Workload
120 hours

T 8.219 Course: Nuclear Power and Reactor Technology [T-MACH-110332]

Responsible: Dr. Aurelian Florin Badea
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107042 - Nuclear Power and Reactor Technology

Type	Credits	Grading scale	Expansion	Version
Oral examination	4	Grade to a third	1 terms	1

Events					
WT 24/25	2189921	Nuclear Power and Reactor Technology	3 SWS	Lecture / 🗣	Badea

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam, approx. 20 min.

Prerequisites
None

Workload
120 hours

T 8.220 Course: Nuclear Power Plant Technology [T-MACH-105402]

Responsible: Dr. Aurelian Florin Badea
Prof. Dr.-Ing. Xu Cheng

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107121 - Nuclear Power Plant Technology

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2170460	Nuclear Power Plant Technology	2 SWS	Lecture / 🗣	Cheng, Schulenberg

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
oral exam, Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Prerequisites
none

Workload
120 hours

T 8.221 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	4

Events					
WT 24/25	2153441	Numerical Fluid Mechanics	4 SWS	Lecture / Practice (/	Gatti

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
oral exam - 30 minutes

Prerequisites
none

Workload
120 hours

T 8.222 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 scale	Recurrence	Version
Written examination	5	Grade to a third	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

Competence Certificate
Success control takes the form of a written examination (120 minutes).

Prerequisites
none

T 8.223 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 scale	Recurrence	Version
Completed coursework	1	pass/fail	Each summer term	1

Competence Certificate
Successful participation in the workshop is confirmed by signing the attendance sheet provided at each practice session.

Prerequisites
None

T 8.224 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 scale	Recurrence	Version
Oral examination	6	Grade to a third	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 8.225 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 scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	1

Competence Certificate
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

8.226 Course: Optical Transmitters and Receivers [T-ETIT-100639]

Responsible: Prof. Dr. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100436 - Optical Transmitters and Receivers

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	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 8.227 Course: Optical Waveguides and Fibers [T-ETIT-101945]

Responsible: Prof. Dr.-Ing. Christian Koos
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100506 - Optical Waveguides and Fibers

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2309464	Optical Waveguides and Fibers	2 SWS	Lecture / 🗣	Koos, N.N., Bao
WT 24/25	2309465	Tutorial for 2309464 Optical Waveguides and Fibers	1 SWS	Practice / 🗣	Koos, N.N.

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.228 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	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 8.229 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 scale	Recurrence	Version
Written examination	5	Grade to a third	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

Competence Certificate
The assessment consists of a written exam (120 min) taking place in the recess period.

Prerequisites
none

T 8.230 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	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

T 8.231 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 scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2106008	Organ support systems	2 SWS	Lecture / 🗣	Pylatiuk

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination (Duration: 45min)

Prerequisites
none

Workload
120 hours

T 8.232 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 scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	2

Events					
ST 2025	24675	Pattern Recognition	4 SWS	Lecture / Practice (/ 🗣	Beyerer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.233 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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

8.234 Course: Photovoltaics [T-ETIT-101939]

Responsible: Prof. Dr.-Ing. Michael Powalla
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100513 - Photovoltaics

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	2

Events					
ST 2025	2313737	Photovoltaics	3 SWS	Lecture / 🗣	Powalla, Lemmer
ST 2025	2313738	Tutorial 2313737 Photovoltaik	1 SWS	Practice / 🗣	Powalla, Lemmer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
"T-ETIT-100774 - Solar Energy" must not have started.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-ETIT-100774 - Solar Energy must not have been started.

T 8.235 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 scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	5

Events					
WT 24/25	2181612	Physical basics of laser technology	3 SWS	Lecture / Practice (/	Schneider

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
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].

Recommendation
Basic knowledge of physics, chemistry and material science

Workload
150 hours

T 8.236 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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 8.237 Course: PLM for Product Development in Mechatronics [T-MACH-102181]

Responsible: Prof. Dr.-Ing. Martin Eigner
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101283 - Virtual Engineering A

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	2

Competence Certificate
Oral examination 20 min.

Prerequisites
none

Workload
120 hours

T 8.238 Course: Polymers in MEMS A: Chemistry, Synthesis and Applications [T-MACH-102192]

Responsible: Dr.-Ing. Matthias Worgull
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107183 - Polymers in MEMS A: Chemistry, Synthesis and Applications

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2141853	Polymers in MEMS A: Chemistry, Synthesis and Applications	2 SWS	/	Worgull

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Oral examination

Prerequisites
none

Workload
120 hours

T 8.239 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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

Competence Certificate
Oral examination

Prerequisites
none

Workload
120 hours

T 8.240 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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

Competence Certificate
Oral examination

Prerequisites
none

Workload
120 hours

T 8.241 Course: Power Electronic Systems in Energy Technology [T-ETIT-112286]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106067 - Power Electronic Systems in Energy Technology

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each winter term	1

Events					
WT 24/25	2306357	Power Electronic Systems in Energy applications	3 SWS	Lecture / 🗣	Hiller
WT 24/25	2306358	Power Electronic Systems in Energy Applications	1 SWS	Practice / 🧩	Hiller, Knierim

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.242 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 scale	Recurrence	Expansion	Version
Written examination	6	Grade to a third	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

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

Prerequisites
none

T 8.243 Course: Power Electronics for Photovoltaics and Wind Energy [T-ETIT-104569]

Responsible: Prof. Dr.-Ing. Marc Hiller
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-102261 - Power Electronics for Photovoltaics and Wind Energy

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Each summer term	2

Events					
ST 2025	2306347	Power Electronics for Photovoltaics and Wind Energy	2 SWS	Lecture	Burger

Prerequisites
none

T 8.244 Course: Power System Protection and Automation [T-ETIT-113164]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106506 - Power System Protection and Automation

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Each winter term	1 terms	1

Events					
WT 24/25	2307396	Power System Protection and Automation	2 SWS	Lecture / 🗣	Loitz

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.245 Course: Power Systems and Economy [T-ETIT-100725]

Responsible: Dr.-Ing. Bernd Hoferer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100413 - Power Systems and Economy

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2307383	Power Systems and Economy	2 SWS	Lecture / 🗣	Weissmüller

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.246 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Annotation
Shift from SoSe to WiSe, does not take place in WiSe24/25 and SoSe25.

T 8.247 Course: Practical Course Polymers in MEMS [T-MACH-105556]

Responsible: Dr.-Ing. Matthias Worgull
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107034 - Practical Course Polymers in MEMS

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	2	pass/fail	Each summer term	1

Events					
ST 2025	2142856	Practical Course Polymers in MEMS	2 SWS	Block /	Worgull

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The practical course will close with an oral examination.There will be only passed and failed results, no grades.

Prerequisites
none

T 8.248 Course: Practical Course: Autonomous Driving [T-MACH-113713]

Responsible: Dr.-Ing. Michael Frey
Dr.-Ing. Martin Gießler
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107052 - Practical Course: Autonomous Driving

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	6	pass/fail	Each winter term	1

Events					
WT 24/25	2113820	Practical Course: Autonomous Driving	3 SWS	Practical course / 🗣	Frey

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
To pass the course it is neccessary to successfully complete the colloquia, the homework and the final demonstration of the driving task.

Prerequisites
none

Workload
180 hours

T 8.249 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 scale	Recurrence	Version
Examination of another type	8	Grade to a third	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 8.250 Course: Practical Course: Robotics [T-INFO-114172]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-107155 - Robotics - Practical Course

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each summer term	1

Events					
ST 2025	24870	Robotics - Practical Course	4 SWS	Practical course / 🗣	Asfour

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). It is composed of several sub-tasks.

Prerequisites
Knowledge of the programming language C++ is required.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-105107 - Robotics - Practical Course must not have been started.

Recommendation
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics and Mechano-Informatics and Robotics is recommended.

T 8.251 Course: Practical Course: Smart Energy System [T-INFO-112030]

Responsible: Dr.-Ing. Simon Waczowicz
Organisation: KIT Department of Informatics
Part of: M-INFO-105955 - Practical Course: Smart Energy System

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

Events					
WT 24/25	2400159	Lab Course: Smart Energy System Lab	4 SWS	Practical course / 🗣	Hagenmeyer, Waczowicz, Jumar, Fernengel
ST 2025	2400170	Laboratory: Smart Energy System Lab	4 SWS	Practical course / 🗣	Hagenmeyer, Waczowicz, Jumar, Fernengel

Legend: 📱 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). A written paper must be prepared and a presentation given.

Prerequisites
None.

Recommendation
- Knowledge of the fundamentals of energy informatics is a prerequisite.
- Knowledge of the fundamentals of electrical engineering and energy technology is required.
- Knowledge of the basics of mechatronics, data analysis and signal processing is helpful.
- Knowledge of power systems or power electronics is helpful.

T 8.252 Course: Practical Course: Software Development and Application of Mobile, Bio-Inspired Robots [T-MACH-113854]

Responsible: Prof. Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-106904 - Practical Course: Software Development and Application of Mobile, Bio-Inspired Robots

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	6	Grade to a third	Each winter term	1 terms	1

Events					
WT 24/25	2121342	Practical Course: Software Development and Application of Mobile, Bio-Inspired Robots	4 SWS	Practical course / 🗣	Rönnau

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed in the form of a different type of examination in accordance with Section 4 (2) No. 3 SPO.

Code must be generated, a written report prepared and a presentation given.

Prerequisites
None

Recommendation
Knowledge of the basics of robotics from Robotics 1 is helpful. Basic knowledge of C++ or Python and Linux is a prerequisite.

Workload
180 hours

T 8.253 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each summer term	2

Events					
ST 2025	2302200	Practical Machine Learning	4 SWS	Lecture / Practice (/	Gardi

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
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

8.254 Course: Practical Project Robotics and Automation I (Software) [T-INFO-104545]

Responsible: Prof. Dr.-Ing. Björn Hein
Prof. Dr.-Ing. Thomas Längle

Organisation: KIT Department of Informatics

Part of: M-INFO-102224 - Practical Project Robotics and Automation I (Software)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

T 8.255 Course: Practical Project Robotics and Automation II (Hardware) [T-INFO-104552]

Responsible: Prof. Dr.-Ing. Björn Hein
Prof. Dr.-Ing. Thomas Längle

Organisation: KIT Department of Informatics

Part of: M-INFO-102230 - Practical Project Robotics and Automation II (Hardware)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

T 8.256 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 scale	Recurrence	Expansion	Version
Examination of another type	4	Grade to a third	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

Competence Certificate
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

Recommendation
The contents of the modules “Optimization of Dynamic Systems (ODS)” and “Regelung linearer Mehrgrößensysteme (RLM)” are helpful for the lecture.

Workload
120 hours

T 8.257 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed in the form of a written examination lasting 60 minutes.

Prerequisites
none

T 8.258 Course: Probabilistic Measurement and Estimation [T-MACH-113873]

Responsible: Prof. Dr.-Ing. Christoph Stiller
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107087 - Probabilistic Measurement and Estimation

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each summer term	1 terms	2

Events					
ST 2025	2138334	Probabilistic Measurement and Estimation	2 SWS	Lecture / 🗣	Stiller, Steiner

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam

60 min.

2 DIN A4 Self-created formular sheets allowed

Prerequisites
none

Workload
120 hours

T 8.259 Course: Product- and Production-Concepts for Modern Automobiles [T-MACH-110318]

Responsible: Dr. Stefan Kienzle
Dr. Dieter Steegmüller

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105346 - Product- and Production-Concepts for modern Automobiles

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2149670	Product- and Production-Concepts for modern Automobiles	2 SWS	Lecture / Blended	Steegmüller, Kienzle

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Oral Exam (20 min)

Prerequisites
T-MACH-105166 - Materials and Processes for Body Leightweight Construction in the Automotive Industry must not have been started.

Workload
120 hours

8.260 Course: Production Techniques Laboratory [T-MACH-105346]

Responsible: Prof. Dr.-Ing. Barbara Deml
Prof. Dr.-Ing. Jürgen Fleischer
Prof. Dr.-Ing. Kai Furmans
Prof. Dr.-Ing. Jivka Ovtcharova

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102711 - Production Techniques Laboratory

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each summer term	4

Events					
ST 2025	2110678	Production Techniques Laboratory	4 SWS	Practical course / Blended	Deml, Fleischer, Furmans, Meyer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Active participation in lab course and succesful completion of colloquia before each course. The colloquia are graded.

Annotation
The course is limited in capacity, therefore the allocation of places is based on § 5 (4) in the Study and Examination Regulations

This results in the following selection criteria:

The selection is based

- on the study progress (here the study progress in credit points and not the study progress in semesters is taken as a basis),
- on the waiting period in the case of equal progress in studies
- by lot if the waiting period is the same.

The procedure is explained in more detail on ILIAS.

Successful participation requires active and continuous participation in the course.

Workload
120 hours

T 8.261 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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 8.262 Course: Project Workshop: Automotive Engineering [T-MACH-102156]

Responsible: Dr.-Ing. Michael Frey
Dr.-Ing. Martin Gießler

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107074 - Project Workshop: Automotive Engineering

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each term	1

Events					
WT 24/25	2115817	Project Workshop: Automotive Engineering	3 SWS	Lecture / 🗣	Gießler, Frey
ST 2025	2115817	Project Workshop: Automotive Engineering	3 SWS	Lecture / 🗣	Gießler, Frey

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Prerequisites
none

Workload
180 hours

T 8.263 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-107193 - Interdisciplinary Qualifications
M-MACH-105418 - ProVIL - Product Development in a Virtual Idea Laboratory

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	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

Competence Certificate
colloquia and presentations.

Prerequisites
none

Annotation
Offered for the last time in summer semester 2025.

Workload
120 hours

T 8.264 Course: Python Algorithms for Vehicle Technology [T-MACH-110796]

Responsible: Stephan Rhode
Organisation:
Part of: M-MACH-107072 - Python Algorithms for Automotive Engineering

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2114862	Python Algorithms for Automotive Engineering	2 SWS	Lecture /	Rhode

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Written Examination

Duration: 90 minutes

Prerequisites
none

Workload
120 hours

T 8.265 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 scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	3

Events					
WT 24/25	2149667	Quality Management	2 SWS	Lecture / Blended	Lanza, Stamer

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
Written Exam (60 min)

Prerequisites
It is not possible to combine this brick with brick Quality Management [T-MACH-112586].

Workload
120 hours

T 8.266 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 scale	Recurrence	Expansion	Version
Written examination	6	Grade to a third	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

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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

Recommendation
Successful completion of the module "Superconductivity for Engineers" is recommended.

T 8.267 Course: Quantum Machines I [T-MACH-113827]

Responsible: Prof. Dr. Marcel Utz
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107164 - Quantum Machines I

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each winter term	1 terms	1

Competence Certificate
Written exam, duration: 90 minutes

Prerequisites
none

Recommendation

- A standard BSc degree in mechanical, materials or electrical engineering
- Solid knowledge of engineering mechanics, including statics, dynamics and mechanics of materials.
- Basic knowledge of engineering thermodynamics.
- Proficiency in complex numbers, including their algebraic and polar forms.
- Understanding of linear algebra, including vector spaces, matrices, eigenvalues and eigenvectors.
- Familiarity with ordinary differential equations (ODEs) and their solutions, especially as they relate to physical systems.

Workload
120 hours

8.268 Course: Quantum Machines II [T-MACH-113826]

Responsible: Prof. Dr. Marcel Utz
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107165 - Quantum Machines II

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each summer term	1 terms	1

Competence Certificate
Written exam, duration: 90 minutes

Prerequisites
none

Recommendation

- A standard BSc degree in mechanical, materials or electrical engineering
- Solid knowledge of engineering mechanics, including statics, dynamics and mechanics of materials.
- Basic knowledge of engineering thermodynamics.
- Foundations of quantum mechanics (Quantum Machines I is recommended).
- Proficiency in complex numbers, including their algebraic and polar forms.
- Understanding of linear algebra, including vector spaces, matrices, eigenvalues and eigenvectors.
- Familiarity with ordinary differential equations (ODEs) and their solutions, especially as they relate to physical systems.

Workload
120 hours

T 8.269 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 scale	Recurrence	Version
Written examination	6	Grade to a third	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

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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 8.270 Course: Rail System Technology [T-MACH-106424]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103232 - Rail System Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each term	4

Events					
WT 24/25	2115919	Rail System Technology	2 SWS	Lecture / 🗣	Cichon
ST 2025	2115919	Rail System Technology	2 SWS	Lecture / 🗣	Cichon

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
writen examination in German language
Duration: 60 minutes
No tools or reference materials may be used during the exam except calculator and dictionary

Prerequisites
none

Workload
120 hours

T 8.271 Course: Rail Vehicle Technology [T-MACH-105353]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102683 - Rail Vehicle Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each term	4

Events					
WT 24/25	2115996	Rail Vehicle Technology	2 SWS	Lecture / 🗣	Cichon
ST 2025	2115996	Rail Vehicle Technology	2 SWS	Lecture / 🗣	Cichon

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
writen examination in German language
Duration: approx 60 minutes
No tools or reference materials may be used during the exam except calculator and dictionary

Prerequisites
none

Workload
120 hours

T 8.272 Course: Railways in the Transportation Market [T-MACH-105540]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107044 - Railways in the Transportation Market

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2114914	Railways in the Transportation Market	2 SWS	Block / 🗣	Cichon

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral examination

Duration: ca. 20 minutes

No tools or reference materials may be used during the exam.

Prerequisites
none

Workload
120 hours

T 8.273 Course: Re:Invent - Revolutionary Business Models as the Basis for Product Innovations [T-MACH-111888]

Responsible: Dr.-Ing. Thomas Schneider
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-106662 - Re:Invent - Revolutionary Business Models as the Basis for Product Innovations

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each summer term	1 terms	1

Events					
ST 2025	2147177	Re:Invent - Revolutionary Business Models as the Basis for Product Innovations (Lecture)	2 SWS	Lecture / 🗣	Schneider

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral exam, duration: approx. 20 minutes

Prerequisites
None

Workload
120 hours

T 8.274 Course: Reactor Safety I: Fundamentals [T-MACH-105405]

Responsible: Dr. Victor Hugo Sanchez-Espinoza
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107116 - Reactor Safety 1: Fundamentals

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2189465	Reactor Safety I: Fundamentals	2 SWS	Lecture / 🗣	Sanchez-Espinoza

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam about 30 minutes

Prerequisites
none

Workload
120 hours

T 8.275 Course: Real Time Control of Electrical Drives [T-ETIT-111898]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105916 - Real Time Control of Electrical Drives

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each winter term	1

Events					
WT 24/25	2306353	Real Time Control of Electrical Drives	3 SWS	Lecture /	Liske
WT 24/25	2306354	Tutorial for 2306353 Real Time Control of Electrical Drives	1 SWS	Practice /	Liske

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

T 8.276 Course: Real-Time Systems [T-INFO-101340]

Responsible: Prof. Dr.-Ing. Thomas Längle
Organisation: KIT Department of Informatics
Part of: M-INFO-100803 - Real-Time Systems

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	1

8.277 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 scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	2

Events					
WT 24/25	2400163	Reinforcement Learning		Lecture / Practice (/ 🗣	Neumann, Lioutikov, Zhou

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Competence Certificate

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.

Recommendation

• 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 8.278 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 scale	Recurrence	Expansion	Version
Examination of another type	5	Grade to a third	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

Competence Certificate
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

Recommendation
None

Workload
150 hours

T 8.279 Course: Renewable Energy-Resources, Technologies and Economics [T-WIWI-100806]

Responsible: Prof. Dr. Patrick Jochem
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-100500 - Renewable Energy-Resources, Technologies and Economics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	8

Events					
WT 24/25	2581012	Renewable Energy – Resources, Technologies and Economics	2 SWS	Lecture / 🗣	Jochem

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes, in English, answers are possible in German or English) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

Prerequisites
None.

T 8.280 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 scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	1

Competence Certificate
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.

Recommendation
Having visited the lectures on Robotics I - Introduction to Robotics and Mechano-Informatics and Robotics is recommended.

T 8.281 Course: Robotics III - Sensors and Perception in Robotics [T-INFO-114155]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-107130 - Robotics III - Sensors and Perception in Robotics

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	1

Events					
ST 2025	2400067	Robotics III - Sensors and Perception in Robotics	2 SWS	Lecture / 🗣	Asfour

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites
none.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-109931 - Robotics III - Sensors and Perception in Robotics must not have been started.

Recommendation
Attending the lecture Robotics I – Introduction to Robotics is recommended.

T 8.282 Course: Seamless Engineering [T-MACH-111401]

Responsible: Prof. Dr.-Ing. Kai Furmans
Prof. Dr.-Ing. Eric Sax

Organisation: KIT Department of Electrical Engineering and Information Technology

KIT Department of Mechanical Engineering

Part of: M-MACH-105725 - Seamless Engineering

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	9	Grade to a third	Each winter term	1

Events					
WT 24/25	2117072	Seamless Engineering - Logistics Robotics Workshop	2 SWS	Lecture / Practice (/ 🗣	Furmans, Sax

Legend: Online, Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
Competence certificate in the form of an examination of another type.

The overall grade is composed as follows:

- 50% assessment of an examination as individual performance as the conclusion of the lecture block.
- 50% assessment of colloquia as individual performance on defined milestones during the project work

Failing the final examination or the colloquia does not result in failing the course.

Prerequisites
None

Recommendation
None

Annotation
The course consists of two components. Theoretical knowledge and basics about structured system design are taught in lecture and exercise. In parallel, a practical part takes place throughout the semester. In this, the students design and implement a mechatronic system in small groups using industry-related hardware and software to deal with a given task in the logistics environment.

Workload
270 hours

T 8.283 Course: Self Assignment-HOC-SPZ-FORUM-graded [T-ETIT-111688]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1

Self service assignment of supplementary studies
This course can be used for self service assignment of grade aquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Annotation
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 8.284 Course: Self Assignment-HOC-SPZ-FORUM-graded [T-ETIT-111689]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1

Self service assignment of supplementary studies
This course can be used for self service assignment of grade aquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Annotation
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 8.285 Course: Self Assignment-HOC-SPZ-FORUM-ungraded [T-ETIT-112899]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

Annotation
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 8.286 Course: Self Assignment-HOC-SPZ-FORUM-ungraded [T-ETIT-112898]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

Self service assignment of supplementary studies
This course can be used for self service assignment of grade aquired from the following study providers:

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Annotation
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 8.287 Course: Seminar Application of Artificial Intelligence in Production [T-MACH-112121]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105968 - Artificial Intelligence in Production

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each summer term	5

Events					
ST 2025	2150910	Seminar Application of Artificial Intelligence in Production	2 SWS	Seminar / 🗣	Fleischer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Competence Certificate
Alternative test achievement (graded):

- Presentation of the results (approx. 20 min) followed by a colloquium (approx. 15 min) with weighting 25%
- Written processing of the results with weighting 75%

Prerequisites
none

Recommendation
Previous participation in the lecture 2149921 "Artificial Intelligence in Production" or advanced knowledge of Python.

Workload
120 hours

T 8.288 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-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	3	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 8.289 Course: Seminar Data-Mining in Production [T-MACH-108737]

Responsible: Prof. Dr.-Ing. Gisela Lanza
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105477 - Seminar Data-Mining in Production

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	2

Events					
WT 24/25	2151643	Seminar Data Mining in Production	2 SWS	Seminar / 🗣	Lanza

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
alternative test achievement (graded):

- written elaboration (workload of at least 80 h)
- oral presentation (approx. 30 min)

Prerequisites
none

Annotation
The number of students is limited to twelve. Dates and deadlines for the seminar will be announced at https://www.wbk.kit.edu/studium-und-lehre.php.

Workload
90 hours

T 8.290 Course: Seminar Development of Automated Production Systems [T-MACH-113999]

Responsible: Prof. Dr.-Ing. Jürgen Fleischer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107020 - Development of Automated Production Systems

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each winter term	1

Competence Certificate
Alternative test achievement (graded):

- Presentation of the results (approx. 20 min) followed by a colloquium (approx. 15 min) with weighting 25%
- Written processing of the results with weighting 75%

Prerequisites
T-MACH-108844 - Automated production systems must not be started

Workload
120 hours

8.291 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 scale	Recurrence	Expansion	Version
Examination of another type	3	Grade to a third	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 8.292 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 scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	3

Events					
WT 24/25	2311627	Seminar Embedded Systems	2 SWS	Seminar / On-Site	Becker, Sax, Stork
ST 2025	2311627	Seminar Embedded Systems	2 SWS	Seminar / Blended (On-Site/Online)	Becker, Sax, Stork

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Prerequisites
none

T 8.293 Course: Seminar for Rail System Technology [T-MACH-108692]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-104197 - Seminar for Rail System Technology

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	2

Events					
WT 24/25	2115009	Seminar for Rail System Technology	2 SWS	Seminar / 🗣	Cichon, Ziesel
ST 2025	2115009	Seminar for Rail System Technology	2 SWS	Seminar / 🗣	Ziesel, Cichon

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Examination: Writing a Seminararbeit, final presentation

Prerequisites
none

Workload
90 hours

T 8.294 Course: Seminar Industrial Process and Plant Engineering [T-ETIT-113932]

Responsible: Prof. Dr.-Ing. Mike Barth
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106970 - Seminar Industrial Process and Plant Engineering

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each summer term	1

Events					
ST 2025	2303650	Seminar Industrial Process and Plant Engineering	3 SWS	Seminar / 🗣	Barth, Jilg

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The examination will be the seminar presentation at the end of the semester. The criteria are:

- Live presentation of the created CAD and simulation models
- Poster design and usage within the presentation
- Answering the questions from the examiners
- Structure of the talk

Prerequisites
none

T 8.295 Course: Seminar Intelligent Industrial Robots [T-INFO-104526]

Responsible: Prof. Dr.-Ing. Björn Hein
Organisation: KIT Department of Informatics
Part of: M-INFO-102212 - Seminar Intelligent Industrial Robots

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

T 8.296 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 scale	Recurrence	Version
Examination of another type	4	Grade to a third	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 8.297 Course: Seminar Novel Concepts for Solar Energy Harvesting [T-ETIT-108344]

Responsible: Prof. Dr. Bryce Sydney Richards
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103447 - Seminar Novel Concepts for Solar Energy Harvesting

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	2

Events					
ST 2025	2313761	Seminar Novel Concepts for Solar Energy Harvesting	2 SWS	Seminar / 🗣	Paetzold

Legend: 🖥 Online, ✣ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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

T 8.298 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-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	3	pass/fail	Each summer term	1

Competence Certificate
Type of Examination: Oral exam

Duration of Examination: approx. 30 minutes

Prerequisites
none

Annotation
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 8.299 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-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (oral)	3	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

T 8.300 Course: Seminar: Bionic Algorithms and Robot Technologies [T-MACH-113842]

Responsible: Prof. Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-106902 - Seminar: Bionic Algorithms and Robot Technologies

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	3	Grade to a third	Each term	1 terms	1

Events					
WT 24/25	2121343	Seminar: Bionic Algorithms and Robot Technologies	2 SWS	Seminar / 🗣	Rönnau
ST 2025	2121343	Seminar: Bionic Algorithms and Robot Technologies	2 SWS	Seminar / 🗣	Rönnau

Legend: 🖥 Online, ⚗ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed through the preparation of a written seminar paper and its presentation as an examination of a different kind.

Prerequisites
None

Recommendation
Attending the lecture "Biologically Inspired Robots" is helpful.

Workload
90 hours

T 8.301 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 scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	2

Events					
ST 2025	2304231	Sensors	2 SWS	Lecture / 🗣	Menesklou

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.302 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 scale	Recurrence	Version
Written examination	6	Grade to a third	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

Competence Certificate
Success is assessed in the form of a written examination lasting 120 minutes.

Prerequisites
none

Recommendation
Knowledge of the contents of the modules "Signals and Systems", "Measurement Technology" and "Methods of Signal Processing" is strongly recommended.

Annotation
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 8.303 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 scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	1

Events					
WT 24/25	2302113	Signal Processing Methods	2 SWS	Lecture / Blended	Wahls
WT 24/25	2302115	Tutorial to 2302113 Signal Processing Methods	2 SWS	Practice / On-Site	Wahls, Al-Hammadi

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
Written exam, approx. 120 minutes.
The module grade is the grade of the written exam.

Prerequisites
none

Recommendation
Familiarity with signals and systems (in particular, Fourier transforms) and probability theory at the Bachelor level is assumed.

T 8.304 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 scale	Recurrence	Version
Written examination	6	Grade to a third	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

Competence Certificate
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 8.305 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 scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2545082	SIL Entrepreneurship Project	4 SWS	Seminar	Terzidis

Competence Certificate
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

Recommendation
None

Workload
90 hours

T 8.306 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 scale	Recurrence	Version
Oral examination	6	Grade to a third	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

Competence Certificate
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

Recommendation
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).

Annotation
Limitation to 30 participants

T 8.307 Course: Simulation with Lumped Parameters [T-MACH-113862]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107053 - Simulation with Lumped Parameters

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Each summer term	1 terms	2

Events					
ST 2025	2114071	Simulation with Lumped Parameters	2 SWS	Lecture / 🗣	Geimer, Michiels

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral examination, duration approx. 20 minutes

Prerequisites
none

Recommendation
Knowledge of mechanics and hydraulics

Workload
90 hours

T 8.308 Course: Simulator Exercises Combined Cycle Power Plants [T-MACH-105445]

Responsible: Prof. Dr.-Ing. Daniel Banuti
Hon.-Prof. Dr. Thomas Schulenberg

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107062 - Combined Cycle Power Plants

Type	Credits	Grading scale	Recurrence	Version
Oral examination	2	Grade to a third	Each summer term	1

Events					
ST 2025	2170491	Simulator Exercises Combined Cycle Power Plants	2 SWS	Practical course / 🗣	Banuti, Schulenberg

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam (ca. 15 min)

Prerequisites
none

Recommendation
Participation at LV-No. 2170490 "Combined Cycle Power Plants" (T-MACH-105444) is recommended.

Workload
60 hours

T 8.309 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 scale	Recurrence	Version
Oral examination	3	Grade to a third	Each summer term	4

Events					
ST 2025	2311611	Software Engineering	2 SWS	Lecture / 🗣	Reichmann

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
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 8.310 Course: Solar Energy [T-ETIT-100774]

Responsible: Prof. Dr. Bryce Sydney Richards
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100524 - Solar Energy

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	1

Events					
WT 24/25	2313745	Solar Energy	3 SWS	Lecture / 🗣	Richards, Paetzold
WT 24/25	2313750	Tutorial 2313745 Solar Energy	1 SWS	Practice / 🗣	Richards, Paetzold

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
Students are not allowed to take „T-ETIT-101939 - Photovoltaik" in addition to this one.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-ETIT-101939 - Photovoltaics must not have been started.

8.311 Course: Solar Thermal Energy Systems [T-MACH-106493]

Responsible: apl. Prof. Dr. Ron Dagan
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101924 - Solar Thermal Energy Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	4

Events					
WT 24/25	2189400	Solar Thermal Energy Systems	2 SWS	Lecture / 🗣	Dagan

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam of about 30 minutes

Prerequisites
none

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-105225 - Thermal Solar Energy must not have been started.

Recommendation
Literature

1. "Solar Engineering of Thermal Processes", 4th Edition, J. Duffie &W. Beckman. Published by Wiley & Sons
2. “Heat Transfer”, 10th Edition, J. P. Holman Mc. Graw Hill publisher
3. “Fundamentals of classical Thermodynamics”, G. Van Wylen & R. E. Sonntag. Published by Wiley &Sons

Workload
120 hours

T 8.312 Course: Spaceborne Radar Remote Sensing - Exam [T-ETIT-112857]

Responsible: Prof. Dr.-Ing. Alberto Moreira
Dr. Pau Prats

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-103042 - Spaceborne Radar Remote Sensing

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2308428	Spaceborne Radar Remote Sensing	2 SWS	Lecture / 🗣	Prats, Moreira
ST 2025	2308429	Tutorial Spaceborne Radar Remote Sensing	1 SWS	Tutorial (/ 🗣	Younis

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment takes place in the form of a written examination lasting 120 min.

Prerequisites
"T-ETIT-106056 - Spaceborne Radar Remote Sensing" is not allowed to be started or to be completed.

Recommendation
Signal processing and radar fundamentals.

Annotation
Further information can be found at the internet page of the IHE (https://s.kit.edu/ihe-srrs).

T 8.313 Course: Spaceborne Radar Remote Sensing - Workshop [T-ETIT-112858]

Responsible: Prof. Dr.-Ing. Marwan Younis
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103042 - Spaceborne Radar Remote Sensing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	2	Grade to a third	Each summer term	1

Events					
ST 2025	2308427	Spaceborne Radar Remote Sensing	1 SWS	/ 🗣	Younis, Prats

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment takes place in the form of reports (other types of examination). Those reports have to be submitted as part of the SAR computer workshop (approx. a total of five workshops). Details will be given during the lecture.

Prerequisites
"T-ETIT-106056 - Spaceborne Radar Remote Sensing" is not allowed to be started or to be completed.

Recommendation
Signal processing and radar fundamentals.

Annotation
Further information can be found at the internet page of the IHE (https://s.kit.edu/ihe-srrs).

T 8.314 Course: Stochastic Information Processing [T-INFO-101366]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: M-INFO-100829 - Stochastic Information Processing

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each winter term	1

Events					
WT 24/25	2424113	Stochastic Information Processing	3 SWS	Lecture / 🗣	Hanebeck, Frisch

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.315 Course: Strategic Product Development - Identification of Potentials of Innovative Products [T-MACH-105696]

Responsible: Prof. Dr.-Ing. Andreas Siebe
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107140 - Strategic Product Development - Identification of Potentials of Innovative Products

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Each summer term	2

Events					
ST 2025	2146198	Strategic product development - identification of potentials of innovative products	2 SWS	Lecture / Blended	Siebe

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Oral exam in small groups (30 minutes)

Prerequisites
The precondition of this partial work is the successful processing of a case study(T-MACH-110396): Documentation and presentation of the overall results (15 minutes)

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-110396 - Strategic Product Development - Identification of Potentials of Innovative Products - Case Study must have been passed.

Workload
90 hours

T 8.316 Course: Strategic Product Development - Identification of Potentials of Innovative Products - Case Study [T-MACH-110396]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Sven Matthiesen
Prof. Dr.-Ing. Andreas Siebe

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107140 - Strategic Product Development - Identification of Potentials of Innovative Products

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	1	Grade to a third	Each summer term	2

Events					
ST 2025	2146198	Strategic product development - identification of potentials of innovative products	2 SWS	Lecture / Blended	Siebe

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Successful processing of a case study(T-MACH-110396): documentation and presentation of the overall results (15 minutes)

Workload
30 hours

T 8.317 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-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (oral)	3	pass/fail	Each winter term	2

Events					
WT 24/25	2314010	Strategy Derivation for Engineer	2 SWS	Seminar /	Arndt

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Prerequisites
none

T 8.318 Course: Structural Materials [T-MACH-100293]

Responsible: Dr.-Ing. Stefan Guth
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100291 - Structural Materials

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each winter term	3

Events					
WT 24/25	2174580	Structural Materials	4 SWS	Lecture / Practice (/ 🗣	Guth

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral exam, about 25 minutes

Prerequisites
none

Workload
180 hours

T 8.319 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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

Competence Certificate
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 8.320 Course: Superconducting Power Systems [T-ETIT-113439]

Responsible: Prof. Dr.-Ing. Mathias Noe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106683 - Superconducting Power Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	2

Events					
WT 24/25	2314011	Superconducting Power Systems	3 SWS	Lecture / Practice (/	Noe

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The examination takes place in form of an oral exam (abt. 45 minutes).

The module grade is the grade of the oral exam.

Prerequisites
none

T 8.321 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 scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2146193	Sustainable Product Engineering	2 SWS	Lecture / 🗣	Ziegahn

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam (90 min)

Prerequisites
none

Recommendation
None

Workload
120 hours

T 8.322 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 scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	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

T 8.323 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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

Competence Certificate
oral exam (Duration: 30 min)

Prerequisites
none

Workload
120 hours

T 8.324 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	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

Competence Certificate
Oral exam, approx. 15 min.

Prerequisites
None

Workload
120 hours

T 8.325 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 scale	Recurrence	Version
Examination of another type	6	Grade to a third	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 8.326 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 scale	Recurrence	Version
Written examination	5	Grade to a third	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

Competence Certificate
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 8.327 Course: Technical Design in Product Development [T-MACH-105361]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Sven Matthiesen
Dr.-Ing. Markus Schmid

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105318 - Technical Design in Product Development

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	1

Competence Certificate
Written exam (60 min)

Only dictionnary is allowed

Workload
120 hours

T 8.328 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 scale	Recurrence	Version
Written examination	5	Grade to a third	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 8.329 Course: Technology Assessment and its Normative Basis [T-MACH-113884]

Responsible: Prof. Dr. Dr. Rafaela Hillerbrand
Organisation: KIT Department of Mechanical Engineering
Part of: M-ETIT-107193 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	2	pass/fail	Each winter term	1 terms	2

Events					
WT 24/25	5000057	Aufbaumodul: Technikfolgenabschätzung und Normativität	2 SWS	Advanced seminar (	Hillerbrand

Competence Certificate
Coursework in the form of written assignments and/or oral performances.

Prerequisites
none

Workload
60 hours

T 8.330 Course: Thermal Solar Energy [T-MACH-105225]

Responsible: apl. Prof. Dr. Ron Dagan
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102388 - Thermal Solar Energy

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	2

Events					
WT 24/25	2189400	Solar Thermal Energy Systems	2 SWS	Lecture / 🗣	Dagan

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Competence Certificate
Oral examination of about 30 minutes

Prerequisites
none

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-106493 - Solar Thermal Energy Systems must not have been started.

Workload
120 hours

T 8.331 Course: Thermal Turbomachines I [T-MACH-114052]

Responsible: Prof. Dr.-Ing. Hans-Jörg Bauer
Organisation: KIT Department of Mechanical Engineering
Institute of Thermal Turbomachinery
Part of: M-MACH-107219 - Thermal Turbomachines I

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Each winter term	1

Competence Certificate
oral exam, duration approx. 30 min.

Prerequisites
none

Workload
240 hours

T 8.332 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 scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2189423	Thermal-Fluid-Dynamics	2 SWS	Lecture / 🗣	Ruck

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
oral exam of about 30 minutes

Prerequisites
none

Workload
120 hours

T 8.333 Course: Tires and Wheel Development for Passenger Cars [T-MACH-102207]

Responsible: Prof. Dr.-Ing. Günter Leister
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107070 - Tires and Wheel Development for Passenger Cars

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2025	2114845	Tires and Wheel Development for Passenger Cars	2 SWS	Lecture / 🗣	Leister

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Prerequisites
none

Workload
120 hours

T 8.334 Course: Tractors [T-MACH-105423]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Hon.-Prof. Dr. Martin Kremmer

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-107058 - Tractors

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2113080	Tractors	2 SWS	/ 🗣	Kremmer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of an written exam taking place in the recess period (90 min).

Prerequisites
none

Recommendation
Basic knowledge in mechanical engineering.

Annotation
Learning Outcomes
After completion of the course the Students know:

- important problems in agritechnological developments
- Customer requirements and their implementation in tractors
- Tractor technology in width and depth

Content
Tractors are one of the most underestimated vehicles in regard to performance und technics. Almost none vehicle is as multifunctional and fulfilled with high-tech as a tractor. Automatic guidance, special chassis suspension or special concepts of power trains are one of the topics where tractors are in leading position in technologies
During the lecture an overview about the design and construction and application area is given. A close look will be taken on the historical background, legal requirements, ways of development, agricultural organizations and the process of development itself.
In detail the following topics will be dealt with:

- agricultural organization / legal requirements
- history of tractors
- tractor engineering
- tractor mechanics
- chassis suspension
- combustion engine
- transmission
- interfaces
- hydraulics
- wheels and tyres
- cabin
- electrics and electronics

Literature

- K.T. Renius: Traktoren - Technik und ihre Anwendung; DLG Verlag (Frankfurt), 1985
- E. Schilling: Landmaschinen - Lehr- und Handbuch für den Landmaschinenbau; Schilling-Verlag (Köln), 1960

Workload
120 hours

T 8.335 Course: Tutorial Continuum Mechanics of Solids and Fluids [T-MACH-110333]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Prof. Dr.-Ing. Bettina Frohnapfel

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105180 - Continuum Mechanics

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	1	pass/fail	Each winter term	1

Events					
WT 24/25	2161253	Tutorial Continuum mechanics of solids and fluids	2 SWS	Practice / 🗣	Gisy, Speichinger, Böhlke

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Successfully passing the Tutorial is a prerequisite for taking part in the exam "Continuum Mechanics of Solids and Fluids" (T-MACH-110377).

For students of Mechanical Engineering (BSc) that have chosen the Major Field "Continuum Mechanics" and for students of Material Science and Material Technology (BSc) 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 of students from different fields of study the prerequisites consist of successfully solving only the written homework sheets.

Prerequisites
None

Annotation
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) and students of the bachelor's degree program in material science and material technology 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 8.336 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 scale	Recurrence	Expansion	Version
Completed coursework	2	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

Competence Certificate
successfully solving the homework sheets. Details are announced in the first lecture.

Prerequisites
None

Workload
60 hours

T 8.337 Course: Tutorial Mathematical Methods in Hydraulics [T-MACH-113913]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107210 - Mathematical Methods in Hydraulics

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	2	pass/fail	Each winter term	1 terms	1

Competence Certificate
Successful completion of Ilias tests. Details will be announced in the first lecture.

Prerequisites
none

Annotation
See "Mathematical methods of hydraulics".

Workload
60 hours

T 8.338 Course: Tutorial Simulation with Lumped Parameters [T-MACH-113863]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107053 - Simulation with Lumped Parameters

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	1	pass/fail	Each summer term	1 terms	1

Events					
ST 2025	2114072	Simulation with Lumped Parameters (Tutorial)	2 SWS	Practice / 🗣	Geimer, Michiels

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Submission of a report at the end of the lecture period.

Prerequisites
none

Recommendation
Knowledge of mechanics and hydraulics

Annotation
This tutorial is a prerequisite for the partial performance T-MACH-113862 - Simulation with concentrated parameters (examination) in the MSc Mechanical Engineering program (SPO 2025).

Workload
30 hours

T 8.339 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 scale	Recurrence	Version
Oral examination	5	Grade to a third	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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-101326 - Ubiquitous Computing must not have been started.

T 8.340 Course: Validation of Technical Systems [T-MACH-113982]

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

Part of: M-MACH-107143 - Validation of Technical Systems

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each summer term	1 terms	3

Events					
ST 2025	2146230	Validation of technical Systems	2 SWS	Lecture / 🗣	Düser

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written exam with a duration of 60 minutes.

Prerequisites
None

Recommendation
None

Annotation
None

Workload
120 hours

T 8.341 Course: Vehicle Drive Technology [T-MACH-113997]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107056 - Vehicle Drive Technology

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each winter term	1 terms	1

Competence Certificate
Oral examination, duration approx. 20 minutes

Prerequisites
none

Workload
120 hours

T 8.342 Course: Vehicle Lightweight Design - Strategies, Concepts, Materials [T-MACH-105237]

Responsible: Prof. Dr.-Ing. Frank Henning
Organisation: KIT Department of Mechanical Engineering

Part of: Lightweight Design
M-MACH-102703 - Vehicle Lightweight Design - Strategies, Concepts, Materials

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	3

Events					
WT 24/25	2113102	Vehicle Lightweight design – Strategies, Concepts, Materials	2 SWS	Lecture /	Henning

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Written exam; Duration approx. 90 min

Prerequisites
T-MACH-114001 must not have been started.

Recommendation
none

Workload
120 hours

T 8.343 Course: Vehicle Systems for Urban Mobility [T-MACH-113069]

Responsible: Prof. Dr.-Ing. Martin Cichon
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-106515 - Vehicle Systems for Urban Mobility

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	3

Events					
WT 24/25	2115922	Vehicle Systems for Urban Mobility	2 SWS	Lecture / 🗣	Cichon, Ziesel
ST 2025	2115922	Vehicle Systems for Urban Mobility	2 SWS	Lecture / 🗣	Ziesel, Cichon

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Oral examination
Duration: approx. 20 minutes
No tools or reference material may be used during the exam.

Workload
120 hours

T 8.344 Course: Virtual Engineering I [T-MACH-102123]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101283 - Virtual Engineering A
M-MACH-105293 - Virtual Engineering 1

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	3

Events					
WT 24/25	2121352	Virtual Engineering I	2 SWS	Lecture / 🗣	Ovtcharova, weitere Mitarbeitende
WT 24/25	2121353	Exercises Virtual Engineering I	2 SWS	Practice / 🗣	Ovtcharova, Mitarbeiter, Mitarbeiter/innen

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Writen examination 90 min.

Prerequisites
None

Workload
120 hours

T 8.345 Course: Virtual Engineering Lab [T-MACH-106740]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-101283 - Virtual Engineering A
M-MACH-105475 - Virtual Engineering Lab

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	1

Events					
WT 24/25	2123350	Virtual Engineering Lab	3 SWS	Project (P / 🗣	Ovtcharova, Häfner
ST 2025	2123350	Virtual Engineering Lab	3 SWS	Project (P / 🗣	Häfner, Ovtcharova

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Assessment of another type (graded), Group project to create a VR application (project task, implementation and presentation of the project work)

T 8.346 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 scale	Recurrence	Version
Written examination	4	Grade to a third	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

Competence Certificate
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.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-106557 - Wearable Robotic Technologies must not have been started.

Recommendation
Attending the lecture Mechano-Informatics and Robotics is recommended.

T 8.347 Course: Windpower [T-MACH-105234]

Responsible: Norbert Lewald
Organisation: KIT Department of Mechanical Engineering
Institute of Thermal Turbomachinery
Part of: M-MACH-105732 - Windpower

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	2

Events					
WT 24/25	2157381	Windpower	2 SWS	Lecture / 🗣	Lewald

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam, 120 minutes

Prerequisites
none

Workload
120 hours

T 8.348 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 scale	Recurrence	Version
Examination of another type	3	Grade to a third	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

Competence Certificate
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

9 Appendix

9.1 Definition - About this MHB

MHB, PDF-Version: https://s.kit.edu/mhb-mit-msc25