Module Handbook
M.Sc. Mechatronics and Information Technology 2015 (Master of Science)

SPO 2015

Summer term 2025

Date: 12/03/2025

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?tab=%5B3687%5D#tabpanel-3687).

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

- General Mechatronics: 32 CR
- Field of Specialization: 35 CR
- Interdisciplinary Subject: 17 CR
- Interdisciplinary Qualifications: 6 CR
- Master's Thesis: 30 CR

In total: 120 CR

General Mechatronics

This subject consists of compulsory modules that must be completed by the students. In the modules "Technische Mechanik" and "Werkstoffe" there are elective options.

Field of Specialization

Students choose a Field of Specialization from the following list. Each field includes 35 credit points:

- Automotive Engineering (*Fahrzeugtechnik*)
- Power Engineering (*Energietechnik*)
- Microsystems Technology (*Mikrosystemtechnik*)
- Medical Technology (*Medizintechnik*)
- Industrial Automation (*Industrieautomation*)
- Control Engineering in Mechatronics (*Regelungstechnik in der Mechatronik*)
- Robotics (*Robotik*)
- Design of Mechatronic Systems (*Konstruktion Mechatronischer Systeme*)

In addition to the compulsory modules, each Field of Specialization contains supplementary modules, which can be compiled from the list of courses given. The minimum number of 35 credit points required for the Field of Specialization must be achieved (or can be exceeded once). If necessary, several modules from the list of selectable supplementary modules must be combined.

The list of supplementary 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 supplementary modules for their study plan that are included in 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.

Modules that have already been taken in the program of the Bachelor's degree in Mechatronics and Information Technology or in related programs cannot be selected as supplementary modules in the Master's degree program. If a compulsory module has already been taken in the Bachelor's degree program, it will be replaced by a supplementary module of the chosen Field of Specialization.

If there is demonstrably no place available in all the selectable internships of the desired Field of Specialization, then, as an exception, an internship of a different Field of Specialization, that is suitable in terms of content, can be selected. This requires the approval of a program consultant (https://www.mach.kit.edu/1982.php?tab=%5B2693%5D#tabpanel-2693).

Students who have already chosen a Field of Specialization that is no longer offered in the current curriculum, please refer to previous module handbooks in the archive (https://www.etit.kit.edu/modulhandbuecher_archiv.php).

Interdisciplinary Subject

The Interdisciplinary Subject consists of modules in the amount of 17 CR. If 17 CR cannot be achieved through the choice of modules exactly, overbooking by a maximum of one module is possible. The modules can be freely chosen by the students from the modules listed below. Other courses of the Master's degree programs in Electrical Engineering and Information Technology, Mechanical Engineering, or Informatics/Computer Science can be chosen after application at the Program Service Master. The chosen modules should fit thematically to the Field of Specialization and at most one practical course and one seminar should be chosen.

Particularly in the case of courses offered by the KIT Department of Informatics, the consent of the lecturer(s) must be obtained before a module is included in the Interdisciplinary Subject.
In the process, it must also be clarified whether the students have the necessary subject-specific prerequisites for the selected module. This matching is the responsibility of the student.

In the Interdisciplinary Subject, no module can be selected, which has already been selected in the Field of Specialization or which has already been examined in the Bachelor's degree program in Mechatronics and Information Technology or in related degree programs.

The choice of supplementary modules in the Field of Specialization and modules in the Interdisciplinary Subject is made electronically in Campus Management Portal (https://campus.studium.kit.edu/english/index.php).

Interdisciplinary Qualifications

Interdisciplinary Qualifications are modules with a predominantly non-technical content; these must be completed with an evaluated proof of credit points. The module "*Das Arbeitsfeld des Ingenieurs*" (2 CR) is already fixed. The other modules in the amount of 4 CR can be selected from the range of events offered by KIT.

For example, courses from the following areas are recommended: Management, Entrepreneurship, Business Administration, Law, Patents. Typically, these are courses from the HOC, ZAK, and Language Center (*SPZ*), as well as Interdisciplinary Qualifications offered by the KIT Department of Electrical Engineering and Information Technology and the KIT Department of Mechanical Engineering. Further Interdisciplinary Qualifications can be acquired within the subject "Additional Examinations".

Achievements can be booked in the module “Key Competences (*Schlüsselqualifikationen*)” 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 HoC, ZAK or SPZ with the title “Self Assignment-HOC-SPZ-ZAK...” according to the grading scale, graded or ungraded. Title and credits of the achievement are adopted automatically.

1.3. Curriculum

Subject/Modul	**1. Term**				**2. Term**				**3. Term**			
	V	**Ü**	**P**	**CR**	**V**	**Ü**	**P**	**CR**	**V**	**Ü**	**P**	**CR**
Technische Mechanik	3			5								
Measurement Technology	2	1		5								
Field of Specialization				15								
Interdisciplinary Subject				5								
Numerical Methods					2	1		5				
Produktentstehung - Entwicklungsmethodik					3			6				
Werkstoffe					3			5				
Das Arbeitsfeld des Ingenieurs					2			2				
Field of Specialization								6				
Interdisciplinary Subject								6				
Regelung linearer Mehrgrößensysteme									3	1		6
Interdisciplinary Qualifications												4
Field of Specialization												14
Interdisciplinary Subject												6

4. Term: Master’s Thesis (30 CR)

Exemplary curriculum in the Field of Specialization Industrieautomation

1. Term (WS)

PF: T-MACH-110375	Math. Methoden der Kontinuumsmechanik	5 CR writ.
PF: M-ETIT-102652	Measurement Technology	5 CR writ.
VF: M-ETIT-100531	Optimization of Dynamic Systems	5 CR writ.
VF: M-INFO-100893	Robotik I - Einführung in die Robotik	6 CR writ.
IF: M-ETIT-100399	Schaltungstechnik in der Industrieelektronik	3 CR oral
IF: M-ETIT-105915	Regelung leistungselektronischer Systeme	6 CR oral

Number of CR: 30
Number of oral examinations: 2
Number of written examinations: 4

2. Term (SS)

PF: M-MATH-105831	Numerical Methods	5 CR writ.
PF: T-MACH-109192	Methoden und Prozesse der PGE	6 CR writ.
PF: T-MACH-100531	Systematische Werkstoffauswahl	5 CR writ.
VF: M-MACH-102687	Dezentral gesteuerte Intralogistiksysteme	4 LP course work
VF: M-MACH-105281	Informationssysteme in Logistik und Supply Chain Management	3 CR oral
VF: M-MACH-106468	Steuerung mobiler Arbeitsmaschinen	4 CR oral
ÜQ: M-MACH-102755	Das Arbeitsfeld des Ingenieurs	2 CR writ.

Number of CR: 29
Number of oral examinations: 2
Number of written examinations: 4
Number of examinations of other types: 1

3. Term (WS)

PF: T-ETIT-100666	Regelung linearer Mehrgrößensysteme	6 CR writ.
VF: M-MACH-105296	Computational Intelligence	4 CR writ.
VF: M-MACH-104984	Materialfluss in Logistiksystemen	9 CR other type
IF: M-MACH-102692	Elektrische Schienenfahrzeuge	4 CR oral
IF: M-ETIT-100417	Hochspannungsprüftechnik	4 CR oral
ÜQ:	Überfachliche Qualifikationen	4 CR other type

Number of CR: 31 CR
Number of oral examinations: 2
Number of written examinations: 2
Number of examinations of other types: 2

4. Term (SS)

MT:	Master’s Thesis	30 CR

Number of CR: 30
Number of oral examinations: -
Number of written examinations: -

Total number of examinations: 19

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:

- Bachelor SPO 2016 of 03-05-2016, Article 19 and changes of 28-09-2018, Article 19
- Master SPO 2015 of 10-07-2015, Article18 and correction of 30-06-2016

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. Examination which are to be recognized instead of a graded examination must also be graded.

The exact procedure is described at “Richtlinien zur Anerkennung von Studien- und Prüfungsleistungen im Studiengang Mechatronik und Informationstechnik“ (in German: https://www.mach.kit.edu/Master-MIT.php?tab=%5B3682%5D#tabpanel-3682).

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 compulsory modules in General Mechatronics and in the Field of Specialization before the stay abroad. The work done at the foreign institution can then be recognized in the Interdisciplinary Subject 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/erasmus_outgoing.php) and the KIT Department of Mechanical Engineering (https://www.mach.kit.edu/1703.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 General Mechatronics, the Field of Specialization, and the Interdisciplinary Subject 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, Article 7, paragraph 4, 7, and 9 as well as Article 2, 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:

- Teaching of basic engineering knowledge within the compulsory subject of General Mechatronics in the first two terms to the extent of 32 credit points. Included are basic modules that convey the basic scientific knowledge of mechatronics, e.g. numerical mathematical methods, multibody dynamics, product development, methods of product engineering, materials selection, measurement technology, control engineering.

- Intensive specialization in an area of choice. For this purpose, eight Fields of Specialization with a total of 35 credit points are offered. Each Field of Specialization consists mainly of compulsory modules (core modules), which are specified according to the chosen Field of Specialization. In addition, further courses (supplementary modules) of the areas electrical and mechanical engineering as well as information and computer technology are offered, which the students can compile themselves.

- Further specialization is possible within the framework of the Interdisciplinary Subject (17 credit points). The modules of the Interdisciplinary Subject are compiled by the students from the master's courses of the areas electrical and mechanical engineering as well as information and computer technology.

- The range of specific elective modules – some are held by lecturers from renowned research institutions and industry – is very large. To provide a flexible offer, some modules are designated with less than 5 credit points. This is explicitly supported by the student representatives.

- The final module composition should be coherent in content and must be approved by the program consultant.

- During the preparation of their Master's thesis, students are guided to conduct independent scientific research.

The final choice of the individual Field of Specialization may be accomplished in the second or third term, as illustrated in the following table:

<table>
<tr><th>Term</th><th>Subject</th><th>LP/CR</th></tr>
<tr><td>1</td><td rowspan="3">General Mechatronics (32 CR)
Field of Specialization (35 CR)
Interdisciplinary Subject (17 CR)</td><td>30</td></tr>
<tr><td>2</td><td>30</td></tr>
<tr><td rowspan="2">3</td><td>24</td></tr>
<tr><td>Interdisciplinary Qualifications</td><td>6</td></tr>
<tr><td>4</td><td>Master's Thesis</td><td>30</td></tr>
</table>

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 compulsory subject Mechatronics are primarily completed in the first two terms. Based on this is the Field of Specialization, in which students can choose from one of eight specializations. The courses in the Field of Specialization are mainly held in the second and third term. At the same time, starting in the first term, the Interdisciplinary Qualifications are completed.
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 Interdisciplinary Subject (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 university's internships and laboratories (each Field of Specialization contains an internship as a core module), 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.

The Interdisciplinary Qualifications with an amount of 6 CR are scheduled within the first to third term.
In the first term, a specific ring course is offered in the Master's degree program in Mechatronics and Information Technology. Within this course professors impart their professional experience and practical knowledge in the areas of project management, cooperation with production and marketing, governance, processes, and organization.
In the third term, another specific course is offered in the Master's degree program, in which students are taught theoretical knowledge as well as practical experience in leading interdisciplinary teams (under guidance). This is done in cooperation with the workshop "Mechatronische Systeme und Produkte" of the Bachelor's degree program in Mechatronics and Information Technology.

In addition, courses from the KIT-Department of Electrical Engineering and Information Technology, Mechanical Engineering, and other departments or the House of Competence can be chosen. The selected courses must have a predominantly non-technical content and should be related to the future professional field of an engineer. 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.

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 Interdisciplinary Subject, 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	2015
Regular terms	4 terms
Maximum terms	8 terms
Credits	120
Language	Deutsch
Grade calculation	Weighted average by credits
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 elective modules in the interdisciplinary subject. The individual selection of the elective modules is approved by a study advisor.

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
General Mechatronics	32 CR
Field of Specialization	35 CR
Interdisciplinary Subject	17 CR
Interdisciplinary Qualifications	6 CR
Voluntary	
Additional Examinations *This field will not influence the calculated grade of its parent.*	

4.1 Master's Thesis

Credits
30

Mandatory		
M-ETIT-103253	Master's Thesis	30 CR

4.2 General Mechatronics

Credits
32

Mandatory		
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-ETIT-102734	Materials	5 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-MATH-105831	Numerical Methods	5 CR
M-ETIT-105982	Measurement Technology	5 CR
M-MACH-103205	Engineering Mechanics	5 CR

4.3 Field of Specialization

Credits
35

Field of Specialization (Election: 1 item)	
Field of Specialization: Automotive Engineering	35 CR
Field of Specialization: Power Engineering	35 CR
Field of Specialization: Microsystems Technology	35 CR
Field of Specialization: Industrial Automation	35 CR
Field of Specialization: Control Engineering in Mechatronics	35 CR
Field of Specialization: Robotics	35 CR
Field of Specialization: Design of Mechatronic Systems	35 CR

4.3.1 Field of Specialization: Automotive Engineering

Part of: Field of Specialization

Credits
35

Election notes

In the Field of Specialization "Automotive Engineering" 35 CR must be selected. Through the compulsory modules and according to the chosen Internship, there is a remaining number of 5-10 CR for the Complementary Modules.

Please make sure that this number is exactly met or exceeded once. Excess modules will be moved to the Interdisciplinary Subject.

Starting winter term 21/22, "M-ETIT-100514 - Hybride und elektrische Fahrzeuge" will be replaced by "M-ETIT-100532 - Batterien und Brennstoffzellen". The latter is thus omitted in the Complementary Modules.

Students who have already successfully completed "Hybride und elektrische Fahrzeuge", please contact the Program Service Master (master-info@etit.kit.edu) for booking "Batterien und Brennstoffzellen" in the Complementary Modules.

Mandatory		
M-ETIT-100532	Batteries and Fuel Cells	5 CR
M-MACH-100501	Automotive Engineering I	8 CR
M-MACH-100502	Automotive Engineering II	4 CR
M-MACH-102683	Rail Vehicle Technology	4 CR
Internships (Election: 1 item)		
M-MACH-102695	Motor Vehicle Laboratory	4 CR
M-ETIT-100381	Batteries and Fuel Cells Laboratory	6 CR
M-ETIT-100401	Lab Course Electrical Drives and Power Electronics	6 CR
M-MACH-105725	Seamless Engineering	9 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Complementary Modules (Election:)		
M-MACH-105800	Drive Train of Mobile Machines	4 CR
M-MACH-103232	Rail System Technology	4 CR
M-ETIT-100377	Battery and Fuel Cells Systems	3 CR
M-MACH-106926	Decision-Making and Motion Planning for Automated Driving neu	6 CR
M-MACH-106513	Railway System Digitalisation	4 CR
M-MACH-102700	Dynamics of the Automotive Drive Train	4 CR
M-ETIT-100515	Design of Electrical Machines	5 CR
M-MACH-105288	Handling Characteristics of Motor Vehicles I	4 CR
M-MACH-102703	Vehicle Lightweight Design - Strategies, Concepts, Materials	4 CR
M-MACH-102693	Automotive Vision	6 CR
M-MACH-106515	Vehicle Systems for Urban Mobility	4 CR
M-MACH-105824	Fundamentals in the Development of Commercial Vehicles	4 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-106514	Innovation and Project Management in Rail Vehicle Engineering	4 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-MACH-107013	Vehicle Lightweight Design - Strategies, Concepts, Materials neu *First usage possible between Apr 01, 2025 and Apr 01, 2025.*	4 CR

4.3.2 Field of Specialization: Power Engineering

Part of: Field of Specialization

Credits 35

Election notes

In the Field of Specialization "Power Engineering" 35 CR must be selected. Through the compulsory modules and according to the chosen Internship, there is a remaining number of 7-10 CR for the Complementary Modules.

Please make sure that this number is exactly met or exceeded once. Excess modules will be moved to the Interdisciplinary Subject.

Mandatory		
M-ETIT-100572	Power Network	5 CR
M-MACH-102690	Fundamentals of Energy Technology	8 CR
M-ETIT-104567	Power Electronics	6 CR
Internships (Election: 1 item)		
M-ETIT-107138	Electric Drives and Power Electronics Lab neu	6 CR
M-ETIT-107137	Electrical Energy Systems Lab neu	6 CR
M-ETIT-107159	Laboratory Information Systems in Power Engineering neu	6 CR
M-INFO-105955	Practical Course: Smart Energy System	6 CR
M-ETIT-102350	Laboratory Solar Energy	6 CR
M-MACH-105725	Seamless Engineering	9 CR
Complementary Modules (Election:)		
M-ETIT-100532	Batteries and Fuel Cells	5 CR
M-WIWI-100498	Introduction into Energy Economics	5 CR
M-ETIT-105394	Electric Power Transmission & Grid Control	6 CR
M-INFO-106864	Energy Informatics	10 CR
M-ETIT-100413	Power Systems and Economy	3 CR
M-ETIT-100515	Design of Electrical Machines	5 CR
M-MACH-102707	Fundamentals of Combustion I	4 CR
M-ETIT-106067	Power Electronic Systems in Energy Technology	6 CR
M-MACH-102714	Microenergy Technologies	4 CR
M-ETIT-100513	Photovoltaics	6 CR
M-ETIT-100394	Practical Aspects of Electrical Drives	4 CR
M-INFO-103153	Seminar: Energy Informatics	4 CR
M-ETIT-103447	Seminar Novel Concepts for Solar Energy Harvesting	3 CR
M-ETIT-100524	Solar Energy	6 CR
M-MACH-102388	Thermal Solar Energy	4 CR
M-MACH-102717	Heat and Mass Transfer	4 CR

4.3.3 Field of Specialization: Microsystems Technology

Part of: Field of Specialization

Credits 35

Election notes

In the Field of Specialization "Microsystems Technology" 35 CR must be selected. Through the compulsory modules and according to the chosen Internship, there is a remaining number of 7-12 CR for the Complementary Modules.

Please make sure that this number is exactly met or exceeded once. Excess modules will be moved to the Interdisciplinary Subject.

Mandatory		
M-MACH-100489	BioMEMS - Microsystems Technologies for Life Sciences and Medicine I	4 CR
M-MACH-102691	Introduction to Microsystem Technology I	4 CR
M-MACH-102706	Introduction to Microsystem Technology II	4 CR
M-MACH-100487	Microactuators	4 CR
M-ETIT-100378	Sensors	3 CR
Internships (Election: 1 item)		
M-ETIT-100451	System-on-Chip Laboratory	6 CR
M-MACH-105479	Practical Training in Basics of Microsystem Technology	4 CR
M-MACH-105725	Seamless Engineering	9 CR
Complementary Modules (Election:)		
M-MACH-105485	Current Topics on BioMEMS	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-MACH-105478	Fabrication Processes in Microsystem Technology	4 CR
M-ETIT-100474	Integrated Systems and Circuits	4 CR
M-MACH-102714	Microenergy Technologies	4 CR
M-MACH-105486	Micro System Simulation	4 CR
M-ETIT-100454	Microsystem Technology	3 CR
M-ETIT-100455	Seminar Embedded Systems	4 CR
M-MACH-105315	System Integration in Micro- and Nanotechnology	4 CR
M-MACH-105316	System Integration in Micro- and Nanotechnology 2	4 CR

4.3.4 Field of Specialization: Industrial Automation

Part of: Field of Specialization

Credits
35

Election notes
In the Field of Specialization "Industrial Automation" 35 CR must be selected. Through the compulsory modules and according to the chosen Internship, there is a remaining number of 8-13 CR for the Complementary Modules.

Please make sure that this number is exactly met or exceeded once. Excess modules will be moved to the Interdisciplinary Subject.

Mandatory		
M-MACH-105296	Computational Intelligence	4 CR
M-MACH-104984	Material Flow in Logistic Systems	9 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
Internships (Election: 1 item)		
M-MACH-106830	Industrial Mobile Robotics Lab neu	4 CR
M-MACH-102699	Laboratory Mechatronics	4 CR
M-ETIT-103448	Laboratory Mechatronic Measurement Systems	6 CR
M-MACH-105725	Seamless Engineering	9 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Complementary Modules (Election:)		
M-ETIT-106953	Cyber-Physical Modeling neu	6 CR
M-MACH-105476	Digitalization of Products, Services & Production	4 CR
M-MACH-102688	Elements of Technical Logistics	4 CR
M-MACH-105015	Elements of Technical Logistics incl. Project	6 CR
M-MACH-107020	Development of Automated Production Systems neu	4 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-105282	IT-Fundamentals of Logistics: Opportunities for Digital Transformation	4 CR
M-ETIT-106789	IT/OT-Security Seminar	4 CR
M-MACH-105968	Artificial Intelligence in Production	8 CR
M-MACH-105298	Logistics and Supply Chain Management	9 CR
M-INFO-100893	Robotics I - Introduction to Robotics *First usage possible until Sep 30, 2025.*	6 CR
M-MACH-105477	Seminar Data-Mining in Production	3 CR
M-MACH-106468	Control of Mobile Machines	4 CR
M-MACH-105107	Machine Tools and Industrial Handling	8 CR

4.3.5 Field of Specialization: Control Engineering in Mechatronics

Part of: Field of Specialization

Credits
35

Election notes

In the Field of Specialization "Control Engineering in Mechatronics" 35 CR must be selected. Through the compulsory modules and according to the chosen Internship, there is a remaining number of 11-16 CR for the Complementary Modules.

Please make sure that this number is exactly met or exceeded once. Excess modules will be moved to the Interdisciplinary Subject.

Mandatory		
M-INFO-106299	Advanced Artificial Intelligence	6 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-ETIT-100361	Distributed Discrete Event Systems	4 CR
Internships (Election: 1 item)		
M-MACH-106744	Cognitive Automobiles - Laboratory	6 CR
M-ETIT-105467	Control Theory Laboratory	6 CR
M-MACH-105291	Lab Computer-Aided Methods for Measurement and Control	4 CR
M-MACH-105725	Seamless Engineering	9 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Complementary Modules (Election:)		
M-INFO-106928	Practical Course: Mathematical and Computational Methods in Robotics and AI neu	6 CR
M-MACH-106926	Decision-Making and Motion Planning for Automated Driving neu	6 CR
M-INFO-104460	Deep Learning and Neural Networks	6 CR
M-MACH-105612	Dynamics of Electro-Mechanical Systems	5 CR
M-INFO-105778	Machine Learning - Foundations and Algorithms	6 CR
M-WIWI-105003	Machine Learning 1	5 CR
M-WIWI-105006	Machine Learning 2	5 CR
M-MACH-102694	Machine Dynamics	5 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-100371	Nonlinear Control Systems	3 CR
M-ETIT-102310	Optimal Control and Estimation	3 CR
M-ETIT-106780	Practical Tools for Control Engineers	4 CR
M-ETIT-105915	Control of Power-Electronic Systems	6 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-INFO-106504	Simulation and Optimization in Robotics and Biomechanics neu	6 CR
M-INFO-100829	Stochastic Information Processing	6 CR
M-ETIT-106953	Cyber-Physical Modeling neu	6 CR

4.3.6 Field of Specialization: Robotics

Part of: Field of Specialization

Credits
35

Election notes

In the Field of Specialization "Robotics" 35 CR must be selected. Through the compulsory modules and according to the chosen Internship, there is a remaining number of 9-14 CR for the Complementary Modules.

Please make sure that this number is exactly met or exceeded once. Excess modules will be moved to the Interdisciplinary Subject.

Mandatory		
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-INFO-100893	Robotics I - Introduction to Robotics	6 CR
M-INFO-102756	Robotics II - Humanoid Robotics	3 CR
M-INFO-104897	Robotics III - Sensors and Perception in Robotics	3 CR
Internships (Election: 1 item)		
M-INFO-106646	Practical Course: Human-Centred Robotics	6 CR
M-INFO-106648	Practical Course: Movement and Technology	6 CR
M-MACH-105291	Lab Computer-Aided Methods for Measurement and Control	4 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-INFO-102522	Robotics - Practical Course	6 CR
M-INFO-105792	Humanoid Robotics Laboratory	6 CR
M-MACH-105725	Seamless Engineering	9 CR
M-ETIT-106633	Signal Processing Lab	6 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Complementary Modules (Election:)		
M-INFO-103294	Wearable Robotic Technologies	4 CR
M-INFO-100826	Automated Visual Inspection and Image Processing	6 CR
M-INFO-106928	Practical Course: Mathematical and Computational Methods in Robotics and AI neu	6 CR
M-MACH-105296	Computational Intelligence	4 CR
M-MACH-106525	Introduction to Bionics	4 CR
M-ETIT-100453	Hardware/Software Co-Design	4 CR
M-INFO-106649	Humanoid Robots - Locomotion and Whole-Body Control	6 CR
M-INFO-102561	Humanoid Robots - Seminar	3 CR
M-INFO-100791	Innovative Concepts for Programming Industrial Robots	4 CR
M-ETIT-106789	IT/OT-Security Seminar	4 CR
M-INFO-100840	Localization of Mobile Agents	6 CR
M-MACH-101923	Machine Vision	8 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-100487	Microactuators	4 CR
M-INFO-102555	Motion in Human and Machine - Seminar	3 CR
M-ETIT-100371	Nonlinear Control Systems	3 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-INFO-106400	Seminar: Assistive robotics and exoskeletons in medical applications	3 CR
M-INFO-102212	Seminar Intelligent Industrial Robots	3 CR
M-INFO-106504	Simulation and Optimization in Robotics and Biomechanics	6 CR
M-MACH-105348	Control Technology	4 CR

4.3.7 Field of Specialization: Design of Mechatronic Systems

Part of: Field of Specialization

Credits
35

Election notes
In the Field of Specialization "Design of Mechatronic Systems" 35 CR must be selected. Through the compulsory modules and according to the chosen Internship, there is a remaining number of 6-11 CR for the Complementary Modules.

Please make sure that this number is exactly met or exceeded once. Excess modules will be moved to the Interdisciplinary Subject.

Mandatory		
M-MACH-105292	Novel Actuators and Sensors	4 CR
M-ETIT-100394	Practical Aspects of Electrical Drives	4 CR
M-ETIT-104475	Project Management in the Development of Products for Safety-Critical Applications	4 CR
M-MACH-105107	Machine Tools and Industrial Handling	8 CR
Internships (Election: 1 item)		
M-MACH-102705	Appliance and Power Tool Design	12 CR
M-MACH-102699	Laboratory Mechatronics	4 CR
M-MACH-102711	Production Techniques Laboratory	4 CR
M-MACH-105725	Seamless Engineering	9 CR
M-MACH-105475	Virtual Engineering Lab	4 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Complementary Modules (Election:)		
M-ETIT-106953	Cyber-Physical Modeling neu	6 CR
M-MACH-105612	Dynamics of Electro-Mechanical Systems	5 CR
M-ETIT-103264	Information Fusion	4 CR
M-MACH-102696	Lightweight Engineering Design	4 CR
M-MACH-105968	Artificial Intelligence in Production	8 CR
M-MACH-102694	Machine Dynamics	5 CR
M-MACH-105332	Quality Management	4 CR
M-ETIT-105915	Control of Power-Electronic Systems	6 CR
M-MACH-106662	Re:Invent - Revolutionary Business Models as the Basis for Product Innovations	4 CR
M-MACH-106468	Control of Mobile Machines	4 CR
M-MACH-105318	Technical Design in Product Development	4 CR
M-INFO-100789	Ubiquitous Computing	5 CR
M-MACH-101283	Virtual Engineering A	9 CR

4.4 Interdisciplinary Subject

Credits
17

Election notes

The modules can be freely chosen by the students from the modules listed below. Other courses of the Master's degree programs in Electrical Engineering and Information Technology, Mechanical Engineering, or Informatics/Computer Science can be chosen after application at the Program Service Master. The chosen modules should fit thematically to the Field of Specialization and at most one practical course and one seminar should be chosen.

Particularly in the case of courses offered by the KIT Department of Informatics, the consent of the lecturer(s) must be obtained before a module is included in the Interdisciplinary Subject. In the process, it must also be clarified whether the students have the necessary subjectspecific prerequisites for the selected module. This matching is the responsibility of the student.

Interdisciplinary Subject (Election: at least 1 item as well as between 17 and 47 credits)		
M-ETIT-106815	Advanced Communications Engineering *First usage possible from Oct 01, 2025.*	6 CR
M-MACH-105485	Current Topics on BioMEMS	4 CR
M-ETIT-100444	Applied Information Theory	6 CR
M-ETIT-106956	Antennas and Beamforming neu *First usage possible from Oct 01, 2025.*	4 CR
M-ETIT-100565	Antennas and Multiple Antenna Systems *First usage possible until Sep 30, 2025.*	5 CR
M-MACH-105800	Drive Train of Mobile Machines	4 CR
M-INFO-103294	Wearable Robotic Technologies	4 CR
M-INFO-100826	Automated Visual Inspection and Image Processing	6 CR
M-MACH-103232	Rail System Technology	4 CR
M-INFO-106928	Practical Course: Mathematical and Computational Methods in Robotics and AI neu	6 CR
M-ETIT-100377	Battery and Fuel Cells Systems	3 CR
M-ETIT-100532	Batteries and Fuel Cells	5 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-ETIT-105616	Channel Coding: Algebraic Methods for Communications and Storage	3 CR
M-ETIT-100539	Communication Systems and Protocols	5 CR
M-ETIT-107136	Communications Engineering Laboratory neu	6 CR
M-MACH-105296	Computational Intelligence	4 CR
M-ETIT-106953	Cyber-Physical Modeling neu	6 CR
M-MACH-106926	Decision-Making and Motion Planning for Automated Driving neu	6 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-INFO-104460	Deep Learning and Neural Networks	6 CR
M-ETIT-100466	Analog Circuit Design	4 CR
M-ETIT-100473	Digital Circuit Design	4 CR
M-ETIT-102266	Digital Hardware Design Laboratory	6 CR
M-ETIT-106040	Digital Twin Engineering	4 CR
M-ETIT-105415	Digital Beam-Forming for Imaging Radar	4 CR
M-MACH-106513	Railway System Digitalisation	4 CR
M-MACH-105476	Digitalization of Products, Services & Production	4 CR
M-MACH-102700	Dynamics of the Automotive Drive Train	4 CR
M-MACH-105612	Dynamics of Electro-Mechanical Systems	5 CR
M-ETIT-105916	Real Time Control of Electrical Drives	6 CR
M-WIWI-100498	Introduction into Energy Economics	5 CR
M-ETIT-107138	Electric Drives and Power Electronics Lab neu	6 CR
M-ETIT-105394	Electric Power Transmission & Grid Control	6 CR
M-ETIT-107137	Electrical Energy Systems Lab neu	6 CR
M-ETIT-100572	Power Network	5 CR
M-MACH-102688	Elements of Technical Logistics	4 CR
M-MACH-105015	Elements of Technical Logistics incl. Project	6 CR
M-ETIT-100413	Power Systems and Economy	3 CR
M-MACH-107020	Development of Automated Production Systems neu	4 CR
M-ETIT-100515	Design of Electrical Machines	5 CR
M-MACH-102702	Organ Support Systems	4 CR

M-MACH-105288	Handling Characteristics of Motor Vehicles I	4 CR
M-MACH-102703	Vehicle Lightweight Design - Strategies, Concepts, Materials	4 CR
M-MACH-102693	Automotive Vision	6 CR
M-MACH-106515	Vehicle Systems for Urban Mobility	4 CR
M-MACH-105478	Fabrication Processes in Microsystem Technology	4 CR
M-ETIT-100566	Field Propagation and Coherence	4 CR
M-INFO-106299	Advanced Artificial Intelligence	6 CR
M-INFO-100725	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	3 CR
M-MACH-102705	Appliance and Power Tool Design	12 CR
M-MACH-102690	Fundamentals of Energy Technology	8 CR
M-MACH-100501	Automotive Engineering I	8 CR
M-MACH-100502	Automotive Engineering II	4 CR
M-MACH-102720	Principles of Medicine for Engineers	4 CR
M-MACH-102691	Introduction to Microsystem Technology I	4 CR
M-MACH-102706	Introduction to Microsystem Technology II	4 CR
M-MACH-105302	Basics of Technical Logistics II	6 CR
M-MACH-102707	Fundamentals of Combustion I	4 CR
M-MACH-105824	Fundamentals in the Development of Commercial Vehicles	4 CR
M-MACH-105289	Principles of Whole Vehicle Engineering I	2 CR
M-MACH-105290	Principles of Whole Vehicle Engineering II	2 CR
M-ETIT-100449	Hardware Modeling and Simulation	4 CR
M-ETIT-106963	Hardware Synthesis and Optimization neu	6 CR
M-ETIT-100453	Hardware/Software Co-Design	4 CR
M-ETIT-100417	High-Voltage Test Technique	4 CR
M-ETIT-105060	High-Voltage Technology	6 CR
M-MACH-106830	Industrial Mobile Robotics Lab neu	4 CR
M-ETIT-103264	Information Fusion	4 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-ETIT-100457	Integrated Intelligent Sensors	3 CR
M-ETIT-100474	Integrated Systems and Circuits	4 CR
M-MACH-105109	International Production Engineering	8 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-106744	Cognitive Automobiles - Laboratory	6 CR
M-MACH-102712	Design with Plastics	4 CR
M-MACH-102696	Lightweight Engineering Design	4 CR
M-MACH-105180	Continuum Mechanics	5 CR
M-MACH-102695	Motor Vehicle Laboratory	4 CR
M-MACH-105968	Artificial Intelligence in Production	8 CR
M-ETIT-105467	Control Theory Laboratory	6 CR
M-ETIT-107159	Laboratory Information Systems in Power Engineering neu	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-ETIT-100485	Lighting Engineering	4 CR
M-MACH-105298	Logistics and Supply Chain Management	9 CR
M-INFO-100840	Localization of Mobile Agents	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-MACH-101923	Machine Vision	8 CR
M-INFO-105778	Machine Learning - Foundations and Algorithms	6 CR
M-WIWI-105003	Machine Learning 1	5 CR
M-WIWI-105006	Machine Learning 2	5 CR
M-MACH-102694	Machine Dynamics	5 CR
M-MACH-104984	Material Flow in Logistic Systems	9 CR
M-MACH-107185	Mechanical Properties of Nanomaterials and Microsystems neu	4 CR
M-MACH-102699	Laboratory Mechatronics	4 CR
M-ETIT-106672	Medical Image Processing for Guidance and Navigation	9 CR
M-ETIT-106670	Medical Imaging Technology II *First usage possible between Apr 01, 2024 and Sep 30, 2025.*	3 CR
M-ETIT-106779	Medical Measurement Technology Lab neu *First usage possible from Oct 01, 2025.*	9 CR
M-MACH-102714	Microenergy Technologies	4 CR
M-ETIT-106973	Microwave Engineering Lab neu	6 CR
M-MACH-100487	Microactuators	4 CR
M-MACH-105486	Micro System Simulation	4 CR
M-ETIT-100454	Microsystem Technology	3 CR
M-ETIT-100424	Microwaves Measurement Techniques	4 CR
M-ETIT-100535	Microwave Engineering *First usage possible until Sep 30, 2025.*	5 CR
M-ETIT-100427	Modern Radio Systems Engineering	6 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-INFO-102555	Motion in Human and Machine - Seminar	3 CR
M-INFO-100825	Pattern Recognition	6 CR
M-ETIT-105274	Communications Engineering II *First usage possible between Apr 01, 2020 and Sep 30, 2025.*	4 CR
M-ETIT-105604	Nano- and Quantum Electronics	6 CR
M-MACH-105292	Novel Actuators and Sensors	4 CR
M-ETIT-100371	Nonlinear Control Systems	3 CR
M-ETIT-100430	Nonlinear Optics	6 CR
M-ETIT-100464	Optical Design Lab	6 CR
M-ETIT-100436	Optical Transmitters and Receivers	6 CR
M-ETIT-100506	Optical Waveguides and Fibers	4 CR
M-ETIT-102310	Optimal Control and Estimation	3 CR
M-ETIT-100531	Optimization of Dynamic Systems	5 CR
M-ETIT-100480	Optoelectronics *First usage possible until Sep 30, 2025.*	4 CR
M-ETIT-100484	Optoelectronic Measurement Engineering	3 CR
M-ETIT-100513	Photovoltaics	6 CR
M-ETIT-105874	Physiology and Anatomy for Biomedical Engineering *First usage possible between Oct 01, 2022 and Sep 30, 2025.*	6 CR
M-ETIT-100481	Plasma Sources	4 CR
M-ETIT-100475	Plastic Electronics / Polymerelectronics	3 CR
M-ETIT-104567	Power Electronics	6 CR
M-INFO-105955	Practical Course: Smart Energy System	6 CR
M-ETIT-106780	Practical Tools for Control Engineers	4 CR
M-ETIT-100381	Batteries and Fuel Cells Laboratory	6 CR

M-ETIT-100389	Laboratory Biomedical Engineering *First usage possible until Sep 30, 2025.*	6 CR
M-ETIT-102264	Digital Hardware Design Laboratory	6 CR
M-ETIT-103448	Laboratory Mechatronic Measurement Systems	6 CR
M-ETIT-100468	Lab Course on Nanoelectronics	6 CR
M-ETIT-100478	Laboratory Nanotechnology	6 CR
M-ETIT-100437	Optical Communicatons Laboratory	6 CR
M-ETIT-100477	Laboratory Optoelectronics	6 CR
M-MACH-105291	Lab Computer-Aided Methods for Measurement and Control	4 CR
M-ETIT-100470	Laboratory FPGA Based Circuit Design	6 CR
M-ETIT-102350	Laboratory Solar Energy	6 CR
M-ETIT-100451	System-on-Chip Laboratory	6 CR
M-MACH-105479	Practical Training in Basics of Microsystem Technology	4 CR
M-ETIT-106673	Practical Machine Learning	6 CR
M-ETIT-100394	Practical Aspects of Electrical Drives	4 CR
M-MACH-102718	Product Development – Methods of Product Engineering	6 CR
M-MACH-102711	Production Techniques Laboratory	4 CR
M-ETIT-104475	Project Management in the Development of Products for Safety-Critical Applications	4 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-INFO-105958	Practical Course: Machine Learning and Intelligent Systems	8 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-ETIT-105915	Control of Power-Electronic Systems	6 CR
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-WIWI-100500	Renewable Energy-Resources, Technologies and Economics	4 CR
M-INFO-102522	Robotics - Practical Course	6 CR
M-INFO-100893	Robotics I - Introduction to Robotics *First usage possible until Sep 30, 2025.*	6 CR
M-INFO-102756	Robotics II - Humanoid Robotics	3 CR
M-INFO-104897	Robotics III - Sensors and Perception in Robotics	3 CR
M-ETIT-100399	Industrial Circuitry	3 CR
M-MACH-102683	Rail Vehicle Technology	4 CR
M-MACH-102626	Major Field: Integrated Product Development	18 CR
M-MACH-105725	Seamless Engineering	9 CR
M-MACH-105477	Seminar Data-Mining in Production	3 CR
M-ETIT-100455	Seminar Embedded Systems	4 CR
M-MACH-104197	Seminar for Rail System Technology	3 CR
M-ETIT-103447	Seminar Novel Concepts for Solar Energy Harvesting	3 CR
M-INFO-106927	Seminar: Exoskelette & Motion Capture neu	3 CR
M-ETIT-100378	Sensors	3 CR
M-ETIT-106633	Signal Processing Lab	6 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 neu	6 CR
M-ETIT-100450	Software Engineering	3 CR
M-ETIT-100439	Software Radio	3 CR
M-ETIT-100524	Solar Energy	6 CR
M-ETIT-103042	Spaceborne Radar Remote Sensing	6 CR

M-MACH-106468	Control of Mobile Machines	4 CR
M-MACH-105348	Control Technology	4 CR
M-INFO-100829	Stochastic Information Processing	6 CR
M-ETIT-105073	Student Innovation Lab	15 CR
M-ETIT-106684	Superconducting Magnet Technology	4 CR
M-ETIT-106683	Superconducting Power Systems	4 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-ETIT-100537	Systems and Software Engineering	5 CR
M-ETIT-100538	Technical Optics	5 CR
M-MACH-105318	Technical Design in Product Development	4 CR
M-MACH-102388	Thermal Solar Energy	4 CR
M-INFO-100839	Fuzzy Sets	6 CR
M-MACH-107013	Vehicle Lightweight Design - Strategies, Concepts, Materials neu *First usage possible between Apr 01, 2025 and Apr 01, 2025.*	4 CR
M-ETIT-100361	Distributed Discrete Event Systems	4 CR
M-MACH-101283	Virtual Engineering A	9 CR
M-MACH-105475	Virtual Engineering Lab	4 CR
M-MACH-105293	Virtual Engineering 1	4 CR
M-MACH-102717	Heat and Mass Transfer	4 CR
M-MACH-102727	Materials for Lightweight Construction	4 CR
M-MACH-105107	Machine Tools and Industrial Handling	8 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
M-ETIT-106971	Electric Drives for E-Mobility neu	4 CR

4.5 Interdisciplinary Qualifications

Credits
6

Mandatory		
M-MACH-102755	Engineer's Field of Work	2 CR
Compulsory Elective Modules (Election: at least 4 credits)		
M-ETIT-103248	Key Competences	4 CR

4.6 Additional Examinations

Additional Examinations (Election: at most 30 credits)		
M-INFO-103294	Wearable Robotic Technologies	4 CR
M-INFO-100826	Automated Visual Inspection and Image Processing	6 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-105296	Computational Intelligence	4 CR
M-MACH-102700	Dynamics of the Automotive Drive Train	4 CR
M-MACH-105612	Dynamics of Electro-Mechanical Systems	5 CR
M-ETIT-105916	Real Time Control of Electrical Drives	6 CR
M-MACH-105015	Elements of Technical Logistics incl. Project	6 CR
M-MACH-102688	Elements of Technical Logistics	4 CR
M-ETIT-100413	Power Systems and Economy	3 CR
M-MACH-102702	Organ Support Systems	4 CR
M-MACH-105288	Handling Characteristics of Motor Vehicles I	4 CR
M-MACH-102690	Fundamentals of Energy Technology	8 CR
M-MACH-100501	Automotive Engineering I	8 CR
M-MACH-100502	Automotive Engineering II	4 CR
M-MACH-102720	Principles of Medicine for Engineers	4 CR
M-MACH-102691	Introduction to Microsystem Technology I	4 CR
M-MACH-102706	Introduction to Microsystem Technology II	4 CR
M-MACH-105824	Fundamentals in the Development of Commercial Vehicles	4 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-105302	Basics of Technical Logistics II	6 CR
M-ETIT-100367	Information Technology in Industrial Automation Systems	3 CR
M-MACH-105281	Information Systems and Supply Chain Management	3 CR
M-MACH-105282	IT-Fundamentals of Logistics: Opportunities for Digital Transformation	4 CR
M-MACH-104984	Material Flow in Logistic Systems	9 CR
M-MACH-102714	Microenergy Technologies	4 CR
M-MACH-100487	Microactuators	4 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-MACH-105292	Novel Actuators and Sensors	4 CR
M-ETIT-100513	Photovoltaics	6 CR
M-MACH-105291	Lab Computer-Aided Methods for Measurement and Control	4 CR
M-ETIT-104475	Project Management in the Development of Products for Safety-Critical Applications	4 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-105332	Quality Management	4 CR
M-MACH-105315	System Integration in Micro- and Nanotechnology	4 CR
M-MACH-105318	Technical Design in Product Development	4 CR
M-MACH-102388	Thermal Solar Energy	4 CR
M-MACH-102717	Heat and Mass Transfer	4 CR
M-MACH-105293	Virtual Engineering 1	4 CR
M-FORUM-106753	Supplementary Studies on Science, Technology and Society	16 CR
M-ETIT-107138	Electric Drives and Power Electronics Lab neu	6 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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7 Modules

M 7.1 Module: Advanced Artificial Intelligence [M-INFO-106299]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (mandatory)
Interdisciplinary Subject

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

Mandatory			
T-INFO-112768	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

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

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject (Usage from 10/1/2025)

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

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

Responsible: Prof. Dr. Ivan Peric
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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.

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

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

Part of: Interdisciplinary Subject (Usage from 10/1/2025)

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 7.5 Module: Antennas and Multiple Antenna Systems [M-ETIT-100565]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject (Usage until 9/30/2025)

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

Mandatory			
T-ETIT-106491	Antennas and Multiple Antenna Systems	5 CR	Zwick

Competence Certificate
The success control takes place within the framework of an oral overall examination (20 minutes).

Prerequisites
none

Competence Goal
The students have in-depth knowledge of antennas and antenna systems. This includes functionality, calculation methods but also aspects of practical implementation. You will be able to understand how any antenna works and to develop and dimension antennas with specified properties.

Content
The lecture teaches the basics of field theory as well as the functioning of all essential antenna structures. The functionality of antenna arrays is also visualized using Matlab exercises. Furthermore, antenna measurement methods are taught, as well as an insight into modern antenna and multi-antenna systems. In addition, a practice-oriented workshop on computer-aided design and simulation of antennas is carried out, in which the students learn to use the software tool CST and thus carry out antenna design tasks independently. Individual antennas are then set up and measured so that the students get to know the entire process.

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

Annotation
In winter term 2024/25, the associated lecture will be offered for the last time.

- **BSc: Successor module from summer term 2026: M-ETIT-106962 - Antennen**
- **MSc: Successor module from winter term 2025/26: M-ETIT-106956 - Antennas and Beamforming**

Workload
The workload includes:

Attendance study time lecture / exercise: 30 h

Attendance study time computer exercise CST / MATLAB: 30h

Self-study time including exam preparation: 90 h

A total of 150 h = 5 LP

M 7.6 Module: Appliance and Power Tool Design [M-MACH-102705]

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

Part of: Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Internships)
Interdisciplinary Subject

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

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

Competence Certificate
Approx. 30 min oral examination.

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

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

Competence Goal
The students are able to ...

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

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

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

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

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

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

Annotation

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

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

Workload

Lecture Appliance and Power Tool Design: 60 h

Appliance and Power Tool Design Project Work: 180 h

Recommendation

None

Learning type

Lecture, exercise, project work

M 7.7 Module: Applied Information Theory [M-ETIT-100444]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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 7.8 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 / Field of Specialization: Industrial Automation (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject

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

7.9 Module: Automated Visual Inspection and Image Processing [M-INFO-100826]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

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

Part of: Field of Specialization / Field of Specialization: Automotive Engineering (mandatory)
Interdisciplinary Subject
Additional Examinations

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'

7.11 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 / Field of Specialization: Automotive Engineering (mandatory)
Interdisciplinary Subject
Additional Examinations

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'

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

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

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject

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

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

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

Part of: Interdisciplinary Subject
Additional Examinations

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 7.14 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 / Field of Specialization: Automotive Engineering (mandatory)
Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject

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

7.15 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 / Field of Specialization: Automotive Engineering (Internships)
Interdisciplinary Subject

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 7.16 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject

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

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

Responsible: Dr.-Ing. Axel Loewe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

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

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

Part of: Field of Specialization / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject

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 7.19 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 / Field of Specialization: Microsystems Technology (mandatory)
Interdisciplinary Subject
Additional Examinations

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

7.20 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 / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

M 7.21 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 / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

7.22 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 / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject

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

M 7.23 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: Interdisciplinary Subject

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 7.24 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 / Field of Specialization: Control Engineering in Mechatronics (Internships)
Interdisciplinary Subject

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 7.25 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: Interdisciplinary Subject

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 7.26 Module: Communications Engineering II [M-ETIT-105274]

Responsible: Dr.-Ing. Holger Jäkel
Prof. Dr.-Ing. Laurent Schmalen

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Interdisciplinary Subject (Usage between 4/1/2020 and 9/30/2025)

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

Mandatory			
T-ETIT-110697	Communications Engineering II	4 CR	Jäkel, Schmalen

Competence Certificate
The assessment will be carried out in the form of a written exam of 120 minutes.

Prerequisites
none

Competence Goal
The students are able to analyze even more complex problems in communications engineering. You can independently develop and validate solutions and use problem-solving software. The transfer of the learned methods enables the students to quickly grasp other topics and to work on them with the appropriate methodological knowledge.

Content
The course broadens the questions dealt with in the lecture Communication Engineering I. The focus here is on the detailed analysis of known algorithms and the introduction of new methods that were not discussed in the lecture Communications Engineering I, especially in the areas of system and channel modeling, equalization and synchronization.

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

Annotation
Please note: The course "Nachrichtentechnik II" (in German) takes place every summer semester and the English version "Communications Engineering II" takes place every winter semester.

In the future, the module will be divided into an English Master's course (from winter term 25/26: Avanced Communications Engineering) and a German Bachelor's course (from summer term 2025: Nachrichtensysteme II). Both will comprise 6 CP each.

The old examination format can be taken for the last time in the first attempt in summer term 2025. The last second attempts in WiSe 25/26.

Workload
1. Attendance Lecture: 15 * 2 h = 30 h

2. Preparation / Postprocessing Lecture: 15 * 4 h = 60 h

3. Presence Exercise: 15 * 1 h = 15 h

4. Preparation / follow-up Exercise: 15 * 2 h = 30 h

5. Exam preparation and presence in the same: charged in preparation / follow-up

Total: 135 h = 4 LP

Recommendation
Knowledge of basic engineering mathematics including integral transformations and probability theory as well as basic knowledge of communications engineering.

Previous visit to the lecture "Communications Engineering I", "Probability Theory" and "Signals and Systems" is recommended.

M 7.27 Module: Communications Engineering Laboratory [M-ETIT-107136]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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".

M 7.28 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 / Field of Specialization: Industrial Automation (mandatory)
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

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

Organisation:

Part of: Interdisciplinary Subject

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

7.30 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: General Mechatronics
Interdisciplinary Subject

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.

7.31 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 / Field of Specialization: Industrial Automation (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject

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

7.32 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 / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject

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

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

Prerequisites
none

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

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

Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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

7.34 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 / Field of Specialization: Control Engineering in Mechatronics (Internships)
Interdisciplinary Subject

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

Responsible: Prof. Dr. Andreas Guber

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject

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 7.36 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 / Field of Specialization: Industrial Automation (Complementary Modules)
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject

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 7.37 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject

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.

M 7.38 Module: Deep Learning and Neural Networks [M-INFO-104460]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject

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

Mandatory			
T-INFO-109124	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.

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

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject

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 7.40 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: Interdisciplinary Subject

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 7.41 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject

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

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

Part of: Interdisciplinary Subject

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

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

Part of: Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
Interdisciplinary Subject

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.

7.44 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: Interdisciplinary Subject

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.

M 7.45 Module: Digital Circuit Design [M-ETIT-100473]

Responsible: Prof. Dr. Ivan Peric
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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.

M 7.46 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: Interdisciplinary Subject

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.

7.47 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: Interdisciplinary Subject

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.

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

Responsible: Prof. Dr.-Ing. Mike Barth
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

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

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

Part of: Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
Interdisciplinary Subject

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 7.50 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 / Field of Specialization: Control Engineering in Mechatronics (mandatory)
Interdisciplinary Subject

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 7.51 Module: Drive Train of Mobile Machines [M-MACH-105800]

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

Part of: Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject

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.

7.52 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 / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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 7.53 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

M 7.54 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 / Field of Specialization: Power Engineering (Internships)
Interdisciplinary Subject
Additional Examinations

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.

M 7.55 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: Interdisciplinary Subject

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 7.56 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 / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject

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

M 7.57 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: Field of Specialization / Field of Specialization: Power Engineering (Internships)
Interdisciplinary Subject

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

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

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

Part of: Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

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

Part of: Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

7.60 Module: Energy Informatics [M-INFO-106864]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)

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

Mandatory			
T-INFO-103582	Energy Informatics 1	5 CR	Hagenmeyer
T-INFO-110356	Energy Informatics 1 - Preliminary Work	0 CR	Hagenmeyer
T-INFO-106059	Energy Informatics 2	5 CR	Hagenmeyer

M 7.61 Module: Engineering Mechanics [M-MACH-103205]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Prof. Dr.-Ing. Wolfgang Seemann

Organisation: KIT Department of Mechanical Engineering

Part of: General Mechatronics

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

Mechanical Engineering (Election: between 5 and 6 credits)			
T-MACH-105209	Introduction to Multi-Body Dynamics	5 CR	Fidlin
T-MACH-105274	Engineering Mechanics IV	5 CR	Proppe
T-MACH-112987	Computational Continuum Mechanics	4 CR	Böhlke
T-MACH-112996	Tutorial Computational Continuum Mechanics *This item will not influence the grade calculation of this parent.*	1 CR	Böhlke

Competence Certificate
A performance assessment in the bricks to be chosen is obligatory and can be an oral or a written exam. For details see eligible bricks

Prerequisites
none

Competence Goal
Introduction to multi-body dynamics: After completing this module, graduates will be able to describe the kinematics of a rigid body using rotational matrices, angular velocities and corresponding derivatives in various reference systems. They can specify holonomic and non-holonomic constraints for closed kinematic chains. In addition, the graduates can derive Newton-Euler's and ie Lagrangian equations and apply the principle of d'Alembert and the principle of virtual power. Finally, they can analyze the structure of the equations of motion.

Engineering Mechanics IV: The graduates can study the kinematics for movements of points and systems. Based on Newton-Euler's axioms they can derive the equations of motion. In addition to classical synthetic methods, graduates can efficiently apply analytical methods with energy expressions as a starting point.

Mathematical methods of continuum mechanics: After completing the module, graduates can perform the essential operations of tensor algebra and tensor analysis for both second and higher-level tensors, in oblique and curvilinear coordinate systems. They can then apply these operations in the description of infinitesimal and finite deformations of continuum mechanical systems. In addition, graduates can specify the transport theorem and balance equations for continuum mechanical systems and use material equations.

Content
Contents of "Introduction to Multi-Body Dynamics": The role of multibody systems in engineering, kinematics of a single rigid body, Kinematics of multibody systems, rotation matrix, angular velocity, derivatives in different reference systems, holonomic and non-holonomic constraints, Newton-Euler's equations, principle of d'Alembert, principle of virtual power, Lagrange's equations, Kane's equations, structure of the equations of motion

Contents of "Engineering Mechanics IV": Spatial kinematics of a rigid body, Euler angles, angular velocity using Euler angles, Euler's equations, inertia tensor, kinetic energy of a rigid body, free gyroscopes, forced gyroscopes, systems of rigid bodies, principle of d'Alembert, Lagrange's equations of the first and second kind, generalized coordinates, free and forced vibration of one degree of freedom systems, frequency response, vibration of multi degree of freedom systems, vibration absorption

Contents of "Mathematical Methods of Continuum Mechanics": Tensor algebra: vectors; Basis transformation; dyadic product; Tensors of second order and their properties, eigenvalue problems, Theorem of Cayley-Hamilton, invariants; Tensors of higher order, tensor analysis: tensor algebra and analysis in oblique coordinate systems, differentiation of tensor-valued functions. Application of tensor calculus in Continuum Mechanics: kinematics of infinitesimal and finite deformations, transport theorem, balance equations, stress tensor, constitutive equations, intial boundary value problems

Workload

Introduction to Multi-Body Dynamics: presence lecture: 15 * 2 h = 30 h, preparation and recap: 15 * 2 h = 30 h, exam preparation and presence during exam: 90 h

Eineering Mechanics IV: presence lecture and tutorial: 15 * 2 h + 15 * 2 h = 60 h, preparation and recap lecture and tutorial: 15 * 2 h + 15 * 2 h = 60 h, exam preparation and presence during exam: 30 h

Mathematical methods of continuum mechanics: presence lecture and tutorial: 15 * 2 h + 8 * 2 h = 46 h, preparation and recap lecture and tutorial: 15 * 2 h + 8 * 2 h = 46 h, exam preparation and presence during exam: 58 h

Learning type

Lecture, Tutorials, Lab Course, Consultation hours

M 7.62 Module: Engineer's Field of Work [M-MACH-102755]

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

Organisation: KIT Department of Mechanical Engineering

Part of: Interdisciplinary Qualifications (mandatory)

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

Mandatory			
T-MACH-105721	Engineer's Field of Work	2 CR	Doppelbauer, Geimer

Competence Certificate
written test

Duration 60 minutes

result: passed / not passed

No tools or reference materials may be used during the exam.

Prerequisites
none

Competence Goal

- The students know the characteristics of an industriell working environment.
- They understand the effectiveness of typical structures in companies and the intention of the most relevant business processes.
- They can judge the impact of regulatory framework on their daily work.

Content

1. **Organization of Companies**
organizational structure, organizational units, managerial structure, organization charts, project organization, relation between superior and staff, board of managing directors, management of the company, supervisory board, advisory board
2. **Project Management**
definition of project, project manager, project team, primary processes, supporting processes
3. **Personnel Development**
applications, trainee programs, management career, professional career, career paths in companies, individual career planning, tasks of HR, manpower requirements planning, training, training-on-the-job, tools for human resource management, annual personnel talk, objective agreement
4. **Scheduling**
Methods for detailed scheduling, network plans, critical path, Gantt-diagram, milestones
5. **Development Processes**
research, advance development, series development, product marketing, V-model, SPALTEN-model, technical specifications, requirement specifications, clarification, concept, draft, elaboration, validation, verification, documentation, FMEA
6. **Standards and Laws**
importance of standards, German and international standardization systems, committees, certification
7. **Commercial Law**
health protection, safety at work, environment protection, product liability, patents
8. **Calculation, Financial Statement**
contract award estimate, project costing, unit cost, target costs, cost center accounting, cost recording, hourly rates, asset accounting, profit and loss statement
9. **Governance**
principles of governance (accountability, responsibility, transparency, fairness), leadership (technical, commercial), reviews, boards, audits, codetermination, compliance

Workload
Regular attendance: 15 hours

Self-study: 15 hours

Test and preparation: 30 hours

total: 60 hours = 2 ECTS

Learning type
Lecture

M 7.63 Module: Fabrication Processes in Microsystem Technology [M-MACH-105478]

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

Part of: Field of Specialization / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject

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

Responsible: Prof. Dr. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

7.65 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

M 7.66 Module: Fundamentals of Combustion I [M-MACH-102707]

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

Part of: Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject

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

7.67 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 / Field of Specialization: Power Engineering (mandatory)
Interdisciplinary Subject
Additional Examinations

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 7.68 Module: Fuzzy Sets [M-INFO-100839]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject

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

Mandatory			
T-INFO-101376	Fuzzy Sets	6 CR	Hanebeck

Competence Goal

- Students should learn how to represent and process fuzzy knowledge in computer systems. They should be able to describe complex systems using fuzzy sets on the basis of natural language rules and knowledge.
- In addition to calculating with fuzzy numbers and logical operations, a comprehensive overview of the application of rules to fuzzy sets will be provided.

Content

This module teaches the theory and practical application of fuzzy sets. The course covers the areas of fuzzy arithmetic, fuzzy logic, fuzzy relations and fuzzy reasoning. The representation and properties of fuzzy sets form the theoretical basis on which arithmetic and logical operations are axiomatically derived and examined. It is also shown how arbitrary mappings and relations can be transferred to fuzzy sets. Fuzzy reasoning as an application of the logic part shows various possibilities of implementing rule-based systems on fuzzy sets. The final part of the lecture looks at fuzzy control as an application.

7.69 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

7.70 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: Interdisciplinary Subject

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

7.71 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: Interdisciplinary Subject

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.

7.72 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 / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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.

7.73 Module: Heat and Mass Transfer [M-MACH-102717]

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

Part of: Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

7.74 Module: High-Voltage Technology [M-ETIT-105060]

Responsible: Dr.-Ing. Rainer Badent
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

M 7.75 Module: High-Voltage Test Technique [M-ETIT-100417]

Responsible: Dr.-Ing. Rainer Badent
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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 7.76 Module: Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy [M-INFO-100725]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject

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 7.77 Module: Humanoid Robotics Laboratory [M-INFO-105792]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Internships)

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

Mandatory			
T-INFO-111590	Humanoid Robotics Laboratory	6 CR	Asfour

Competence Goal

- Students will be able to independently understand, structure, analyze, and solve a complex humanoid robotics problem using existing programming skills, alone or in a small team.
- Students can convey complex technical content in a presentation.

Content

In this practical course, a is worked on alone or in small teams with up to 3 students. Questions of humanoid robotics are dealt with, such as semantic scene interpretation, active perception, planning of grasping and manipulation tasks, action representation with motion primitives, and programming by demonstration.

The project work (alone or in groups) is performed largely independently but supported by scientific staff of the H2T. At the end of the practical course, the work has to be documented and presented in a scientific talk.

Annotation

- Internship dates are always by arrangement with the supervising staff member.
- An extension work of the topic as a master thesis is possible in principle.
- The number of participants in this practical course is generally **limited** and varies with the number of available research projects at the institute.

Workload

Practical course with 4 SWS, 6 LP.
6 LP corresponds to ca. 180 hours, thereof
ca. 10h Attendance time in project discussion meetings
ca. 10h Preparation and follow-up of the above
ca. 150h Self-study to work on the topic
ca. 10h Preparation and giving of a scientific presentation

Recommendation

- Very good programming skills in at least one high-level programming language are strongly recommended.
- Attendance of the lectures Robotics 1, Robotics 2, Robotics 3, as well as the robotics practical course are recommended.
- Project-specific recommendations (knowledge of C++, Python, ...) will be announced in the individual project descriptions

7.78 Module: Humanoid Robots - Locomotion and Whole-Body Control [M-INFO-106649]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)

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

Mandatory			
T-INFO-113395	Humanoid Robots - Locomotion and Whole-Body Control	6 CR	Mombaur
T-INFO-114282	Humanoid Robots - Locomotion and Whole-Body Control -Pass	0 CR	Mombaur

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
By the end of the course, students will be able to:
- Develop kinematic and dynamic models of humanoid robots
- Understand basic principles of human whole-body movement
- Control gaits and other whole-body motions for humanoid robots and maintain balance
- Explain advanced methods for humanoid motion generation, optimization, and learning
- Give an overview of the state of the art in locomotion and whole-body control of humanoid robotics
- Complete a graduate level research project on humanoid robots including simulation and real-robot implementation

Content
This course introduces fundamentals and recent developments in the field of humanoid robotics with a focus on locomotion and whole-body motions. We will cover kinematic and dynamic modeling of anthropomorphic systems, basic concepts of bipedal walking control, stability aspects, gait generation in different terrains, humanoid balance and push recovery, motion primitives and optimal control-based approaches, motion imitation and learning. The course will also give some insights in basic principles of passive dynamic walking, human motion generation and control and human motion modeling. Students will work with different robotics tools and perform a graduate level research project related to a whole-body humanoid robot.
This module is complementary to the course “4.290 Robotik II - Humanoide Robotik” which focuses on upper body motions and cognitive architectures while this course focuses on the specific aspects of legged humanoids and whole-body motions. The modules can be taken at the same time.

Annotation
Limitation to 30 participants

Workload
Estimated effort for this module is 180 hours:
60h - Lecture and exercises (2+2 SWS)
40h - Repetition of lecture contents, preparation of assignments
80h – Work on final project, documentation and presentation

Recommendation
Attendance of the lectures Robotics I - Introduction to Robotics and Mechano-Informatics in Robotics is required.

7.79 Module: Humanoid Robots - Seminar [M-INFO-102561]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)

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

Mandatory			
T-INFO-105144	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.

7.80 Module: Industrial Circuitry [M-ETIT-100399]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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.

7.81 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 / Field of Specialization: Industrial Automation (Internships)
Interdisciplinary Subject

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 7.82 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 / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject

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 7.83 Module: Information Systems and Supply Chain Management [M-MACH-105281]

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

Part of: Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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 7.84 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 / Field of Specialization: Industrial Automation (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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 7.85 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject

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 7.86 Module: Innovative Concepts for Programming Industrial Robots [M-INFO-100791]

Responsible: Prof. Dr.-Ing. Björn Hein
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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 7.87 Module: Integrated Intelligent Sensors [M-ETIT-100457]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

7.88 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 / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject

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

7.89 Module: International Production Engineering [M-MACH-105109]

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

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 7.90 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 / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject

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.

7.91 Module: Introduction to Bionics [M-MACH-106525]

Responsible: apl. Prof. Dr. Hendrik Hölscher
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)

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 attendence 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.

7.92 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 / Field of Specialization: Microsystems Technology (mandatory)
Interdisciplinary Subject
Additional Examinations

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

M 7.93 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 / Field of Specialization: Microsystems Technology (mandatory)
Interdisciplinary Subject
Additional Examinations

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

M 7.94 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 / Field of Specialization: Industrial Automation (Complementary Modules)
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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.

7.95 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 / Field of Specialization: Industrial Automation (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

7.96 Module: Key Competences [M-ETIT-103248]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Qualifications (Compulsory Elective Modules)

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

Election notes
For self assignment of taken interdisciplinary qualifications of HoC, FORUM or SPZ the courses ('Teilleistungen') with the title 'Self Assignment-HOC-SPZ-FORUM-...' 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.

Elective Key Competences (Election: at least 1 item as well as at least 4 credits)			
T-MACH-105721	Engineer's Field of Work	2 CR	Doppelbauer, Geimer
T-ETIT-111316	Introduction to the Scientific Method (Seminar, German)	1 CR	Nahm
T-MACH-106460	Leadership in Interdisciplinary Teams	4 CR	Matthiesen
T-WIWI-100796	Industrial Business Administration	3 CR	Fichtner
T-MACH-105442	Intellectual Property Rights and Strategies in Industrial Companies	4 CR	Zacharias
T-MACH-106738	ProVIL - Product Development in a Virtual Idea Laboratory	4 CR	Albers, Düser
T-ETIT-100814	Seminar Project Management for Engineers	3 CR	Noe
T-ETIT-108820	Seminar Project Management for Engineers	3 CR	Day, Noe
T-ETIT-111369	Strategy Derivation for Engineers	3 CR	Arndt
T-ETIT-100754	Seminar Creating a Patent Specification	3 CR	Stork
T-ETIT-111923	Ethics of Technology - ARs ReflecTIonis	2 CR	Kühler
T-ETIT-100797	Educational Development for Student Teachers - Basic Level	2 CR	
T-ETIT-111526	Self Assignment-HOC-SPZ-FORUM-graded	2 CR	
T-ETIT-111527	Self Assignment-HOC-SPZ-FORUM-graded	2 CR	
T-ETIT-111528	Self Assignment-HOC-SPZ-FORUM-graded	2 CR	
T-ETIT-111530	Self Assignment-HOC-SPZ-FORUM-ungraded	2 CR	
T-ETIT-111531	Self Assignment-HOC-SPZ-FORUM-ungraded	2 CR	
T-ETIT-111532	Self Assignment-HOC-SPZ-FORUM-ungraded	2 CR	

7.97 Module: Lab Computer-Aided Methods for Measurement and Control [M-MACH-105291]

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

Organisation:

Part of: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Internships)
Field of Specialization / Field of Specialization: Robotics (Internships)
Interdisciplinary Subject
Additional Examinations

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

7.98 Module: Lab Course Electrical Drives and Power Electronics [M-ETIT-100401]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Automotive Engineering (Internships)

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

Mandatory			
T-ETIT-100718	Lab Course Electrical Drives and Power Electronics	6 CR	Doppelbauer

Prerequisites
none

M 7.99 Module: Lab Course on Nanoelectronics [M-ETIT-100468]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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.

7.100 Module: Laboratory Biomedical Engineering [M-ETIT-100389]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject (Usage until 9/30/2025)

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

Mandatory			
T-ETIT-101934	Laboratory Biomedical Engineering	6 CR	Nahm

Competence Certificate
Success is assessed in the form of a different type of examination. The examination is carried out by evaluating the written preparation and follow-up protocols for the individual attempts. The overall impression is assessed.

The experiments and protocols are always carried out or prepared in joint teamwork by a team consisting of two or, in special cases, three permanent internship participants. It must be possible to assign which participant worked on which task. The preparation protocols will be checked in advance of a practical course and an insufficient assessment will lead to exclusion from the course. We reserve the right to review individual preparation questions in an oral form at the beginning of the practical course. Attendance is compulsory for the individual internship dates. In the event of absence or exclusion from the attempt, the individual attempt will be assessed with the grade "unsatisfactory". If students are excluded twice, the internship will be assessed as "failed".

Prerequisites
Passed exam of the module "Biomedizinische Messtechnik I" or "Medical Measurement Technology".

Modeled Conditions
You have to fulfill one of 2 conditions:

1. The module M-ETIT-100387 - Biomedical Measurement Techniques I must have been passed.
2. The module M-ETIT-106679 - Medical Measurement Technology must have been passed.

Competence Goal
Graduates will be able to design and build a functioning measurement system for the real-time acquisition and

-display of the pulse wave transit time.

They can dimension, set up and test the analog circuits consisting of a measuring amplifier and filter according to specified circuit diagrams.

Graduates will be able to analyze the physiological signal characteristics and dimension the circuit on this basis.

They can design digital filters to improve signal-to-noise ratios and implement them in Matlab.

Graduates will be able to develop algorithms for parameter extraction and representation and program them in Matlab.

Graduates will be able to name, implement and demonstrate the relevant safety requirements before using the measurement system on humans.

Graduates will be able to define a measurement protocol and use it to carry out a measurement in a self-experiment in accordance with the measurement protocol, document it and interpret the results.

Content

In the practical course, a measurement system is developed in 8 sessions that takes into account the complete signal processing chain for a bioelectric signal and a plethysmographic signal in order to determine the pulse wave transit time and thus display the change in blood pressure in a trend. The dates are divided into 4 practical sessions in which the measurement system is set up and tested in terms of hardware and 3 practical sessions in which digital signal processing and algorithms are covered. A final measurement on humans is carried out on the 8th practical course date.

The following topics will be covered:

- bioelectric signal of cardiac excitation
- plethysmographic signal of the volume flow change of a pulse wave
- Signal acquisition with sensors
- Setting up a symmetrical power supply
- Dimensioning and setting up the circuit consisting of:

- Amplifier to amplify the signal

- High-pass filter and low-pass filter for analog filtering of the signal

- Analog/digital conversion
- Compliance with the electrical safety of medical products
- Modular testing of the implemented circuit for freedom from errors, functionality and effect with natural, defined modulated interference signals
- Process errors that occur due to the analogue circuit and digitalization
- Digital filtering IIR/FIR
- Development and implementation of simple real-time algorithms using Matlab for the detection and calculation of relevant parameters such as

- R-wave maxima of the recorded electrocardiogram

- Maxima of the pulse wave

- heart rate

- pulse rate

- Pulse wave transit time

- Real-time output of the parameters in Matlab
- Develop and formulate a measurement protocol to generate changes in pulse wave transit time with quantitative and qualitative expectations
- Perform measurements according to the developed measurement protocol
- Documenting, interpreting and discussing the results with the expectations from the measurement protocol

Module grade calculation

The assessment of the test protocols is included in the module grade. Further details will be provided at the beginning of the course.

Annotation

Last offer in SoSe25 (incl. mentioned prerequisites)

Thereafter:

- BSc: no replacement
- MSc: Replacement by English-language module "M-ETIT-106779 - Medical Measurement Technology Lab".

Workload

The workload includes

1. Attendance time in eight internship sessions: 8 * 7.5 h = 60 h
2. Preparation/follow-up of the internship dates: 8 * 15 h = 120 h

Total: 180 h

Recommendation

- Knowledge of physiological principles from the lecture Physiology and Anatomy

- Knowledge of the generation and measurement of bioelectric signals from the lecture Bioelectric Signals

- Knowledge of signal processing from the lecture Signal Processing in Communications Engineering

- Basic knowledge of Matlab

7.101 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: Interdisciplinary Subject

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 7.102 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 / Field of Specialization: Power Engineering (Internships)
Interdisciplinary Subject

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 7.103 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: Field of Specialization / Field of Specialization: Industrial Automation (Internships)
Interdisciplinary Subject

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 7.104 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 / Field of Specialization: Industrial Automation (Internships)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Internships)
Interdisciplinary Subject

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

M 7.105 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: Interdisciplinary Subject

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

M 7.106 Module: Laboratory Optoelectronics [M-ETIT-100477]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

M 7.107 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 / Field of Specialization: Power Engineering (Internships)
Interdisciplinary Subject

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 7.108 Module: Lighting Engineering [M-ETIT-100485]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

7.109 Module: Lightweight Engineering Design [M-MACH-102696]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject

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

7.110 Module: Localization of Mobile Agents [M-INFO-100840]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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 7.111 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 / Field of Specialization: Industrial Automation (Complementary Modules)
Interdisciplinary Subject

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 7.112 Module: Machine Dynamics [M-MACH-102694]

Responsible: Prof. Dr.-Ing. Carsten Proppe
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject

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 7.113 Module: Machine Learning - Foundations and Algorithms [M-INFO-105778]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject

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

Mandatory			
T-INFO-111558	Machine Learning - Foundations and Algorithms	6 CR	Neumann

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Competence Goal
• Students acquire knowledge of the basic methods of Machine Learning
• Students acquire the mathematical knowledge to understand the theoretical foundations of Machine Learning
• Students can categorize, formally describe and evaluate methods of Machine Learning
• Students can apply their knowledge to select appropriate models and methods for selected problems in the field of Machine Learning.

Content
The field of Machine Learning has made enormous progress in recent years and good knowledge of Machine Learning is becoming increasingly in demand on the job market. Machine Learning describes the acquisition of knowledge by an artificial system based on experience or data. Rules or certain calculations no longer have to be manually coded but can be extracted from data by intelligent systems.

This lecture provides an overview of essential and current methods of Machine Learning. After reviewing the necessary mathematical background, the lecture primarily deals with algorithms for classification, regression, and density estimation, with a focus on the mathematical understanding of probabilistic methods and neural networks.

Examples of topics include:
- Basics in Linear Algebra, Probability Theory, Optimization and Constraint Optimization
- Linear Regression
- Linear Classification
- Model Selection, Overfitting, and Regularization
- Support Vector Machines
- Kernel Methods
- Bayesian Learning and Gaussian Processes
- Neural Networks
- Dimensionality Reduction
- Density estimation
- Clustering
- Expectation Maximization
- Graphical Models

Workload
180h, divided into:
- ca 45h lecture attendance
- approx. 15h attending exercises
- approx. 90h post-processing and working on the exercise sheets
- ca 30h exam preparation

M 7.114 Module: Machine Learning 1 [M-WIWI-105003]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject

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.

7.115 Module: Machine Learning 2 [M-WIWI-105006]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject

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 7.116 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: Interdisciplinary Subject

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

7.117 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 / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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 7.118 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 / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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.

7.119 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 / Field of Specialization: Industrial Automation (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (mandatory)
Interdisciplinary Subject

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

7.120 Module: Machine Vision [M-MACH-101923]

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

Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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 7.121 Module: Major Field: Integrated Product Development [M-MACH-102626]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering

Part of: Interdisciplinary Subject

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

Mandatory			
T-MACH-105401	Integrated Product Development	18 CR	Albers, Düser

Competence Certificate
See course ("Teilleistung")

Prerequisites
None

Competence Goal
By working practically in experience-based learning arrangements with industrial development tasks, graduates are able to succeed in new and unknown situations when developing innovative products by using methodological and systematic approaches. They can apply and adapt strategies of development and innovation management, technical system analysis and team leadership to the situation. As a result, they are able to foster the development of innovative products in industrial development teams in prominent positions, taking into account social, economic and ethical aspects.

Content
Organizational integration: integrated product development model, core team management and simultaneous engineering, informational integration: innovation management, cost management, quality management and knowledge management

Personal integration: team development and leadership

Guest lectures from the industry

Annotation
The participation in the course "Integrated Product Development" requires the simultaneous participation in the lecture(2145156), the workshop (2145157) and the product development project (2145300).

For organizational reasons, the number of participants for the product development project is limited. Therefore, a selection process will take place. Registration for the selection process is made by means of a registration form, which is available annually from April to July on the homepage of the IPEK. Afterwards the selection itself will be discussed in personal interviews with Professor Albers.

The rule here is:

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

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
lecture
tutorial
product development project

M 7.122 Module: Master's Thesis [M-ETIT-103253]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Master's Thesis

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

Mandatory			
T-ETIT-106463	Master's Thesis	30 CR	Doppelbauer

Modeled Conditions
The following conditions have to be fulfilled:

1. You need to have earned at least 75 credits in the following fields:
    - General Mechatronics
    - Interdisciplinary Subject
    - Interdisciplinary Qualifications
    - Field of Specialization
    - Field of Specialization

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 written by at least one university lecturer or one senior scientist according to § 14 para. 3 no. 1 KITG and another examiner. As a rule, one of the examiners is Person who has awarded the work in accordance with paragraph 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; he can too order another appraiser. The assessment must be completed within eight weeks of the submission of the Master's Thesis respectively. Section 14 of the study and examination regulations (SPO) regulates further details.

The module grade consists of the Master's Thesis and a presentation (SPO §14, 1b).

M 7.123 Module: Material Flow in Logistic Systems [M-MACH-104984]

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

Part of: Field of Specialization / Field of Specialization: Industrial Automation (mandatory)
Interdisciplinary Subject
Additional Examinations

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

M 7.124 Module: Materials [M-ETIT-102734]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: General Mechatronics

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

Materials (Election: 1 item)			
T-MACH-100531	Systematic Materials Selection	5 CR	Dietrich, Schulze
T-MACH-105535	Composite Manufacturing - Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies	5 CR	Henning
T-ETIT-109292	Electrical Engineering Components	6 CR	Kempf

Prerequisites
Application and exam is allowed only in one lecture of this modul (M-ETIT-102734 - Werkstoffe): "T-ETIT-109292 - Bauelemente der Elektrotechnik" or " T-MACH-100531 - Systematische Werkstoffauswahl" or "T-MACH-105535 - Faserverstärkte Kunststoffe ..."

Annotation
The three parts of the module "M-ETIT-102734 - Materials" are mutually exclusive

Course „Passive Bauelemente“ will be taught in Wintersemester 2020/21 for the last time.Replacement will be "Bauelemente der Elektrotechnik".

M 7.125 Module: Materials for Lightweight Construction [M-MACH-102727]

Responsible: Dr.-Ing. Wilfried Liebig
Organisation: KIT Department of Mechanical Engineering

Part of: Interdisciplinary Subject

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 7.126 Module: Measurement Technology [M-ETIT-105982]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: General Mechatronics

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

Mandatory			
T-ETIT-112147	Measurement Technology	5 CR	Heizmann

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

Prerequisites
M-ETIT-102652 - Messtechnik (German version) must not have started.

Competence Goal

- Students have a sound knowledge of the theoretical foundations of measurement technology, including modeling of measurement systems, consideration of nonlinearities, stochastic deviations and stochastic signals, acquisition of analog signals, and frequency and rotational speed measurement.
- Students are proficient in the approaches to measurement system design in terms of model assumptions, methods, and achievable results.
- Students are able to analyze and formally describe measurement technology tasks, synthesize possible solutions for measurement systems and assess the properties of the solution obtained.

Content
The module deals with the formal, methodical and mathematical fundamentals for the analysis and design of measurement systems. Focal points of the course are

- Measurement systems and deviations (including scales, the SI systems, modeling of measurement systems)
- Curve fitting (approximation, interpolation)
- Stationary behavior of measurement systems (characteristic curve, errors of the characteristic curve, nonlinearities, adjustment)
- Stochastic measurement errors (probabilistic analysis, samples, statistical test methods, statistic process control, error propagation)
- Stochastic processes (correlational measurements, spectral description of stochastic signals, system identification, matched filter, Wiener filter)
- Digitization of analog signals (sampling, quantization, analog-digital converters, digital-analog converters)
- Frequency and rotational speed measurement (generalized frequency concept, digital speed measurement, detection of direction)

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

Annotation
In the module a lecture, an exercise and an examination are offered.

Workload
The workload includes:

1. attendance in lectures and exercises: 34 h
2. preparation / follow-up of lectures and exercises: 51 h
3. preparation of and attendance in examination: 65 h

total: 150 h = 5 CR

Recommendation
Basic knowledge in the fields of “Probability Theory” as well as “Signals and Systems” is helpful.

M 7.127 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: Interdisciplinary Subject

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

M 7.128 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: Interdisciplinary Subject

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)

7.129 Module: Medical Imaging Technology II [M-ETIT-106670]

Responsible: Prof. Dr.-Ing. Maria Francesca Spadea
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject (Usage between 4/1/2024 and 9/30/2025)

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

Mandatory			
T-ETIT-113421	Medical Imaging Technology II	3 CR	Spadea

Competence Certificate
The examination takes place in form of a written examination lasting 90 minutes.

Prerequisites
none

Competence Goal
For each imaging modality students will be able to:

- identify required energy source;
- analyze the interactions between the form of energy and biological tissue
- distinguishing desired signal from noise contribution;
- critically interpret the image content to derive knowledge
- evaluate image quality and implementing strategies to improve it.

Moreover, the student will be able to communicate in technical and clinical English language.

Content

- the basic knowledge of mathematical and physical principles of medical imaging formation, including nuclear medicine imaging and magnetic resonance imaging.
- the component of medical imaging devices.
- assessment of image quality in terms of signal-to-noise-ratio, presence of artifact, spatial, spectral and temporal resolution
- safety and protection for patients and workers.

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

Workload

- attendance in class: 15*2h = 30h
- preparation / follow-up: 15*2h = 30h
- exam preparation / attendance: 30h = 90h

A total of 90h = 3 CR

Recommendation

- Basic knowledge in the field of physics and signal processing is helpful.
- The contents of the module "Medical Imaging Technology I" are recommended.

7.130 Module: Medical Measurement Technology Lab [M-ETIT-106779]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject (Usage from 10/1/2025)

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

Mandatory			
T-ETIT-113721	Preparatory Lecture Medical Measurement Technology *This item will not influence the grade calculation of this parent.*	2 CR	Nahm
T-ETIT-113758	Preparatory Lab Medical Measurement Technology *This item will not influence the grade calculation of this parent.*	1 CR	Nahm
T-ETIT-113626	Development Lab Medical Measurement Technology	6 CR	Nahm

Competence Certificate

1. The examination of the Preparatory Lecture takes place in form of other types of examinations. It consists of an ungraded written test.
2. The examination of the Preparatory Lab takes place in form of other types of examinations. It consists of an ungraded practical test.
3. The examination of the Development Lab takes place in form of other types of examinations. It consists of 6 graded protocols to the 6 experiments.
   The grade for the Development Lab is the average grade of the 6 protocols.

Prerequisites
none

Competence Goal
The aim of the practical course is to develop and implement a measuring system for the continuous recording of pulse transit time (PTT). For this purpose, the time difference between the electrocardiographically measured heart excitation (ECG) and the photoplethysmographically measured peripheral volume pulse (PPG) is determined and displayed. To validate the tested and verified system, the students develop a practical self-experiment.

This module promotes the development of both engineering and application-oriented professional competencies.

- Engineering competence:
  Students can design, set up, test and operate electronic measuring systems, including signal processing software.
- Medical application competence:
  Students can translate medical application problems into technical requirements. They know the sources of biosignals and their signal properties.
- Methodological competence for the development of medical devices: Students know the normative and regulatory requirements for the development of medical devices and are able to implement them.

Content

The Preparatory Lecture consists of 6 weekly classes and the written test. It will cover the following topics:

- Development of blood pressure
- Blood pressure as a biosignal
- Blood volume as a biosignal
- ECG as a biosignal
- Measurement principles and non-invasive methods for blood pressure measurement
- Measuring principle and measuring method of photoplethysmography
- Basics of analog and digital circuit technology
- Advantages, disadvantages, limitations of the methods
- Interference sources and measures for suppression
- Specifications and measures for electrical safety

The Prep Lab consists of 6 experiments and the practical test. The following program is completed as part of the Preparatory Labs:

- Laboratory safety briefing
- Construction of electronic circuits on a breadboard
- Rules for a clear layout and error prevention
- Operation and use of the oscilloscope
- Operation and use of the function generator
- Systematic troubleshooting

The Development Lab consists of 8 experiments and imparts the following know-how:

- Design and construction of sensor technology and analog circuits.
- Software design and implementation of digital signal processing
- Design and implementation of testing, verification and validation of systems and system components
- Design, implementation and testing of electrical safety measures

Module grade calculation

The module grade is the grade for the Development Lab.

Annotation

For capacity reasons, the laboratory is limited to 32 students. If necessary, a selection procedure will be carried out. Places will be allocated according to the progress of the students (semester and subject-specific programming knowledge). Details will be announced in the first course and on the course website.

Students may only take part in the Development Lab (in summer term) if they have successfully completed the Preparatory Lecture and the Preparatory Lab (both in winter term).

Workload

Preparatory Lecture (winter term)

- In-class time: 7 x 1,5h = 10,5h
- Preparation and revision of the lecture units and preparation of and participation in the test exam: 7 x 5h + 2,5h = 37,5h
- Total time: 10,5h + 37,5h = 48h

Preparatory Lab (winter term)

- In-presence lab time: 7 x 1,5h = 10,5h
- Preparation and revision of the lab units, preparation of the protocols and preparation of and participation in the test exam: 7 x 4,5 h = 31,5h
- Total time: 10,5h + 31,5h = 42h

Development Lab (summer term)

- In-presence lab time: 8 x 7,5h = 60h
- Preparation and revision of the lab units and preparation of the protocols: 8x 15h = 120h
- Total time: 120h + 60h = 180h

Total effort
48h + 42h + 180h = 270h, equivalent 9 ECTS

Recommendation

Basic knowledge of analog circuit technology, digital signal processing and physiology and anatomy is strongly recommended.

7.131 Module: Micro System Simulation [M-MACH-105486]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject

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
Oral exam (20 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

7.132 Module: Microactuators [M-MACH-100487]

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

Part of: Field of Specialization / Field of Specialization: Microsystems Technology (mandatory)
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

7.133 Module: Microenergy Technologies [M-MACH-102714]

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

Part of: Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
Field of Specialization / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

7.134 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 / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject

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 7.135 Module: Microwave Engineering [M-ETIT-100535]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject (Usage until 9/30/2025)

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.

7.136 Module: Microwave Engineering Lab [M-ETIT-106973]

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

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.

7.137 Module: Microwaves Measurement Techniques [M-ETIT-100424]

Responsible: Dr.-Ing. Mario Pauli
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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.

M 7.138 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: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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 7.139 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 / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

M 7.140 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 / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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.

7.141 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: Interdisciplinary Subject

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.

7.142 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 / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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 7.143 Module: Motor Vehicle Laboratory [M-MACH-102695]

Responsible: Dr.-Ing. Michael Frey
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Automotive Engineering (Internships)
Interdisciplinary Subject

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

Mandatory			
T-MACH-105222	Motor Vehicle Labor	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

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 7.144 Module: Nano- and Quantum Electronics [M-ETIT-105604]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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.

M 7.145 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 / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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 7.146 Module: Nonlinear Optics [M-ETIT-100430]

Responsible: Prof. Dr.-Ing. Christian Koos
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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 7.147 Module: Novel Actuators and Sensors [M-MACH-105292]

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

Part of: Field of Specialization / Field of Specialization: Design of Mechatronic Systems (mandatory)
Interdisciplinary Subject
Additional Examinations

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 7.148 Module: Numerical Methods [M-MATH-105831]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: General Mechatronics

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 7.149 Module: Optical Communicatons Laboratory [M-ETIT-100437]

Responsible: Prof. Dr.-Ing. Christian Koos
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

Mandatory			
T-ETIT-100742	Optical Communications Laboratory	6 CR	Koos

Prerequisites
none

M 7.150 Module: Optical Design Lab [M-ETIT-100464]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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 7.151 Module: Optical Transmitters and Receivers [M-ETIT-100436]

Responsible: Prof. Dr. Wolfgang Freude
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

7.152 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: Interdisciplinary Subject

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 7.153 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 / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject

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 7.154 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 / Field of Specialization: Industrial Automation (mandatory)
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (mandatory)
Field of Specialization / Field of Specialization: Robotics (mandatory)
Interdisciplinary Subject

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 7.155 Module: Optoelectronic Measurement Engineering [M-ETIT-100484]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

M 7.156 Module: Optoelectronics [M-ETIT-100480]

Responsible: Prof. Dr. Ulrich Lemmer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject (Usage until 9/30/2025)

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

Mandatory			
T-ETIT-100767	Optoelectronics	4 CR	Lemmer

Competence Certificate
The success check is carried out in the context of a written exam (90 minutes).

Prerequisites
none

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

Workload
1. Presence time in lectures, exercises: 32 h
2. Preparation / Post-processing of the same: 48 h
3. Exam preparation and presence in same: 40 h

M 7.157 Module: Organ Support Systems [M-MACH-102702]

Responsible: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: Interdisciplinary Subject
Additional Examinations

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.

M 7.158 Module: Pattern Recognition [M-INFO-100825]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject

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

M 7.159 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 / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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 7.160 Module: Physiology and Anatomy for Biomedical Engineering [M-ETIT-105874]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject (Usage between 10/1/2022 and 9/30/2025)

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

Mandatory			
T-ETIT-111815	Physiology and Anatomy for Biomedical Engineering	6 CR	Nahm

Competence Certificate
The exmaniation is carried out in the form of a written test of 120 minutes.

The examination includes the contents of Physiologie und Anatomie I (offered every winter term) and Physiologie und Anatomie II (offered every summer term).

Prerequisites
The modules "M-ETIT-100390 - Physiologie und Anatomie I" and "M-ETIT-100391 - Physiologie und Anatomie II" must not been started.

Competence Goal
After studying this module

- students will be able to describe and explain the basic structural and functional principles of the organism at various levels of organization (molecular and cellular to organ and organ system level) in order to classify the organism in its environment,
- have the ability to apply this knowledge to explain higher-level organ and organ system functions,
- know advanced mathematical, scientific and engineering methods for describing physiological processes and are able to apply them,
- be able to describe the functional relationships at the organ and organ system level from a diagnostic and therapeutic perspective and derive the requirements for medical technology systems from this
- and can identify the sources of biosignals and derive connections between physiological parameters and physical measured variables.

Sustainability competence objective: The students have actively shaped their learning process.

Content

Physiologie und Anatomie I (winter semester)

This course provides basic knowledge of the major human organ systems and medical terminology. It is intended for students of technical courses who are interested in physiological issues.

Topic blocks:

- Organizational levels of the organism
- Building blocks of life
    - Proteins
    - Lipids
    - Carbohydrates
    - Lipids
    - Nuleic acids
- Cells
    - Structure
    - Membrane transport processes
    - Protein biosynthesis
    - Cell respiration
    - Nerve cells
    - Muscle cells
- Tissue
    - Tissue types
    - Cell connections
- Sensory organs
    - Eye
    - Hearing

Physiologie und Anatomie II (summer term)

This course expands on the knowledge taught in the first part of the course and introduces additional human organ systems.

Topic blocks:

- The nervous system
    - Anatomy and functional structure
- The cardiovascular system
    - Anatomy and function of the heart
    - Vascular system and blood pressure
- The respiratory system
    - Anatomy and ventilation
    - Gas transport
- The digestive system
    - Anatomy
    - Physiology of digestion
- The endocrine system
    - Endocrine organs
    - Hormonal signal transduction
- Acid-base balance
- Water-electrolyte balance
- Thermoregulation

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

Bonus points can be awarded for a student contribution to the lecture.

- The student contribution consists of the formulation of learning objectives and questions to check the learning objectives for the lecture units. The corresponding lecture units are made available for selection in ILIAS.
- The students create the student contributions in small groups. They submit their contribution in the form of a PowerPoint presentation in ILIAS by the specified deadline.
- The presentation will be corrected and approved by the lecturer or course tutor if necessary.
- The contribution will be presented by the group in the following lecture unit within the specified period and discussed with the plenum. If necessary, the presenting group takes on board the feedback and creates a revised vision. The final version of the contribution is made available to all lecture participants in ILIAS for exam preparation.
- Bonus points are awarded by the lecturer on the basis of the written paper and the presentation in the plenary session.
- Each participant can earn a maximum of 6 bonus points. Bonus points can only be earned once.
- Participation in the student contributions is voluntary.

The bonus points are credited as follows:

- A maximum of 6 points can be credited to the exam result for the bonus task passed.
- The grade can thus be improved by a maximum of one grade step.
- The total number of points remains limited to 120 points. The bonus points are only taken into account if the exam is passed. Bonus points do not expire and are retained for any examinations taken at a later date.

Annotation
This module is part of the Orientation Exam of SPO BSc Medizintechnik § 8. The examination must be taken by the end of the 2nd semester. A repeat examination must be taken by the end of the 3rd semester.

Workload
The workload includes:

- Attendance time in lectures (2 h, 30 appointments each) = 60 h
- Self-study (3 h, 30 appointments each) = 90 h
- Preparation / post-processing = 30 h

Total effort approx. 180 hours = 6 LP

Learning type
Winter/summer term:

- WT: Physiologie und Anatomie I
- ST: Physiologie und Anatomie II

7.161 Module: Plasma Sources [M-ETIT-100481]

Responsible: Dr.-Ing. Rainer Kling
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

7.162 Module: Plastic Electronics / Polymerelectronics [M-ETIT-100475]

Responsible: Prof. Dr. Gerardo Hernandez Sosa
Prof. Dr. Ulrich Lemmer

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Interdisciplinary Subject

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

Mandatory			
T-ETIT-100763	Plastic Electronics / Polymerelectronics	3 CR	Lemmer

Competence Certificate
Type of Examination: oral exam (approx. 20 minutes)

Prerequisites
none

Competence Goal
The students

- understand the electronic and optical characteristics of organic semiconductors
- know the fundamental differences between organic and conventional inorganic semiconductors.
- have basic knowledge of manufacturing and processing technologies,
- have knowledge of organic light-emitting diodes, organic solar cells and photodiodes, organic field-effect transistors and organic lasers.
- have an overview of the possible applications, markets and development lines for these components.
- are able to work in multidisciplinary teams with engineers, chemists and physicists

Content

1. Introduction
2. Optoelectronic properties of organic semiconductors
3. Organic light emitting diodes (OLEDs
4. Applications in Lighting and Displays
5. Organic FETs
6. Organic photodetectors and solar cells
7. Lasers and integrated optics

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

Annotation
Lecture and excersises are held as required in German or English.

Workload
1. lecture: 21 h
2. recapitulation and self-studie: 42 h
3. preparation of examniation: 27 h

Recommendation
Knowledge of semiconductor components

Literature
The corresponding documents are available online in the VAB (https://studium.kit.edu/)

7.163 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 / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject

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

7.164 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 / Field of Specialization: Power Engineering (mandatory)
Interdisciplinary Subject

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 7.165 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: Interdisciplinary Subject (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

M 7.166 Module: Power Network [M-ETIT-100572]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Power Engineering (mandatory)
Interdisciplinary Subject

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

Mandatory			
T-ETIT-100830	Power Network	5 CR	Leibfried

M 7.167 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 / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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 7.168 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 / Field of Specialization: Power Engineering (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (mandatory)
Interdisciplinary Subject

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"

M 7.169 Module: Practical Course: Human-Centred Robotics [M-INFO-106646]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Internships)

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

Mandatory			
T-INFO-113393	Practical Course: Human-Centred Robotics	6 CR	Mombaur

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn to understand and scrutinize complex scientific topics and to reproduce and verify published results. They gain in-depth knowledge and practical experience in the field of motion generation and control of human-centered robots while working on a specific project task. They also learn how to plan, work together and communicate in a team. Students will be able to present their project results in a scientific presentation, demonstrate the practical results and answer detailed questions. They can also summarize their project results in writing using Latex in the style of a scientific paper and place them in a scientific context.

Content
Human-centered robots are robots that directly interact with humans or support humans in their motions. This includes humanoid robots, but also wearable robots (exoskeletons and prostheses) or external physical assistive devices. In this practical course, students learn how to implement theoretical knowledge about human-centered robots and use it to solve a given task based on a individual project with robot hardware. Projects can either focus on code development for a given hardware or on the development or modification of robot hardware along with the basic code. Students learn about the challenges of working with real robot hardware vs model computations, and about working principles and practical implementation of sensors and actuators.

Annotation
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week.

Workload
Estimated effort for this module is 180 hours:
20h – In person events (kickoff meeting, individual meetings with supervisor, presentations)
130h – Individual project work
30h - Writing report and preparing presentation

Recommendation
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) are very helpful.

7.170 Module: Practical Course: Machine Learning and Intelligent Systems [M-INFO-105958]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject

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

7.171 Module: Practical Course: Mathematical and Computational Methods in Robotics and AI [M-INFO-106928]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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

Mandatory			
T-INFO-113893	Practical Course: Mathematical and Computational Methods in Robotics and AI	6 CR	Mombaur

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn to understand scientific topics. They will learn how to address specific project tasks and solve them in a structured way. They will obtain deepened knowledge about fundamental mathematical and computational methods, including their potential, strengths and limitations and in which areas they are suited to be applied. Students learn to present their results to a an audience, as well as suitably documenting their results in form or in addition to a scientific paper and being capable of assessing the advantages and disadvantages of the methods used.

Content

Efficient mathematical and computational methods are an irreplaceable cornerstone of modern research and industrial applications in forms such as numerical simulation, optimization or inference, ranging from the generation of task-specific trajectories for robotic systems over stabilization of existing robots to data-driven prediction and inference as well as AI-applications.
In this practical course, students learn, on the basis of an individual programming project, how to implement and apply fundamental mathematical and computational methods to solve an existing task in a robotics application or related fields and gain experience leveraging methods from this area in said real-world context.

Annotation
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week or can be indivdually agreed upon with people supervising the practical. Students can propose topics on their own as well.

Workload
Estimated effort for this module is 180 hours:
20h – In person events (kickoff meeting, individual meetings with supervisor, presentations)
130h – Individual project work
30h - Writing report and preparing presentation

Recommendation
Basic mathematical knowledge will be helpful, depending on topic. For Projects in the context of robotics, knowledge of robotics is recommended, but not strictly necessary.

M 7.172 Module: Practical Course: Movement and Technology [M-INFO-106648]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Internships)

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

Mandatory			
T-INFO-113394	Practical Course: Movement and Technology	6 CR	Mombaur

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn to analyze and understand complex scientific topics in the area of human motion capture and motion analysis. They gain in-depth knowledge and practical experience with motion capture technology, experiment planning, and analysis. They also learn how to plan, work together and communicate in an interdisciplinary team. Students will be able to present their project results in a scientific presentation, demonstrate the practical results and answer detailed questions. They can also summarize their project results in writing using Latex and place them in a scientific context.

Content
In this joint course between Informatics and Sports Science, and in the sense of research-oriented teaching, students learn about current research projects of the BioRobotics Lab (Informatics) and the BioMotion Center (Sports Science) at the interface of motor control and biomechanics of human movement. This research involves the use of latest motion capture technology, advanced analysis tools, and partly also assistive robotics technology. Students work in in teams (interdisciplinary teams between students from different study programs are highly encouraged) to carry out motion capture experiments, analyze the data and present the results in written and oral form. Depending on the specific project, these motion capture studies are either stand-alone studies just for this course or part of a larger research project at one of the organizing research groups.

Annotation
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week.

Workload
Estimated effort for this module is 180 hours:
20h – In person events (kickoff meeting, individual meetings with supervisor, presentations)
120h – Individual project work
40h - Writing report and preparing presentation

Recommendation
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) are very helpful.

Programming skills.

M 7.173 Module: Practical Course: Smart Energy System [M-INFO-105955]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Power Engineering (Internships)
Interdisciplinary Subject

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.

7.174 Module: Practical Machine Learning [M-ETIT-106673]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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)

7.175 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: Field of Specialization / Field of Specialization: Robotics (Internships)
Interdisciplinary Subject
Additional Examinations

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

Modeled Conditions
You have to fulfill one of 2 conditions:

1. The module M-INFO-102522 - Robotics - Practical Course must not have been started.
2. The module M-INFO-102230 - Practical Project Robotics and Automation II (Hardware) must not have been started.

M 7.176 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: Field of Specialization / Field of Specialization: Robotics (Internships)
Interdisciplinary Subject
Additional Examinations

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

Modeled Conditions

You have to fulfill one of 2 conditions:

1. The module M-INFO-102522 - Robotics - Practical Course must not have been started.
2. The module M-INFO-102224 - Practical Project Robotics and Automation I (Software) must not have been started.

M 7.177 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 / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject

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 7.178 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 / Field of Specialization: Microsystems Technology (Internships)
Interdisciplinary Subject

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.

M 7.179 Module: Principles of Medicine for Engineers [M-MACH-102720]

Responsible: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: Interdisciplinary Subject
Additional Examinations

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

Mandatory			
T-MACH-105235	Principles of Medicine for Engineers	4 CR	Pylatiuk

Competence Certificate
A performance assessment is held in form of a written examination of 45 minutes.

Prerequisites
none

Competence Goal
Students have a comprehensive understanding of the functioning and anatomical construction of organs, which are assigned to different medical disciplines. Furthermore, they know the physical basics, the technical solutions and the essential aspects of the application of medical technology procedures in diagnostics and therapy. They are familiar with common clinical pictures in the different medical disciplines and their relevance in health care. Through their acquired knowledge, students can communicate with physicians about medical-technical procedures and assess mutual expectations more realistically.

Content
Definition of disease and health and history of medicine, evidence-based medicine" and personalized medicine, nervous system, conduction, musculoskeletal system, cardiovascular system, anesthesia, respiratory system, sensory organs, gynecology, digestive organs, surgery, nephrology, orthopedics, immune system, genetics.

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

Workload

1. Attendance time Lecture: 15 * 2h = 30h
2. Pre- and postprocessing time Lecture: 15 * 3h= 45h
3. Exam preparation and attendance exam: 45h

Total: 120h = 4 LP

Recommendation
The content of module MMACH-105228 complements this lecture.

Literature

- Adolf Faller, Michael Schünke: Der Körper des Menschen. Thieme Verlag.
- Renate Huch, Klaus D. Jürgens: Mensch Körper Krankheit. Elsevier Verlag.

7.180 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: Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

M 7.181 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: Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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 7.182 Module: Product Development – Methods of Product Engineering [M-MACH-102718]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering

Part of: General Mechatronics
Interdisciplinary Subject

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

M 7.183 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 / Field of Specialization: Design of Mechatronic Systems (Internships)
Interdisciplinary Subject

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 7.184 Module: Project Management in the Development of Products for Safety-Critical Applications [M-ETIT-104475]

Responsible: Dr.-Ing. Manfred Nolle
Prof. Dr.-Ing. Eric Sax

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Field of Specialization / Field of Specialization: Design of Mechatronic Systems (mandatory)
Interdisciplinary Subject
Additional Examinations

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

M 7.185 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: Interdisciplinary Subject

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

7.186 Module: Quality Management [M-MACH-105332]

Responsible: Prof. Dr.-Ing. Gisela Lanza
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

7.187 Module: Rail System Technology [M-MACH-103232]

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

Part of: Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject

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

7.188 Module: Rail Vehicle Technology [M-MACH-102683]

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

Part of: Field of Specialization / Field of Specialization: Automotive Engineering (mandatory)
Interdisciplinary Subject

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

7.189 Module: Railway System Digitalisation [M-MACH-106513]

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

Part of: Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject

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

7.190 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 / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject

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

M 7.191 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: Interdisciplinary Subject
Additional Examinations

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 7.192 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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.

7.193 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 / Field of Specialization: Automotive Engineering (Internships)
Field of Specialization / Field of Specialization: Industrial Automation (Internships)
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Internships)
Field of Specialization / Field of Specialization: Robotics (Internships)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Internships)
Interdisciplinary Subject

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 7.194 Module: Renewable Energy-Resources, Technologies and Economics [M-WIWI-100500]

Responsible: Prof. Dr. Russell McKenna
Organisation: KIT Department of Economics and Management
Part of: Interdisciplinary Subject

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 7.195 Module: Robotics - Practical Course [M-INFO-102522]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Internships)
Interdisciplinary Subject

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

Mandatory			
T-INFO-105107	Robotics - Practical Course	6 CR	Asfour

Competence Certificate
See partial Achievements (Teilleistung)

Prerequisites
See partial Achievements (Teilleistung)

Modeled Conditions
You have to fulfill one of 2 conditions:

1. The module M-INFO-102224 - Practical Project Robotics and Automation I (Software) must not have been started.
2. The module M-INFO-102230 - Practical Project Robotics and Automation II (Hardware) must not have been started.

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 7.196 Module: Robotics I - Introduction to Robotics [M-INFO-100893]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules) (Usage until 9/30/2025)
Field of Specialization / Field of Specialization: Robotics (mandatory)
Interdisciplinary Subject (Usage until 9/30/2025)

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

Mandatory			
T-INFO-108014	Robotics I - Introduction to Robotics	6 CR	Asfour

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Competence Goal
The students are able to apply the presented concepts to simple and realistic tasks from robotics. This includes mastering and deriving the mathematical concepts relevant for robot modeling. Furthermore, the students master the kinematic and dynamic modeling of robot systems, as well as the modeling and design of simple controllers. The students know the algorithmic basics of motion and grasp planning and can apply these algorithms to problems in robotics. They know algorithms from the field of image processing and are able to apply them to problems in robotics. They are able to model and solve tasks as a symbolic planning problem. The students have knowledge about intuitive programming procedures for robots and know procedures for programming and learning by demonstration.

Content
The lecture provides an overview of the fundamentals of robotics using the examples of industrial robots, service robots and autonomous humanoid robots. An insight into all relevant topics is given. This includes methods and algorithms for robot modeling, control and motion planning, image processing and robot programming. First, mathematical basics and methods for kinematic and dynamic robot modeling, trajectory planning and control as well as algorithms for collision-free motion planning and grasp planning are covered. Subsequently, basics of image processing, intuitive robot programming especially by human demonstration and symbolic planning are presented.

In the exercise, the theoretical contents of the lecture are further illustrated with examples. Students deepen their knowledge of the methods and algorithms by independently working on problems and discussing them in the exercise. In particular, students can gain practical programming experience with tools and software libraries commonly used in robotics.

Workload
Lecture with 3 SWS + 1 SWS Tutorial, 6 LP
6 LP corresponds to 180 hours, including
15 * 3 = 45 hours attendance time (lecture)
15 * 1 = 15 hours attendance time (tutorial)
15 * 6 = 90 hours self-study and exercise sheets
30 hours preparation for the exam

M 7.197 Module: Robotics II - Humanoid Robotics [M-INFO-102756]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (mandatory)
Interdisciplinary Subject

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

Mandatory			
T-INFO-105723	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.

7.198 Module: Robotics III - Sensors and Perception in Robotics [M-INFO-104897]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (mandatory)
Interdisciplinary Subject

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

Mandatory			
T-INFO-109931	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.

7.199 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 / Field of Specialization: Automotive Engineering (Internships)
Field of Specialization / Field of Specialization: Power Engineering (Internships)
Field of Specialization / Field of Specialization: Microsystems Technology (Internships)
Field of Specialization / Field of Specialization: Industrial Automation (Internships)
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Internships)
Field of Specialization / Field of Specialization: Robotics (Internships)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Internships)
Interdisciplinary Subject

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 7.200 Module: Seminar Data-Mining in Production [M-MACH-105477]

Responsible: Prof. Dr.-Ing. Gisela Lanza
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
Interdisciplinary Subject

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

7.201 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 / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each term	1 term	German	1	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 7.202 Module: Seminar for Rail System Technology [M-MACH-104197]

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

Part of: Interdisciplinary Subject

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

7.203 Module: Seminar Intelligent Industrial Robots [M-INFO-102212]

Responsible: Prof. Dr.-Ing. Björn Hein
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)

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 7.204 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: Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject

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.

M 7.205 Module: Seminar: Assistive robotics and exoskeletons in medical applications [M-INFO-106400]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)

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

Mandatory			
T-INFO-112922	Seminar: Assistive robotics and exoskeletons in medical applications	3 CR	Mombaur

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal

- The students know the state of the art of exoskeletons and assistive robots and current medical applications.
- Students are able to independently research, understand, critically evaluate and summarize scientific literature on a given topic (usually in English).
- Students will be able to prepare and deliver a scientific presentation, taking into account the level of knowledge of the other seminar participants, and to answer detailed questions on the topic
- Students will be able to ask questions about scientific presentations of other students and make active contributions to scientific discussions
- Students will be able to use Latex to create a scientific text (in English) incorporating the sources they have read.

Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and successfully apply these guidelines in the preparation of their scientific work.

Content
This module provides an overview of the current state of the art and practical use of assitive robots and exoskeletons in medicine, as well as the potential of these technologies to improve patient care and the quality of life of people with and without physical impairments. Medical assistive robots are designed to perform a variety of healthcare tasks, such as assisting with surgeries or nursing care, reminding patients to take their medications, and monitoring patients' vital signs. Exoskeletons are designed to improve mobility and will be worn by people directly on their bodies to assist or completely replace their muscle strength. Some types of exoskeletons help people with mobility impairments to walk, stand and perform other physical activities to regain independence and participate in activities of daily living. Other types of exoskeletons are used by healthy people to prevent injuries in difficult working conditions. Mobility assistance robots for geriatric patients also exist in the form of robotic rollators designed to help their users to stand, walk, and navigate their surroundings in a safe and stable manner. Seminar topics cover the spectrum of different robot types and applications. Students can give their presentations in English or German as they prefer.

Annotation
Max 10 Participants

Workload
Estimated effort for this module is 90 hours:
20h – In person events (kickoff meeting, indiidual preparatory meetings, seminar block)
20h – Literature rechearch
20h – Preparation of presentation
30h - Paper writing

Recommendation
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) is helpful

M 7.206 Module: Seminar: Energy Informatics [M-INFO-103153]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)

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

Mandatory			
T-INFO-106270	Seminar: Energy Informatics	4 CR	Hagenmeyer

M 7.207 Module: Seminar: Exoskelette & Motion Capture [M-INFO-106927]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject

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

Mandatory			
T-INFO-113892	Seminar: Exoskelette & Motion Capture	3 CR	Mombaur

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- The students know the state of the art of exoskeletons and assistive robots and current medical applications.
- Students are familiar with the most important methods and devices for measuring human movements with and without robotic mobility assistance systems
- Students are able to independently research, understand, critically evaluate and summarize scientific literature on a given topic (usually in English).
- Students will be able to prepare and deliver a scientific presentation, taking into account the level of knowledge of the other seminar participants, and to answer detailed questions on the topic
- Students will be able to ask questions about scientific presentations of other students and make active contributions to scientific discussions
- Students will be able to use Latex to create a scientific text (in English) incorporating the sources they have read.

Content
This seminar provides an insight into the current state of research and the practical use of exoskeletons in medicine and their potential to improve the quality of life of people with and without physical disabilities. It also gives an overview of different motion capture technologies, which play an important role in exoskeleton research but have many other applications. The proseminar is offered by the research group Optimization and Biomechanics for Human-Centred Robotics at the IAR.

Exoskeletons are used to improve mobility and are worn by people directly on the body to support or completely replace their muscle strength. One class of exoskeletons assists people with mobility impairments to walk, stand and perform other physical activities so that they can regain their independence and participate in the activities of daily living. Other types of exoskeletons are used by healthy people to prevent injuries in difficult working conditions.

The applications of motion capture include many disciplines in which human behavior and movements are of interest, such as sports science, biomechanics, medicine, psychology, etc., but they also play an important role in the creation of animated films and computer games. In robotics, and especially in the development of exoskeletons, they are important for analyzing human-robot interaction and improving robot design and control. Various motion capture technologies exist for recording movement kinematics, ground reaction forces and muscle activity.

The proseminar presentation topics cover the spectrum of different exoskeleton types and motion capture technologies.

Schedule of the proseminar:
In an event in the first week of the semester, the topic of the seminar and the individual lecture topics are presented in detail and distributed to the students according to their preferences. In a second session in week 3, an introduction to academic literature research, writing and presentations will take place. Afterwards, the students carry out a literature search under supervision and prepare a presentation and a corresponding paper. As the scientific literature is mostly in English, the paper should also be written in English. Presentations can be held in either English or German and take place in one or more block courses during the last third of the semester.

Annotation
Limited number of participants

Workload
Estimated effort for this module is 90 hours:
20h – In person events (kickoff meeting, indiidual preparatory meetings, seminar block)
20h – Literature research
20h – Preparation of presentation
30h - Paper writing

Recommendation
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) is helpful

7.208 Module: Sensors [M-ETIT-100378]

Responsible: Dr. Wolfgang Menesklou
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Microsystems Technology (mandatory)
Interdisciplinary Subject

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 7.209 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 / Field of Specialization: Robotics (Internships)
Interdisciplinary Subject

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.

7.210 Module: Signal Processing Methods [M-ETIT-106899]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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 7.211 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: Interdisciplinary Subject

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.

7.212 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 / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject

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

7.213 Module: Software Engineering [M-ETIT-100450]

Responsible: Dr. Clemens Reichmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

7.214 Module: Software Radio [M-ETIT-100439]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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

Prerequisites
none

M 7.215 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 / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject

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 7.216 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: Interdisciplinary Subject

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 7.217 Module: Stochastic Information Processing [M-INFO-100829]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Interdisciplinary Subject

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 7.218 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: Interdisciplinary Subject

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)

M 7.219 Module: Superconducting Magnet Technology [M-ETIT-106684]

Responsible: Prof. Dr. Tabea Arndt
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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.

7.220 Module: Superconducting Power Systems [M-ETIT-106683]

Responsible: Prof. Dr.-Ing. Mathias Noe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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“

7.221 Module: Supplementary Studies on Science, Technology and Society [M-FORUM-106753]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: Additional Examinations

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

Election notes

Students have to self-record the achievements obtained in the Supplementary Studies on Science, Technology and Society in their study plan. FORUM (formerly ZAK) records the achievements as "non-assigned" under "ÜQ/SQ-Leistungen". Further instructions on self-recording of achievements can be found in the FAQ at https://campus.studium.kit.edu/ and on the FORUM homepage at https://www.forum.kit.edu/english/. The title of the examination and the amount of credits override the modules placeholders.

If you want to use FORUM achievements for both your Interdisciplinary Qualifications and for the Supplementary Studies, please record them in the Interdisciplinary Qualifications first. You can then get in contact with the FORUM study services (stg@forum.kit.edu) to also record them in your Supplementary Studies.

In the Advanced Unit you can choose examinations from three subject areas: "About Knowledge and Science", "Science in Society" and "Science in Social Debates". It is advised to complete courses from each of the three subject areas in the Advanced Unit.

To self-record achievements in the Advanced Unit, you have to select a free placeholder partial examination first. The placeholders' title do *not* affect which achievements the placeholder can be used for!

Mandatory			
T-FORUM-113578	Lecture Series Supplementary Studies on Science, Technology and Society - Self Registration	2 CR	Mielke, Myglas
T-FORUM-113579	Basic Seminar Supplementary Studies on Science, Technology and Society - Self Registration	2 CR	Mielke, Myglas
Advanced Unit Supplementary Studies on Science, Technology and Society (Election: at least 12 credits)			
T-FORUM-113580	Elective Specialization Supplementary Studies on Science, Technology and Society / About Knowledge and Science - Self-Registration	3 CR	Mielke, Myglas
T-FORUM-113581	Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Society - Self-Registration	3 CR	Mielke, Myglas
T-FORUM-113582	Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Public Debates - Self Registration	3 CR	Mielke, Myglas
Mandatory			
T-FORUM-113587	Registration for Certificate Issuance - Supplementary Studies on Science, Technology and Society	0 CR	Mielke, Myglas

Competence Certificate

The monitoring is explained in the respective partial achievement.

They are composed of:
- Protocols
- Reflection reports
- Presentations
- Preparation of a project work
- An individual term paper
- An oral examination
- A written exam

Upon successful completion of the supplementary studies, graduates receive a graded report and a certificate issued by the FORUM.

Prerequisites
The course is offered during the course of study and does not have to be completed within a defined period. Enrollment is required for all assessments of the modules in the supplementary studies.
Participation in the supplementary studies is regulated by § 3 of the statutes. KIT students register for the supplementary studies by selecting this module in the student portal and booking a performance themselves. Registration for courses, assessments, and exams is regulated by § 8 of the statutes and is usually possible shortly before the start of the semester.
The course catalog, module description (module manual), statutes (study regulations), and guidelines for creating the various written performance requirements can be downloaded from the FORUM homepage at **https://www.forum.kit.edu/begleitstudium-wtg.php**.

Registration and exam modalities

PLEASE NOTE:
Registration on the FORUM, i.e. additionally via the module selection in the student portal, enables students to receive up-to-date information about courses or study modalities. In addition, registering on the FORUM ensures that you have proof of the credits you have earned. As it is currently (as of winter semester 24-25) not yet possible to continue additional credits acquired in the Bachelor's programme electronically in the Master's programme, we strongly advise you to digitally secure the credits you have earned by archiving the Bachelor's transcript of records yourself and by registering on FORUM.
In the event that a transcript of records of the Bachelor's certificate is no longer available - we can only assign the achievements of registered students and thus take them into account when issuing the certificate.

Competence Goal
Graduates of the Supplementary Studies on Science, Technology, and Society gain a solid foundation in understanding the interplay between science, the public, business, and politics. They develop practical skills essential for careers in media, political consulting, or research management. The program prepares them to foster innovation, influence social processes, and engage in dialogue with political and societal entities. Participants are introduced to interdisciplinary perspectives, encompassing social sciences and humanities, to enhance their understanding of science, technology, and society. The teaching objectives of this supplementary degree program include equipping participants with both subject-specific knowledge and insights from epistemological, economic, social, cultural, and psychological perspectives on scientific knowledge and its application in various sectors. Students are trained to critically assess and balance the implications of their actions at the intersection of science and society. This training prepares them for roles as students, researchers, future decision-makers, and active members of society.

Through the program, participants learn to contextualize in-depth content within broader frameworks, independently analyze and evaluate selected course materials, and communicate their findings effectively in both written and oral formats. Graduates are adept at analyzing social issues and problem areas, reflecting on them critically from a socially responsible and sustainable standpoint.

Content

The Supplementary Studies on Science, Technology and Society can be started in the 1st semester of the enrolled degree programme and is not limited in time. The wide range of courses offered by FORUM makes it possible to complete the program usually within three semesters. The supplementary studies comprises 16 or more credit points (LP). It consists of **two modules: the Basic Module (4 LP) and the Advanced Module (12 LP)**.

The **basic Module** comprises the compulsory courses ‘Lecture Series Supplementary Studies on Science, Technology and Society’ and a basic seminar with a total of 4 LP.

The **Advanced Module** comprises courses totalling 12 LP in the humanities and social sciences subject areas ‘On Knowledge and Science’, ‘Science in Society’ and ‘Science in Public Debates’. The allocation of courses to the accompanying study programme can be found on the homepage https://www.forum.kit.edu/wtg-aktuelland in the printed FORUM course catalogue.

The 3 thematic subject areas:

Subject area 1: About Knowledge and Science

This is about the internal perspective of science: students explore the creation of knowledge, distinguishing between scientific and non-scientific statements (e.g., beliefs, pseudo-scientific claims, ideological statements), and examining the prerequisites, goals, and methods of knowledge generation. They investigate how researchers address their own biases, analyze the structure of scientific explanatory and forecasting models in various disciplines, and learn about the mechanisms of scientific quality assurance.

After completing courses in the "Knowledge and Science" area, students can critically reflect on the ideals and realities of contemporary science. They will be able to address questions such as: How robust is scientific knowledge? What are the capabilities and limitations of predictive models? How effective is quality assurance in science, and how can it be improved? What types of questions can science answer, and what questions remain beyond its scope?

Subject area 2: Science in Society

This focuses on the interactions between science and different areas of society, such as how scientific knowledge influences social decision-making and how social demands impact scientific research. Students learn about the specific functional logics of various societal sectors and, based on this understanding, estimate where conflicts of goals and actions might arise in transfer processes—for example, between science and business, science and politics, or science and journalism. Typical questions in this subject area include: How and under what conditions does an innovation emerge from a scientific discovery? How does scientific policy advice work? How do business and politics influence science, and when is this problematic? According to which criteria do journalists incorporate scientific findings into media reporting? Where does hostility towards science originate, and how can social trust in science be strengthened?

After completing courses in the "Sciene in Society" area, students can understand and assess the goals and constraints of actors in different societal sectors. This equips them to adopt various perspectives of communication and action partners in transfer processes and to act competently at various social interfaces with research in their professional lives.

Subject area 3: Science in Public Debates

The courses in this subject area provide insights into current debates on major social issues such as sustainability, digitalization, artificial intelligence, gender equality, social justice, and educational opportunities. Public debates on complex challenges are often polarized, leading to oversimplifications, defamation, or ideological thinking. This can hinder effective social solution-finding processes and alienate people from the political process and from science. Debates about sustainable development are particularly affected, as they involve a wide range of scientific and technological knowledge in both problem diagnosis (e.g., loss of biodiversity, climate change, resource consumption) and solution development (e.g., nature conservation, CCS, circular economy).

By attending courses in "Science in Public Debates," students are trained in an application-oriented way to engage in factual debates—exchanging arguments, addressing their own prejudices, and handling contradictory information. They learn that factual debates can often be conducted more deeply and with more nuance than is often seen in public discourse. This training enables them to handle specific factual issues in their professional lives independently of their own biases and to be open to differentiated, fact-rich arguments.

Supplementary credits:

Additional LP (supplementary work) totalling a maximum of 12 LP can also be acquired from the complementary study programme (see statutes for the WTG complementary study programme § 7). § 4 and § 5 of the statutes remain unaffected by this. These supplementary credits are not included in the overall grade of the accompanying study programme. At the request of the participant, the supplementary work will be included in the certificate of the accompanying study programme and marked as such. Supplementary coursework is listed with the grades provided for in § 9.

Module grade calculation

The overall grade of the supplementary course is calculated as a credit-weighted average of the grades that were achieved in the advanced module.

Annotation

Climate change, biodiversity crisis, antibiotic resistance, artificial intelligence, carbon capture and storage, and gene editing are just a few areas where science and technology can diagnose and address numerous social and global challenges. The extent to which scientific findings are considered in politics and society depends on various factors, such as public understanding and trust, perceived opportunities and risks, and ethical, social, or legal considerations.
To enable students to use their expertise as future decision-makers in solving social and global challenges, we aim to equip them with the skills to navigate the interfaces between science, business, and politics competently and reflectively. In the Supplementary Studies, they acquire foundational knowledge about the interactions between science, technology, and society.

They learn:
- How reliable scientific knowledge is produced,
- how social expectations and demands influence scientific research, and
- how scientific knowledge is adopted, discussed, and utilized by society.

The program integrates essential insights from psychology, philosophy, economics, social sciences, and cultural studies into these topics. After completing the supplementary studies programme, students can place the content of their specialized studies within a broader social context. This prepares them, as future decision-makers, to navigate competently and reflectively at the intersections between science and various sectors of society, such as politics, business, or journalism, and to contribute effectively to innovation processes, public debates, or political decision-making.

Workload

The workload is made up of the number of hours of the individual modules:

- Basic Module approx. 120 hours
- Advanced Module approx. 390 hours

> Total: approx. 510 hours

In the form of supplementary services, up to approximately 390 hours of work can be added.

Recommendation

It is recommended to complete the supplementary study program in three or more semesters, beginning with the lecture series on science, technology, and society in the summer semester. Alternatively, you can start with the basic seminar in the winter semester and then attend the lecture series in the summer semester.

Courses in the Advanced Module can be taken simultaneously. It is also advised to complete courses from each of the three subject areas in the advanced unit.

Learning type

- Lectures
- Seminars/Project Seminars
- Workshops

M 7.222 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 / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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 7.223 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 / Field of Specialization: Microsystems Technology (Complementary Modules)
Interdisciplinary Subject

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

7.224 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 / Field of Specialization: Microsystems Technology (Internships)
Interdisciplinary Subject

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 7.225 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: Interdisciplinary Subject

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)

7.226 Module: Technical Design in Product Development [M-MACH-105318]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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.

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7.227 Module: Technical Optics [M-ETIT-100538]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject

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 7.228 Module: Thermal Solar Energy [M-MACH-102388]

Responsible: apl. Prof. Dr. Ron Dagan
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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.

<u>Optional</u>

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.

<u>At the end</u>:

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 7.229 Module: Ubiquitous Computing [M-INFO-100789]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)

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

Mandatory			
T-INFO-101326	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

7.230 Module: Vehicle Lightweight Design - Strategies, Concepts, Materials [M-MACH-107013]

Responsible: Prof. Dr.-Ing. Frank Henning
Organisation: KIT Department of Mechanical Engineering

Lightweight Design

Part of: Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules) (Usage between 4/1/2025 and 4/1/2025)
Interdisciplinary Subject (Usage between 4/1/2025 and 4/1/2025)

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

Mandatory			
T-MACH-114010	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.

7.231 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject

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 7.232 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 / Field of Specialization: Automotive Engineering (Complementary Modules)
Interdisciplinary Subject

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

7.233 Module: Virtual Engineering 1 [M-MACH-105293]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation:
Part of: Interdisciplinary Subject
Additional Examinations

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 7.234 Module: Virtual Engineering A [M-MACH-101283]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
Interdisciplinary Subject

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-102185	CATIA CAD Training Course	2 CR	Ovtcharova
T-MACH-105312	CATIA Advanced	4 CR	Ovtcharova
T-MACH-102209	Information Engineering	3 CR	Meyer, Ovtcharova
T-MACH-106743	IoT Platform for Engineering	4 CR	Ovtcharova
T-MACH-113669	Hot Research Topics in AI for Engineering Applications	4 CR	Meyer
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

7.235 Module: Virtual Engineering Lab [M-MACH-105475]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Internships)
Interdisciplinary Subject

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

7.236 Module: Wearable Robotic Technologies [M-INFO-103294]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Prof. Dr.-Ing. Michael Beigl

Organisation: KIT Department of Informatics

Part of: Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Interdisciplinary Subject
Additional Examinations

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

Mandatory			
T-INFO-106557	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.

8 Courses

T 8.1 Course: Advanced Artificial Intelligence [T-INFO-112768]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-106299 - Advanced Artificial Intelligence

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	1

Events					
ST 2025	2400141	Advanced Artificial Intelligence	4 SWS	Lecture / 🗣	Niehues, Lioutikov

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites
None.

T 8.2 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 8.3 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 8.4 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.

8.5 Course: Antennas and Multiple Antenna Systems [T-ETIT-106491]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100565 - Antennas and Multiple Antenna Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	4

Events					
WT 24/25	2308416	Antennas and Multiple Antenna Systems	2 SWS	Lecture / 🗣	Zwick
WT 24/25	2308417	Workshop for 2308416 Antennas and Multiple Antenna Systems	2 SWS	Practice / 🧩	Zwick, Kretschmann, Bekker

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The success control takes place within the framework of an oral overall examination (20 minutes).

Prerequisites
T-ETIT-100638 - Antennen und Mehrantennensysteme wurde weder begonnen, noch abgeschlossen.

Das Modul "Antennen und Antennensysteme" darf nichtbegonnen oder abgeschlossen sein.

T 8.6 Course: Appliance and Power Tool Design [T-MACH-105229]

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

Part of: M-MACH-102705 - Appliance and Power Tool Design

Type	Credits	Grading 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, ✕ 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 8.7 Course: Appliance and Power Tool Design Project Work [T-MACH-110767]

Responsible: Prof. Dr.-Ing. Sven Matthiesen
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-102705 - Appliance and Power Tool Design

Type	Credits	Grading 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 8.8 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 8.9 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 8.10 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 8.11 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
Only one out of the two modules "M-MACH-100501 - Grundlagen der Fahrzeugtechnik I" and "M-MACH-102686 - Automotive Engineerin I" is allowed

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-102203 - Automotive Engineering I must not have been started.

Workload
240 hours

T 8.12 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 8.13 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 8.14 Course: Basic Seminar Supplementary Studies on Science, Technology and Society - Self Registration [T-FORUM-113579]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	2	pass/fail	Each summer term	1 terms	1

Competence Certificate
Study achievement in the form of a presentation or a term paper or project work in the selected course.

Prerequisites
None

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendation
It is recommended that the basic seminar be completed during the same semester as the lecture series "Science in Society". If it is not possible to attend the lecture series and the basic seminar in the same semester, the basic seminar can also be attended in the semesters before the lecture series.
However, attending courses in the advanced unit before attending the basic seminar should be avoided.

Annotation

T 8.15 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 8.16 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

T 8.17 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 8.18 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 8.19 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 8.20 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 8.21 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 8.22 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 8.23 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

T 8.24 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

T 8.25 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

8.26 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
50 hours

T 8.27 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 /	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 8.28 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 8.29 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 8.30 Course: Communications Engineering II [T-ETIT-110697]

Responsible: Dr.-Ing. Holger Jäkel
Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105274 - Communications Engineering II

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each term	1 terms	1

Events					
WT 24/25	2310509	Communications Engineering II	2 SWS	Lecture / Blended	Jäkel
WT 24/25	2310510	Übung zu 2310509 Communications Engineering II	1 SWS	Practice / Blended	Jäkel
ST 2025	2310511	Communications Engineering II	2 SWS	Lecture / ×	Jäkel
ST 2025	2310513	Tutorial for 2310511 Communications Engineering II	1 SWS	Practice / ×	Jäkel

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
The assessment will be carried out in the form of a written exam of 120 minutes. The module grade is the grade of the written exam.

Prerequisites
none

Recommendation
Knowledge of basic engineering mathematics including integral transformations and probability theory as well as basic knowledge of communications engineering.

Previous visit to the lecture "Communications Engineering I", "Probability Theory" and "Signals and Systems" is recommended.

T 8.31 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 8.32 Course: Composite Manufacturing - Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies [T-MACH-105535]

Responsible: Prof. Dr.-Ing. Frank Henning
Organisation: KIT Department of Mechanical Engineering

Lightweight Design
Part of: M-ETIT-102734 - Materials

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	4

Events					
ST 2025	2114053	Composite Manufacturing – Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies	2 SWS	Lecture / 🗣	Henning

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
written exam 90 minutes

Prerequisites
T-MACH-114001, T-MACH-114002 and T-MACH-114191 must not have been started

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-100531 - Systematic Materials Selection must not have been started.

Workload
120 hours

T 8.33 Course: Computational Continuum Mechanics [T-MACH-112987]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103205 - Engineering Mechanics

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	4	Grade to a third	Each summer term	1 terms	3

Events					
ST 2025	2162261	Computational Continuum Mechanics	2 SWS	Lecture / 🗣	Böhlke

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written exam (90 min). Additives as announced.

Admission to the exam: Coursework in *Tutorial Computational Continuum Mechanics* (T-MACH-112996) must be passed

Prerequisites
Coursework in *Tutorial Computational Continuum Mechanics* (T-MACH-112996) must be passed

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-112996 - Tutorial Computational Continuum Mechanics must have been passed.

Workload
90 hours

8.34 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 /	Mikut, Reischl, Meisenbacher

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Written exam (Duration: 1h)

Prerequisites
none

Workload
120 hours

T 8.35 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 8.36 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 8.37 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-102150 - BUS-Controls must not have been started.
2. The course T-MACH-111820 - Control of Mobile Machines – Prerequisites must have been passed.

Workload
120 hours

T 8.38 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 8.39 Course: Control of Power-Electronic Systems [T-ETIT-111897]

Responsible: Dr.-Ing. Andreas Liske
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105915 - Control of Power-Electronic Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each summer term	1

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 8.40 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 8.41 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

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.42 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 8.43 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-111013 - Physical and Data-Based Modelling must not have been started.
2. The course T-ETIT-112223 - Cyber Physical Production Systems must not have been started.

T 8.44 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 8.45 Course: Deep Learning and Neural Networks [T-INFO-109124]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-104460 - Deep Learning and Neural Networks

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	1

Events					
ST 2025	2400024	Deep Learning and Neural Networks	4 SWS	Lecture / 🗣	Niehues

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
T-INFO-101383 - Neural networks must not be started.

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

T 8.46 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

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.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-109796 - Deep Learning for Computer Vision must not have been started.

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 8.47 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 8.48 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 8.49 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 8.50 Course: Development Lab Medical Measurement Technology [T-ETIT-113626]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106779 - Medical Measurement Technology Lab

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each summer term	1

Competence Certificate
The examination of the Development Lab takes place in form of other types of examinations. It consists of 6 graded protocols to the 6 experiments.
The grade for the Development Lab is the average grade of the 6 protocols.

The module grade is the grade for the Development Lab.

Prerequisites
Students may only take part in the Development Lab if they have successfully completed the Preparatory Lecture and the Preparatory Lab.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-ETIT-113758 - Preparatory Lab Medical Measurement Technology must have been passed.
2. The course T-ETIT-113721 - Preparatory Lecture Medical Measurement Technology must have been passed.

T 8.51 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 8.52 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 8.53 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 8.54 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 8.55 Course: Digital Twin Engineering [T-ETIT-112224]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106040 - Digital Twin Engineering

Type	Credits	Grading 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

8.56 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 8.57 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 8.58 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 8.59 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 8.60 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	Expansion	Version
Written examination	5	Grade to a third	1 terms	2

Competence Certificate
Written exam, 180 minutes

Prerequisites
None

Workload
150 hours

T 8.61 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

T 8.62 Course: Educational Development for Student Teachers - Basic Level [T-ETIT-100797]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-103248 - Key Competences

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.

8.63 Course: Elective Specialization Supplementary Studies on Science, Technology and Society / About Knowledge and Science - Self-Registration [T-FORUM-113580]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Competence Certificate
Another type of examination assessment under § 5, section 3 involves a presentation, term paper, or project work within the chosen course.

Prerequisites
None

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendation
The contents of the basic module are helpful. The basic module should be completed or attended in parallel, but not after the advanced module.
The reading recommendations for primary and specialist literature are determined individually by the respective lecturers according to the subject area and course.

Annotation
This placeholder can be used for any achievement in the Advanced Unit of the Supplementary Studies.

In the Advanced Module, students can choose their own individual focus, e.g. sustainable development, data literacy, etc. The focus should be discussed with the module coordinator at the FORUM.

T 8.64 Course: Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Public Debates - Self Registration [T-FORUM-113582]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Competence Certificate
Another type of examination assessment under § 5, section 3 involves a presentation, term paper, or project work within the chosen course.

Prerequisites
None

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendation
The contents of the basic module are helpful. The basic module should be completed or attended in parallel, but not after the advanced module.
The reading recommendations for primary and specialist literature are determined individually by the respective lecturers according to the subject area and course.

Annotation
This placeholder can be used for any achievement in the Advanced Unit of the Supplementary Studies.

T 8.65 Course: Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Society - Self-Registration [T-FORUM-113581]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Competence Certificate
Another type of examination assessment under § 5, section 3 involves a presentation, term paper, or project work within the chosen course.

Prerequisites
None

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendation
The contents of the basic module are helpful. The basic module should be completed or attended in parallel, but not after the advanced module.
The reading recommendations for primary and specialist literature are determined individually by the respective lecturers according to the subject area and course.

Annotation
This placeholder can be used for any achievement in the Advanced Unit of the Supplementary Studies.

T 8.66 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 8.67 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 8.68 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 8.69 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 8.70 Course: Electrical Engineering Components [T-ETIT-109292]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-102734 - Materials

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	2

Events					
WT 24/25	2312700	Electrical Engineering Components	3 SWS	Lecture / 🗣	Kempf, Lemmer
WT 24/25	2312701	Tutorial for 2312700 Electrical Engineering Components	1 SWS	Practice / 🗣	Ilin

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.

Prerequisites
none

T 8.71 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 8.72 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 8.73 Course: Energy Informatics 1 [T-INFO-103582]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: M-INFO-106864 - Energy Informatics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	2

Events					
WT 24/25	2400058	Energy Informatics 1	4 SWS	Lecture / Practice (	Hagenmeyer, Süß, Schmurr, Langner

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-110356 - Energy Informatics 1 - Preliminary Work must have been passed.

T 8.74 Course: Energy Informatics 1 - Preliminary Work [T-INFO-110356]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: M-INFO-106864 - Energy Informatics

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	0	pass/fail	Each term	1

T 8.75 Course: Energy Informatics 2 [T-INFO-106059]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: M-INFO-106864 - Energy Informatics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each summer term	2

Events					
ST 2025	2400017	Energy Informatics 2	4 SWS	Lecture / Practice (/ 🗣	Hagenmeyer, Förderer, Bao, Elbez, Suess, Kühnapfel, Cakmak, Mikut

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-103582 - Energy Informatics 1 must have been passed.
2. The course T-INFO-110356 - Energy Informatics 1 - Preliminary Work must have been passed.

T 8.76 Course: Engineering Mechanics IV [T-MACH-105274]

Responsible: Prof. Dr.-Ing. Carsten Proppe
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103205 - Engineering Mechanics

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	2

Competence Certificate
Written examination, 75 Min.

T 8.77 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-103248 - Key Competences M-MACH-102755 - Engineer's Field of Work

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 8.78 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 /	Terzidis, Dang
ST 2025	2545001	Entrepreneurship	2 SWS	Lecture /	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

T 8.79 Course: Ethics of Technology - ARs ReflecTIonis [T-ETIT-111923]

Responsible: Dr. phil. Michael Kühler
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103248 - Key Competences

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	2	pass/fail	Each term	1 terms	1

Events					
WT 24/25	9003013	ARS REFLECTIONIS. Thinking and Acting Responsibly in Engineering, Science, and Innovation		Block / 🖥	Does, Krüger
ST 2025	9003013	ARS REFLECTIONIS. Thinking and Acting Responsibly in Engineering, Science, and Innovation		Block / 🧩	Does, Krüger, Derpmann

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Prerequisites
none

T 8.80 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 8.81 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 8.82 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 8.83 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 8.84 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 8.85 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 8.86 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 8.87 Course: Fuzzy Sets [T-INFO-101376]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: M-INFO-100839 - Fuzzy Sets

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each summer term	1

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes

Prerequisites
None.

Recommendation
Basic knowledge of formal logic and expert systems is helpful.

T 8.88 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 8.89 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 8.90 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, ✕ 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 8.91 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 8.92 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

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written exam, approx. 3 h

Prerequisites
none

Workload
120 hours

T 8.93 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 8.94 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 8.95 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

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 8.96 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 8.97 Course: Humanoid Robotics Laboratory [T-INFO-111590]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-105792 - Humanoid Robotics Laboratory

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each winter term	3

Events					
WT 24/25	2424890	Humanoid Robotics Laboratory	4 SWS	Practical course / 🗣	Asfour, Meixner, Dreher

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-105142 - Humanoid Robots - Practical Course must not have been started.

Recommendation

- Very good programming skills in at least one high-level programming language are strongly recommended.
- Attendance of the lectures Robotics 1, Robotics 2, Robotics 3, as well as the robotics practical course are recommended.
- Project-specific recommendations (knowledge of C++, Python, ...) will be announced in the individual project descriptions

Annotation

- Internship dates are always by arrangement with the supervising staff member.
- An extension work of the topic as a master thesis is possible in principle.
- The number of participants in this practical course is generally **limited** and varies with the number of available research projects at the institute.

T 8.98 Course: Humanoid Robots - Locomotion and Whole-Body Control [T-INFO-113395]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106649 - Humanoid Robots - Locomotion and Whole-Body Control

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

Events					
ST 2025	2400135	Humanoid Robots – Locomotion and Whole-Body Control	4 SWS	Lecture / 🗣	Mombaur, Ackermann

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).

The grade of the course is given based on the performance in in an individual programming project on the topic of humanoid robots, which consists of the definition and solution of the project itself as well as a subsequent oral presentation in a block event and the submission of a written report. Project work starts in the exercise slots during the second half of the term and ends during the lecture free time.

As a prerequisite for the enrollment in the project, the students must regularly and successfully participate in the exercises and present their results for the exercise sheets during the first part of the term, according to the modalities announced at the beginning of the course.
Both components can be completed in the same group of two students. Withdrawal is possible until 2 weeks after enrollment in the project.
Active participation in the class is expected from all students and is a necessary requirement for the course.

Prerequisites

- Completion of module Robotics 1 or corresponding knowledge required.
- Programing skills

Recommendation
Attendance of the lectures Robotics I - Introduction to Robotics and Mechano-Informatics in Robotics is required.

Annotation
Limitation to 30 participants

T 8.99 Course: Humanoid Robots - Locomotion and Whole-Body Control -Pass [T-INFO-114282]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106649 - Humanoid Robots - Locomotion and Whole-Body Control

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (oral)	0	pass/fail	Each term	1

Events					
ST 2025	2400135	Humanoid Robots – Locomotion and Whole-Body Control	4 SWS	Lecture / 🗣	Mombaur, Ackermann

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO).

The grade of the course is given based on the performance in in an individual programming project on the topic of humanoid robots, which consists of the definition and solution of the project itself as well as a subsequent oral presentation in a block event and the submission of a written report. Project work starts in the exercise slots during the second half of the term and ends during the lecture free time.

As a prerequisite for the enrollment in the project, the students must regularly and successfully participate in the exercises and present their results for the exercise sheets during the first part of the term, according to the modalities announced at the beginning of the course.
Both components can be completed in the same group of two students. Withdrawal is possible until 2 weeks after enrollment in the project.
Active participation in the class is expected from all students and is a necessary requirement for the course.

Prerequisites

- Completion of module Robotics 1 or corresponding knowledge required.
- Programing skills

Recommendation
Attendance of the lectures Robotics I - Introduction to Robotics and Mechano-Informatics in Robotics is required.

Annotation
Limitation to 30 participants

T 8.100 Course: Humanoid Robots - Seminar [T-INFO-105144]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-102561 - Humanoid Robots - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2400048	Seminar Humanoid Robots	2 SWS	Seminar / 🗣	Asfour, Meixner, Plewnia

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 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 8.101 Course: Industrial Business Administration [T-WIWI-100796]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-ETIT-103248 - Key Competences

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 8.102 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

8.103 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.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-105230 - Decentrally Controlled Intralogistic Systems must not have been 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

8.104 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

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
Alternative exam assessment (written composition and speech)

Prerequisites
None

Workload
90 hours

T 8.105 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, Cancelled

Prerequisites
none

T 8.106 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 8.107 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

T 8.108 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 8.109 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

8.110 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 8.111 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 8.112 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-102626 - Major Field: 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 8.113 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 8.114 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-103248 - Key Competences

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

8.115 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 / Blended	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 8.116 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 8.117 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 8.118 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 8.119 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 8.120 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 8.121 Course: Introduction to Multi-Body Dynamics [T-MACH-105209]

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

Part of: M-MACH-103205 - Engineering Mechanics

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	2

Competence Certificate
Written examination, 180 min.

Prerequisites
none

Recommendation
Engineering Mechanics III/IV

Workload
150 hours

T 8.122 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-103248 - Key Competences

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 8.123 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 8.124 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 8.125 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 8.126 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 8.127 Course: Lab Course Electrical Drives and Power Electronics [T-ETIT-100718]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100401 - Lab Course Electrical Drives and Power Electronics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	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

Prerequisites
none

T 8.128 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 8.129 Course: Laboratory Biomedical Engineering [T-ETIT-101934]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100389 - Laboratory Biomedical Engineering

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each summer term	4

Events					
ST 2025	2305276	Laboratory Biomedical Engineering	4 SWS	Practical course / 🗣	Nahm

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
Success is assessed in the form of a different type of examination. The examination is carried out by evaluating the written preparation and follow-up protocols for the individual experiments.

The experiments and protocols are always carried out or prepared in joint teamwork by a team consisting of two or, in special cases, three permanent internship participants. It must be possible to assign which participant worked on which task. The preparation protocols will be checked in advance of a practical course and an insufficient assessment will lead to exclusion from the course. We reserve the right to review individual preparation questions in an oral form at the beginning of the practical course. Attendance is compulsory for the individual internship dates. In the event of absence or exclusion from the attempt, the individual attempt will be assessed with the grade "unsatisfactory". If students are excluded twice, the internship will be assessed as "failed".

Prerequisites
Passed exam of the module "Biomedizinische Messtechnik I" or "Medical Measurement Technology".

Recommendation
- Knowledge of physiological principles from the lecture Physiology and Anatomy
- Knowledge of the generation and measurement of bioelectric signals from the lecture Bioelectric Signals
- Knowledge of signal processing from the lecture Signal Processing in Communications Engineering
- Basic knowledge of Matlab

8.130 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 8.131 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, ✕ 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 8.132 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.

T 8.133 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

T 8.134 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 8.135 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 8.136 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 8.137 Course: Leadership in Interdisciplinary Teams [T-MACH-106460]

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

Part of: M-ETIT-103248 - Key Competences

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 /	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 8.138 Course: Lecture Series Supplementary Studies on Science, Technology and Society - Self Registration [T-FORUM-113578]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	2	pass/fail	Each summer term	1 terms	1

Competence Certificate
Active participation, learning protocols, if applicable.

Prerequisites
None

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendation
It is recommended that you complete the lecture series "Science in Society" before attending events in the advanced module and in parallel with attending the basic seminar.
If it is not possible to attend the lecture series and the basic seminar in the same semester, the lecture series can also be attended after attending the basic seminar.
However, attending events in the advanced module before attending the lecture series should be avoided.

Annotation
The basic module consists of the lecture series "Science in Society" and the basic seminar. The lecture series is only offered during the summer semester.
The basic seminar can be attended in the summer or winter semester.

T 8.139 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

T 8.140 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

T 8.141 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 8.142 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 8.143 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

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-102089 - Logistics - Organisation, Design and Control of Logistic Systems must not have been started.

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

T 8.144 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 / Online	Proppe
ST 2025	2161224	Machine Dynamics	2 SWS	Lecture / On-Site	Proppe
ST 2025	2161225	Machine Dynamics (Tutorial)	1 SWS	Practice / On-Site	Proppe, Fischer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
written exam, 180 min.

Prerequisites
none

Workload
150 hours

T 8.145 Course: Machine Learning - Foundations and Algorithms [T-INFO-111558]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-105778 - Machine Learning - Foundations and Algorithms

Type	Credits	Grading 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 8.146 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 8.147 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 8.148 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 8.149 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 8.150 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 8.151 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.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-110963 - Machine Tools and High-Precision Manufacturing Systems must not have been started.

Workload
240 hours

T 8.152 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 8.153 Course: Master's Thesis [T-ETIT-106463]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103253 - Master's Thesis

Type	Credits	Grading scale	Recurrence	Version
Final Thesis	30	Grade to a third	Each term	1

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 8.154 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 8.155 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 8.156 Course: Measurement Technology [T-ETIT-112147]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105982 - Measurement Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each winter term	1

Events					
WT 24/25	2302117	Measurement Technology	2 SWS	Lecture / 🧩	Heizmann
WT 24/25	2302118	Exercise for 2302117 Measurement Technology	1 SWS	Practice / 🗣	Heizmann, Schmerbeck

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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
T-ETIT-101937 – Messtechnik (German version) must not have started.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-ETIT-101937 - Measurement Technology must not have been started.

T 8.157 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

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-114071 - Mechanical Properties of Nanomaterials and Microsystems must not have been started.

Workload
120 hours

T 8.158 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 8.159 Course: Medical Imaging Technology II [T-ETIT-113421]

Responsible: Prof. Dr.-Ing. Maria Francesca Spadea
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106670 - Medical Imaging Technology II

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	1

Events					
ST 2025	2305262	Medical Imaging Technology II	2 SWS	Lecture / ✕	Spadea, Arndt
ST 2025	2305263	Medical Imaging Technology	4 SWS	Lecture / Practice (/ 🗣	Spadea, Arndt

Legend: 🖥 Online, ✿ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The examination takes place in form of a written examination lasting 90 minutes. The course grade is the grade of the written exam.

Prerequisites
none

8.160 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 8.161 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 8.162 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 8.163 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 8.164 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 8.165 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.

8.166 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 / 🗣	Pauli
ST 2025	2308415	Microwave Engineering Lab	4 SWS	Practical course / 🗣	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 8.167 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 8.168 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 / 🧩	Matthes, Groell
ST 2025	2106020	Tutorial on Modern Control Concepts I	2 SWS	Practice / 🖥	Matthes

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written exam (Duration: 1 h)

Prerequisites
none

Workload
120 hours

T 8.169 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 8.170 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 8.171 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 8.172 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 8.173 Course: Motor Vehicle Labor [T-MACH-105222]

Responsible: Dr.-Ing. Michael Frey
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102695 - Motor Vehicle Laboratory

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each term	4

Events					
WT 24/25	2115808	Motor Vehicle Laboratory	2 SWS	Practical course / 🗣	Frey
ST 2025	2114833	Motor Vehicle Labor	2 SWS	Practical course / 🗣	Frey
ST 2025	2115808	Motor Vehicle Laboratory	2 SWS	Practical course / 🗣	Frey

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
Colloquium before each experiment

After completion of the experiments: written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
none

Workload
120 hours

T 8.174 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

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-ETIT-100971 - Nanoelectronics must not have been started.

Recommendation
Successful completion of the modules "Superconductivity for Engineers" and „Einführung in die Quantentheorie für Elektrotechniker“ is recommended.

T 8.175 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 8.176 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 8.177 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 8.178 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

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 8.179 Course: Optical Communications Laboratory [T-ETIT-100742]

Responsible: Prof. Dr.-Ing. Christian Koos
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100437 - Optical Communicatons Laboratory

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

Prerequisites
none

T 8.180 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

8.181 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 8.182 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 8.183 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 8.184 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 8.185 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 8.186 Course: Optoelectronics [T-ETIT-100767]

Responsible: Prof. Dr. Ulrich Lemmer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100480 - Optoelectronics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	3

Events					
WT 24/25	2313726	Optoelectronics	2 SWS	Lecture / ✕	Lemmer
WT 24/25	2313728	Übungen zu 2313726 Optoelektronik	1 SWS	Practice / ✕	Lemmer
ST 2025	2313726	Optoelectronics	2 SWS	Lecture / 🗣	Lemmer
ST 2025	2313728	Practice to 2313726 Optoelectronics	1 SWS	Practice / 🗣	Lemmer

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The success check is carried out in the context of a written exam (90 minutes).

Prerequisites
none

Recommendation
Knowledge of solid state electronics

T 8.187 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

8.188 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 8.189 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
"M-ETIT-100524 - 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.

8.190 Course: Physiology and Anatomy for Biomedical Engineering [T-ETIT-111815]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105874 - Physiology and Anatomy for Biomedical Engineering

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	1

Events					
WT 24/25	2305281	Physiology and Anatomy for Engineers I	2 SWS	Lecture / 🗣	Nahm
ST 2025	2305282	Physiology and Anatomy for Engineers II	2 SWS	Lecture / 🗣	Nahm

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The exmaniation is carried out in the form of a written test of 120 minutes.

The examination includes the contents of Physiologie und Anatomie I (offered every winter term) and Physiologie und Anatomie II (offered every summer term).

Prerequisites
The courses "T-ETIT-101932 - Physiologie und Anatomie I" und "T-ETIT-101933 - Physiologie und Anatomie II" must not been started.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-ETIT-101932 - Physiology and Anatomy for Engineers I must not have been started.
2. The course T-ETIT-101933 - Physiology and Anatomy for Engineers II must not have been started.

Annotation
Winter/summer term:

WT: Physiologie und Anatomie I
ST: Physiologie und Anatomie II

T 8.191 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 8.192 Course: Plastic Electronics / Polymerelectronics [T-ETIT-100763]

Responsible: Prof. Dr. Ulrich Lemmer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100475 - Plastic Electronics / Polymerelectronics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2313709	Polymerelectronics/ Plastic Electronics	2 SWS	Lecture / ⚙	Hernandez Sosa

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
The control of success takes place within the framework of an oral overall examination (approx. 30 minutes).

Prerequisites
none

Recommendation
Knowledge of semiconductor devices

Annotation
Lecture and examination are held in German or English, as required.

T 8.193 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 8.194 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 8.195 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 8.196 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 8.197 Course: Power Network [T-ETIT-100830]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100572 - Power Network

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each winter term	2

Events					
WT 24/25	2307371	Power Network	2 SWS	Lecture / 🗣	Leibfried
WT 24/25	2307373	Tutorial for 2307371 Power Network	1 SWS	Practice / 🗣	Leibfried, Geis-Schroer

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.198 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 8.199 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 8.200 Course: Practical Course: Human-Centred Robotics [T-INFO-113393]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106646 - Practical Course: Human-Centred Robotics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

Events					
WT 24/25	2400193	Practical Course: Human-Centred Robotics Projects	4 SWS	Practical course / 🗣	Mombaur
ST 2025	2400149	Practical course: Human-Centred Robotics	4 SWS	Practical course / 🗣	Mombaur, Lee

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

This includes the preparation of a project report (ca. 10 pages and an oral presentation with slides and hardware demonstration (30 Min + 15 min questions). Students may withdraw from the examination during the first two weeks after the topic has been communicated.

Prerequisites
Programming skills are required.

Recommendation
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) are very helpful.

Annotation
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week.

T 8.201 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

Modeled Conditions

The following conditions have to be fulfilled:

1. The course T-INFO-105278 - Practical Course Research Project: Hands-on Anthropomatics must not have been started.

T 8.202 Course: Practical Course: Mathematical and Computational Methods in Robotics and AI [T-INFO-113893]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106928 - Practical Course: Mathematical and Computational Methods in Robotics and AI

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

Events					
WT 24/25	2400191	Basic Practical Course: Mathematical and Computational Methods in Robotics & AI	4 SWS	Practical course / 🗣	Mombaur

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).

This includes the preparation of a project report (ca. 10 pages and an oral presentation (30 Min + 15 min questions). Students may withdraw from the examination during the first two weeks after the topic has been communicated.

Prerequisites
Programming skills

Recommendation
Basic mathematical knowledge will be helpful, depending on topic. For Projects in the context of robotics, knowledge of robotics is recommended, but not strictly necessary.

Annotation
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week or can be indivdually agreed upon with people supervising the practical. Students can propose topics on their own as well.

T 8.203 Course: Practical Course: Movement and Technology [T-INFO-113394]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106648 - Practical Course: Movement and Technology

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each summer term	2

Events					
ST 2025	2400151	Practical Course: Movement and Technology	4 SWS	Practical course / 🗣	Mombaur, Lau

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

This includes the preparation of a project report (ca. 10 pages and an oral presentation of the project topics and results with slides. Students may withdraw from the examination during the first two weeks after the topic has been communicated.

Prerequisites
Programming skills are required.

Recommendation
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) are very helpful.

Programming skills.

Annotation
Limited number of projects and participants. Specific project topics will be different each term and will be announced in a presentation during the first semester week.

T 8.204 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 8.205 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

T 8.206 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

Modeled Conditions
You have to fulfill one of 2 conditions:

1. The course T-INFO-105107 - Robotics - Practical Course must not have been started.
2. The course T-INFO-104552 - Practical Project Robotics and Automation II (Hardware) must not have been started.

T 8.207 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

Modeled Conditions

You have to fulfill one of 2 conditions:

1. The course T-INFO-105107 - Robotics - Practical Course must not have been started.
2. The course T-INFO-104545 - Practical Project Robotics and Automation I (Software) must not have been started.

T 8.208 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 8.209 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
Examination of another type	4	Grade to a third	Each term	1

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
The assessment consists of a written exam

Prerequisites
none

8.210 Course: Preparatory Lab Medical Measurement Technology [T-ETIT-113758]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106779 - Medical Measurement Technology Lab

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	1	pass/fail	Each winter term	2

Competence Certificate
The examination of the Preparatory Lab takes place in form of other types of examinations. It consists of an ungraded practical test.

Prerequisites
none

8.211 Course: Preparatory Lecture Medical Measurement Technology [T-ETIT-113721]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106779 - Medical Measurement Technology Lab

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	2	pass/fail	Each winter term	2

Competence Certificate
The examination of the Preparatory Lecture takes place in form of other types of examinations. It consists of an ungraded written test.

Prerequisites
none

T 8.212 Course: Principles of Medicine for Engineers [T-MACH-105235]

Responsible: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102720 - Principles of Medicine for Engineers

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2105992	Principles of Medicine for Engineers	2 SWS	Lecture / 🗣	Pylatiuk

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination (Duration: 45min)

Prerequisites
none

Workload
120 hours

T 8.213 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

8.214 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 8.215 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-103248 - Key Competences
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 8.216 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 /	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 8.217 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 8.218 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 8.219 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 8.220 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 8.221 Course: Registration for Certificate Issuance - Supplementary Studies on Science, Technology and Society [T-FORUM-113587]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	0	pass/fail	Each term	1

Prerequisites

In order to register, it is mandatory that the basic module and the advanced module have been completed and that the grades for the partial performances in the advanced module are available.

Registration as a partial achievement means the issue of a certificate.

T 8.222 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, × 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 8.223 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 8.224 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 8.225 Course: Robotics - Practical Course [T-INFO-105107]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-102522 - Robotics - Practical Course

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each summer term	2

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
You have to fulfill one of 2 conditions:

1. The course T-INFO-104545 - Practical Project Robotics and Automation I (Software) must not have been started.
2. The course T-INFO-104552 - Practical Project Robotics and Automation II (Hardware) 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 8.226 Course: Robotics I - Introduction to Robotics [T-INFO-108014]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-100893 - Robotics I - Introduction to Robotics

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	2

Events					
WT 24/25	2424152	Robotics I - Introduction to Robotics		Lecture / 🗣	Asfour, Daab, Hyseni

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.

8.227 Course: Robotics II - Humanoid Robotics [T-INFO-105723]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-102756 - Robotics II - Humanoid Robotics

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	4

Events					
ST 2025	2400074	Robotics II: Humanoid 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.

Recommendation
Having visited the lectures on Robotics I - Introduction to Robotics and Mechano-Informatics and Robotics is recommended.

T 8.228 Course: Robotics III - Sensors and Perception in Robotics [T-INFO-109931]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-104897 - Robotics III - Sensors and Perception in Robotics

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	2

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-101352 - Robotics III - Sensors in Robotics must not have been started.

Recommendation
Attending the lecture Robotics I – Introduction to Robotics is recommended.

T 8.229 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 8.230 Course: Self Assignment-HOC-SPZ-FORUM-graded [T-ETIT-111528]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103248 - Key Competences

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1

Self service assignment of supplementary stdues
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 8.231 Course: Self Assignment-HOC-SPZ-FORUM-graded [T-ETIT-111526]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103248 - Key Competences

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1

Self service assignment of supplementary stdues
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 8.232 Course: Self Assignment-HOC-SPZ-FORUM-graded [T-ETIT-111527]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103248 - Key Competences

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1

Self service assignment of supplementary stdues
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 8.233 Course: Self Assignment-HOC-SPZ-FORUM-ungraded [T-ETIT-111531]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103248 - Key Competences

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

Self service assignment of supplementary stdues
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 8.234 Course: Self Assignment-HOC-SPZ-FORUM-ungraded [T-ETIT-111532]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-103248 - Key Competences

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

Self service assignment of supplementary stdues

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 8.235 Course: Self Assignment-HOC-SPZ-FORUM-ungraded [T-ETIT-111530]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103248 - Key Competences

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

Self service assignment of supplementary stdues
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 8.236 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, ✕ 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 8.237 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-103248 - Key Competences

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 8.238 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 8.239 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

T 8.240 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 / 🗣	Becker, Sax, Stork
ST 2025	2311627	Seminar Embedded Systems	2 SWS	Seminar / 🧩	Becker, Sax, Stork

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

T 8.241 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 8.242 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 8.243 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 8.244 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-103248 - Key Competences

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 8.245 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-103248 - Key Competences

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 8.246 Course: Seminar: Assistive robotics and exoskeletons in medical applications [T-INFO-112922]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106400 - Seminar: Assistive robotics and exoskeletons in medical applications

Type	Credits	Grading 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). This includes the preparation of a term paper in form aof a scientific paper (6 pages double column) an oral presentation with slides (30 Min + 15 Min discussion) . Students may redraw from the examination during the first two weeks after the topic has been communicated.

Participation in the block seminar is mandatory.
Students have to actively participate in all discussions.

Recommendation
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) is helpful

Annotation
Max 10 Participants

T 8.247 Course: Seminar: Energy Informatics [T-INFO-106270]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: M-INFO-103153 - Seminar: Energy Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Events					
WT 24/25	2400013	Seminar: Energy Informatics	2 SWS	Seminar / 🗣	Hagenmeyer, Bläsius, Bauer, Geiges, Süß

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 8.248 Course: Seminar: Exoskelette & Motion Capture [T-INFO-113892]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106927 - Seminar: Exoskelette & Motion Capture

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2400187	Seminar: Exoskeletons & Motion Capture	2 SWS	Seminar / 🗣	Mombaur

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).

This includes the preparation of a term paper in form of a scientific paper (6 pages double column) an oral presentation with slides (30 Min + 15 Min discussion) . Students may redraw from the examination during the first two weeks after the topic has been communicated.

Participation in the block seminar is mandatory.
Students have to actively participate in all discussions.

Prerequisites
None.

Recommendation
Knowledge in Robotics (e.g. from the class Robotics 1 and follow-ups) is helpful

T 8.249 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 8.250 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 8.251 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 / 🧩	Wahls
WT 24/25	2302115	Tutorial to 2302113 Signal Processing Methods	2 SWS	Practice / 🗣	Wahls, Al-Hammadi

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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.

8.252 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 8.253 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 8.254 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	3

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
Completion of module Robotics 1 or corresponding knowledge required
Programing skills in C/C++

Modeled Conditions
The following conditions have to be fulfilled:

1. You have to fulfill one of 2 conditions:
    1. The course T-INFO-101465 - Robotics I - Introduction to Robotics must have been passed.
    2. The course T-INFO-108014 - Robotics I - Introduction to Robotics must have been passed.

Annotation
Limitation to 30 participants

T 8.255 Course: Software Engineering [T-ETIT-108347]

Responsible: Dr. Clemens Reichmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100450 - Software Engineering

Type	Credits	Grading 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 8.256 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.

T 8.257 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 8.258 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 8.259 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 8.260 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-103248 - Key Competences

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 8.261 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	1

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 8.262 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	1

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 8.263 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 8.264 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 8.265 Course: Systematic Materials Selection [T-MACH-100531]

Responsible: Dr.-Ing. Stefan Dietrich
Prof. Dr.-Ing. Volker Schulze

Organisation: KIT Department of Mechanical Engineering

Part of: M-ETIT-102734 - Materials

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	5

Events					
ST 2025	2174576	Systematic Materials Selection	3 SWS	Lecture / 🗣	Dietrich
ST 2025	2174577	Excercises in Systematic Materials Selection	1 SWS	Practice / 🗣	Dietrich

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
The assessment is carried out as a written exam of 2 h.

Prerequisites
Application and exam is allowed only in one lecture of this modul (M-ETIT-102734 - Werkstoffe):

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-105535 - Composite Manufacturing - Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies must not have been started.

Recommendation
Basic knowledge in materials science, mechanics and mechanical design due to the lecture Materials Science I/II.

Workload
120 hours

T 8.266 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 8.267 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 / Blended	Sax
WT 24/25	2311607	Tutoral for 2311605 Systems and Software Engineering	1 SWS	Practice / Blended	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 8.268 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 8.269 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 8.270 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, ✕ Cancelled

Competence Certificate
Oral examination of about 30 minutes

Prerequisites
none

Workload
120 hours

T 8.271 Course: Tutorial Computational Continuum Mechanics [T-MACH-112996]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103205 - Engineering Mechanics

Type	Credits	Grading scale	Recurrence	Expansion	Version
Completed coursework	1	pass/fail	Each summer term	1 terms	1

Events					
ST 2025	2162262	Tutorial Computational Continuum Mechanics	2 SWS	Practice / 🗣	Hille, Lalović, Böhlke

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Successful solution of the homework sheets. Details are announced during the first lecture "Computational Continuum Mechanics".

Prerequisites
none

Workload
30 hours

T 8.272 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

8.273 Course: Ubiquitous Computing [T-INFO-101326]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-100789 - Ubiquitous Computing

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	1

Events					
WT 24/25	2424146	Ubiquitäre Informationstechnologien		Lecture / Practice (	Beigl, Röddiger

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

T 8.274 Course: Vehicle Lightweight Design - Strategies, Concepts, Materials [T-MACH-114010]

Responsible: Prof. Dr.-Ing. Frank Henning

Organisation: KIT Department of Mechanical Engineering

Lightweight Design

Part of: M-MACH-107013 - Vehicle Lightweight Design - Strategies, Concepts, Materials

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	2

Competence Certificate
written exam, duration 180 minutes

Prerequisites
T-MACH-114001 - Lightweighting Concepts and Technologies not started

Workload
120 hours

T 8.275 Course: Vehicle Lightweight Design - Strategies, Concepts, Materials [T-MACH-105237]

Responsible: Prof. Dr.-Ing. Frank Henning
Organisation: KIT Department of Mechanical Engineering

Lightweight Design

Part of: 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 8.276 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 8.277 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 8.278 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 8.279 Course: Wearable Robotic Technologies [T-INFO-106557]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-103294 - Wearable Robotic Technologies

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	4

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.

Recommendation
Attending the lecture Mechano-Informatics and Robotics is recommended.

9 Appendix

9.1 Definition - About this MHB

MHB, PDF-Version: **https://s.kit.edu/mhb-mit-msc15-en**