Karlsruher Institut für Technologie

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

SPO 2015

Summer term 2024

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KIT DEPARTMENT OF MECHANICAL ENGINEERING / KIT DEPARTMENT OF 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 Competence 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:

A – 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).

B – 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).

C – 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.

D – 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.

2.2 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.

2.3 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 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.*	

3.1 Master's Thesis

Credits
30

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

3.2 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

3.3 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: Medical 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

3.3.1 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-106513	Railway System Digitalisation	4 CR
M-MACH-102700	Dynamics of the Automotive Drive Train	5 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

3.3.2 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-100419	Lab Course Electrical Power Engineering	6 CR
M-ETIT-100401	Lab Course Electrical Drives and Power Electronics	6 CR
M-ETIT-100415	Laboratory Information Systems in Power Engineering	6 CR
M-INFO-105955	Practical Course: Smart Energy System Lab	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-INFO-101885	Energy Informatics 1	5 CR
M-INFO-103044	Energy Informatics 2	5 CR
M-ETIT-100534	Power Transmission and Power Network Control	5 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

3.3.3 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-102698	Actuators and Sensors in Nanotechnology	4 CR
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-INFO-100895	Information Processing in Sensor Networks	6 CR
M-ETIT-100474	Integrated Systems and Circuits	4 CR
M-MACH-102713	Mechanics in Microtechnology	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-ETIT-105607	Seminar on Quantum Detectors and Sensors	3 CR
M-MACH-105315	System Integration in Micro- and Nanotechnology	4 CR
M-MACH-105316	System Integration in Micro- and Nanotechnology 2	4 CR

3.3.4 Field of Specialization: Medical Technology

Part of: Field of Specialization

Credits
35

Election notes

In the Field of Specialization "Medical Technology" 35 CR must be selected. Through the compulsory modules there is a remaining number of 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-ETIT-100387	Biomedical Measurement Techniques I	3 CR
M-MACH-100489	BioMEMS - Microsystems Technologies for Life Sciences and Medicine I	4 CR
M-MACH-102702	Organ Support Systems	4 CR
M-MACH-102720	Principles of Medicine for Engineers	4 CR
M-ETIT-106449	Medical Imaging Technology I	3 CR
M-ETIT-100389	Laboratory Biomedical Engineering	6 CR
Complementary Modules (Election:)		
M-INFO-103294	Wearable Robotic Technologies	4 CR
M-MACH-105485	Current Topics on BioMEMS	4 CR
M-ETIT-100549	Bioelectric Signals	3 CR
M-ETIT-100388	Biomedical Measurement Techniques II	3 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-INFO-100725	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	3 CR
M-ETIT-106670	Medical Imaging Technology II neu	3 CR
M-ETIT-105874	Physiology and Anatomy for Biomedical Engineering	6 CR
M-INFO-102374	Seminar Accessibility - Assistive Technologies for Visually Impaired Persons	3 CR
M-ETIT-100560	Ultrasound Imaging	3 CR

3.3.5 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-102687	Decentrally Controlled Intralogistic Systems	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-MACH-105108	Automated Manufacturing Systems	8 CR
M-ETIT-106039	Cyber Physical Production Systems	4 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-ETIT-103043	Manufacturing Measurement Technology	3 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-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	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

3.3.6 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-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-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-105468	Physical and Data-Based Modelling	6 CR
M-ETIT-105915	Control of Power-Electronic Systems	6 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-INFO-100829	Stochastic Information Processing	6 CR

3.3.7 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-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 neu	6 CR
M-MACH-106050	Reliability and Test Engineering	5 CR
Complementary Modules (Election:)		
M-MACH-102698	Actuators and Sensors in Nanotechnology	4 CR
M-INFO-103294	Wearable Robotic Technologies	4 CR
M-INFO-100826	Automated Visual Inspection and Image Processing	6 CR
M-INFO-100814	Biologically Inspired Robots	3 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-102561	Humanoid Robots - Seminar	3 CR
M-INFO-100791	Innovative Concepts for Programming Industrial Robots	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 neu	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 neu	6 CR
M-INFO-102212	Seminar Intelligent Industrial Robots	3 CR
M-MACH-105348	Control Technology	4 CR

3.3.8 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	8 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-106039	Cyber Physical Production Systems	4 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 neu	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

3.4 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-MACH-102698	Actuators and Sensors in Nanotechnology	4 CR
M-MACH-105485	Current Topics on BioMEMS	4 CR
M-ETIT-100444	Applied Information Theory	6 CR
M-ETIT-100565	Antennas and Multiple Antenna Systems	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-105108	Automated Manufacturing Systems	8 CR
M-MACH-103232	Rail System Technology	4 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-INFO-100814	Biologically Inspired Robots	3 CR
M-ETIT-100387	Biomedical Measurement Techniques I	3 CR
M-ETIT-100388	Biomedical Measurement Techniques II	3 CR
M-MACH-100489	BioMEMS - Microsystems Technologies for Life Sciences and Medicine I	4 CR
M-MACH-100490	BioMEMS - Microsystems Technologies for Life Sciences and Medicine II	4 CR
M-MACH-100491	BioMEMS - Microsystems Technologies for Life Sciences and Medicine III	4 CR
M-MACH-105483	BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV	4 CR
M-MACH-105484	BioMEMS - Microfludic Chipsystems V	4 CR
M-ETIT-105616	Channel Coding: Algebraic Methods for Communications and Storage	3 CR
M-MACH-105296	Computational Intelligence	4 CR
M-ETIT-100539	Communication Systems and Protocols	5 CR
M-ETIT-106039	Cyber Physical Production Systems	4 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-MACH-102687	Decentrally Controlled Intralogistic Systems	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	5 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-100572	Power Network	5 CR
M-MACH-105015	Elements of Technical Logistics incl. Project	6 CR
M-MACH-102688	Elements of Technical Logistics	4 CR
M-ETIT-100419	Lab Course Electrical Power Engineering	6 CR
M-ETIT-100534	Power Transmission and Power Network Control	5 CR
M-ETIT-100413	Power Systems and Economy	3 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-ETIT-103043	Manufacturing Measurement Technology	3 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	8 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-100453	Hardware/Software Co-Design	4 CR
M-ETIT-100452	Hardware Synthesis and Optimisation	6 CR
M-ETIT-100417	High-Voltage Test Technique	4 CR
M-ETIT-105060	High-Voltage Technology	6 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-INFO-100895	Information Processing in Sensor Networks	6 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-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-102261	Power Electronics for Photovoltaics and Wind Energy	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-MACH-101923	Machine Vision	8 CR
M-WIWI-105003	Machine Learning 1	5 CR
M-WIWI-105006	Machine Learning 2	5 CR
M-INFO-105778	Machine Learning - Foundations and Algorithms	6 CR
M-WIWI-106604	Machine Learning and Optimization in Energy Systems neu	4 CR

M-MACH-106457	Machine Learning for Robotic Systems 1	5 CR
M-MACH-106652	Machine Learning for Robotic Systems 2 neu	5 CR
M-MACH-102694	Machine Dynamics	5 CR
M-MACH-104984	Material Flow in Logistic Systems	9 CR
M-MACH-102713	Mechanics in Microtechnology	4 CR
M-MACH-102699	Laboratory Mechatronics	4 CR
M-ETIT-106672	Medical Image Processing for Guidance and Navigation neu	6 CR
M-ETIT-106449	Medical Imaging Technology I	3 CR
M-ETIT-106670	Medical Imaging Technology II neu	3 CR
M-ETIT-100540	Methods of Signal Processing	6 CR
M-MACH-102714	Microenergy Technologies	4 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	5 CR
M-ETIT-100427	Modern Radio Systems Engineering	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-INFO-102555	Motion in Human and Machine - Seminar	3 CR
M-INFO-100825	Pattern Recognition	6 CR
M-ETIT-105274	Communications Engineering II	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	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	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-ETIT-100381	Batteries and Fuel Cells Laboratory	6 CR
M-ETIT-100389	Laboratory Biomedical Engineering	6 CR
M-ETIT-100401	Lab Course Electrical Drives and Power Electronics	6 CR
M-ETIT-102264	Digital Hardware Design Laboratory	6 CR
M-ETIT-100415	Laboratory Information Systems in Power Engineering	6 CR
M-ETIT-103448	Laboratory Mechatronic Measurement Systems	6 CR
M-ETIT-105300	Microwave Engineering Lab	6 CR
M-ETIT-100442	Communications Engineering Laboratory	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-INFO-105955	Practical Course: Smart Energy System Lab	6 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 neu	5 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-105958	Practical Course: Machine Learning and Intelligent Systems	8 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-ETIT-105468	Physical and Data-Based Modelling	6 CR
M-MACH-105332	Quality Management	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-MACH-106662	Re:Invent - Revolutionary Business Models as the Basis for Product Innovations neu	4 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	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-ETIT-100428	Seminar Radar and Communication Systems	4 CR
M-ETIT-105607	Seminar on Quantum Detectors and Sensors	3 CR
M-ETIT-100378	Sensors	3 CR
M-ETIT-106633	Signal Processing Lab neu	6 CR
M-ETIT-106675	Signal Processing with Nonlinear Fourier Transforms and Koopman Operators 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 neu	4 CR
M-ETIT-106683	Superconducting Power Systems neu	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-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

3.5 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

3.6 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-INFO-100814	Biologically Inspired Robots	3 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	5 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-ETIT-103043	Manufacturing Measurement Technology	3 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-ETIT-100401	Lab Course Electrical Drives and Power Electronics	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-ZAK-106099	Supplementary Studies on Sustainable Development	19 CR

M-ZAK-106235	Supplementary Studies on Culture and Society	22 CR

4 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**.

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

Where elective options exist, students make a binding declaration of module choice when registering for the examination. Upon application of the student to the examination board, the choice or assignment may be changed subsequently. Each module and competence certificate may be assessed only once in the same degree program.

An examination will be passed, if the grade is at least "sufficient" (4.0).

A module will be passed if all required courses are passed.

5 Publisher

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6 Modules

M 6.1 Module: Actuators and Sensors in Nanotechnology [M-MACH-102698]

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

Part of: Field of Specialization / Field of Specialization: Microsystems Technology (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	German	4	2

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

Competence Certificate
oral exam: 45 min

Prerequisites
keine

Competence Goal
The students can:

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

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

The lecture includes amongst others the following topics:

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

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

- Multivariant data analysis / interpretation

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

Workload

Time of attendance: 15 * 1,5 h = 22,5 h

Preparation and follow up: 15 * 5,5 h = 82,5 h

Exam Preaparation and Exam: 15 h

Total: 120 h = 4 LP

Recommendation

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

Literature

- Lecture notes

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

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

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

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

6.2 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

6.3 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

M 6.4 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

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
The "Antenna and Multiple Antenna Systems" module must not be started or completed.

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.

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

6.5 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
8	Grade to a tenth	Each summer term	1 term	German	4	4

Mandatory			
T-MACH-105229	Appliance and Power Tool Design	2 CR	Matthiesen
T-MACH-110767	Appliance and Power Tool Design Project Work *This item will not influence the grade calculation of this parent.*	6 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

6.6 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

Prerequisites
none

M 6.7 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)

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.

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

6.8 Module: Automated Manufacturing Systems [M-MACH-105108]

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
8	Grade to a tenth	Each summer term	1 term	German	4	2

Mandatory			
T-MACH-108844	Automated Manufacturing Systems	8 CR	Fleischer

Competence Certificate
oral exam (40 min)

Competence Goal
The students

- are able to analyze implemented automated manufacturing systems and describe their components.
- are capable to assess the implemented examples of implemented automated manufacturing systems and apply them to new problems.
- are able to name automation tasks in manufacturing plants and name the components which are necessary for the implementation of each automation task.
- are capable with respect to a given task to plan the configuration of an automated manufacturing system and to determine the necessary components to its realization.
- are able to design and select components for a given use case of the categories: "Handling Technology", "Industrial Robotics", "Sensory" and "Controls".
- are capable to compare different concepts for multi-machine systems and select a suitable concept for a given use case.

Content
The module gives an overview of the structure and functioning of automated production plants. In a basic chapter, fundamental elements for the realisation of automated production systems are taught. These include:

- Drive and control technology
- Handling technology for handling workpieces and tools
- Industrial robot technology
- Quality assurance in automated production plants
- Automated machines, cells, centres and systems for production and assembly
- Structures of multi-machine systems
- Project planning of automated production plants

An interdisciplinary view of these sub-areas results in interfaces to Industry 4.0 approaches. The basic chapters are supplemented by practical application examples and live demonstrations in the Karlsruhe Forschungsfabrik.

In the second part of the module, the fundamentals taught will be clarified using practically executed production processes for manufacturing and disassembling components, and the automated production facilities for manufacturing these components will be analyzed. In the field of automotive powertrain technology, the automated production process for both the manufacture and disassembly of batteries is considered. In the powertrain area, automated production facilities for the disassembly of electric motors are considered. Furthermore, automated production systems for the field of additive manufacturing are considered.

Within tutorials, the contents from the module are deepened and applied to concrete problems and tasks.

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
Lectures, exercise, field trip

M 6.9 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 6.10 Module: Automotive Engineering I [M-MACH-100501]

Responsible: Prof. Dr. Frank Gauterin
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	Gauterin, 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'

M 6.11 Module: Automotive Engineering II [M-MACH-100502]

Responsible: Prof. Dr. Frank Gauterin
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 (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	Gauterin, 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'

6.12 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	1

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

Competence Certificate
Type of Examination: written exam

Duration of Examination: 60 minutes

Prerequisites
none

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

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

Workload
180 hours

composed out of

hours of lecture: 15*3 h = 45 h

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

exam preparation and exam: 60 h

Learning type
Lecture

Literature
TBA

M 6.13 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

6.14 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

Prerequisites
none

M 6.15 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	4	1

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

Prerequisites
none

6.16 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

M 6.17 Module: Bioelectric Signals [M-ETIT-100549]

Responsible: Dr.-Ing. Axel Loewe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Medical Technology (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-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

6.18 Module: Biologically Inspired Robots [M-INFO-100814]

Responsible: Prof. Dr.-Ing. Rüdiger Dillmann
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
3	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-INFO-101351	Biologically Inspired Robots	3 CR	Rönnau

M 6.19 Module: Biomedical Measurement Techniques I [M-ETIT-100387]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Medical Technology (mandatory)
Interdisciplinary Subject

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

Mandatory			
T-ETIT-106492	Biomedical Measurement Techniques I	3 CR	Nahm

Competence Certificate
The assessment takes place in the form of a written examination lasting 60 min. The module grade is the grade of the written exam.

Bonus points can also be awarded. Information on this can be found under "Module grade calculation".

Prerequisites
none

Module grade calculation
The module grade is the grade of the written exam.
Bonus points can also be awarded. The achievement of bonus points works as follows:

- Bonus tasks are solved voluntarily.
- In ILIAS the students wear groups of max. 3 participants for a bonus task.
- The solution to the bonus task must be set in ILIAS at the specified time.
- The solutions are read by the lecture assistants and corrected and approved if necessary.
- The groups present their solutions in the lecture (20 min).
- Lecturers award the bonus points individually for each student based on the written solution and the presentation.
- Each participant can acquire a maximum of 6 bonus points.
- Bonus points can only be earned once.

The bonus points are credited as follows:

- Success control is carried out in a written test (written exam) of 60 min (max. 60 points).
- The exam consists of 6 tasks with 5 points each and 5 tasks with 6 points = 11 tasks.
- For the passed bonus task, a maximum of 6 points can be credited to the exam result.
- The grade can thus be improved by a maximum one step.

The total number of points remains limited to 60 points. The bonus points are only taken into account if the exam is passed. Bonus points do not expire and are retained for any examination achievements taken at a later date.

M 6.20 Module: Biomedical Measurement Techniques II [M-ETIT-100388]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Medical Technology (Complementary Modules)
Interdisciplinary Subject

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

Mandatory			
T-ETIT-106973	Biomedical Measurement Techniques II	3 CR	Nahm

Competence Certificate
Success is checked in the form of a written test of 60 minutes. The module grade is the grade of the written exam.

Bonus points can also be awarded. You can find information on this under "Module grade".

Prerequisites
none

Competence Goal
The students have analyzed medical problems and identified metrological tasks.

They have proposed a suitable combination of analog circuit technology and digital signal processing and applied it to solve the metrological problem.

They have identified the sources of biosignals and explained the underlying physiological mechanisms. They have analyzed the signal characteristics and derived the resulting requirements for the measurement system.

Students have broken down the measurement chain from the acquisition of the physical measurand to the presentation of the medically relevant information and compared alternative concepts.

In addition, the students can work in a self-organized and reflexive manner in small teams and present the current state of knowledge and the history of science on selected topics.

Content

- Physiology
- Sensor technology, physical/chemical measurement technology
- Analog amplification and filtering
- disturbances, measurement errors
- Analog-to-digital conversion, digital signal processing, user interface
- Patient safety, standards, norms

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

Bonus points can also be awarded:

The achievement of bonus points works as follows:

- the solution of bonus tasks is voluntary.
- the students register in ILIAS in groups of max. 3 participants for a bonus task.
- the solution of the bonus task has to be entered in ILIAS by the given deadline.
- the solutions are read by the lecture assistants and, if necessary, corrected and approved.
- the groups present their solutions in the lecture (20 min)
- the bonus points are awarded by lecturers individually for each student on the basis of the written solution and the presentation.
- Each student can earn a maximum of 6 bonus points.
- Bonus points can be acquired only once.

The crediting of bonus points is done as follows:

- The success control takes place in a written examination (Klausur) in the extent of 60 min (max. 60 points).
- The written exam consists of 6 tasks with 5 points each and 5 tasks with 6 points = 11 tasks.
- For the passed bonus task, a maximum of 6 points can be credited to the exam result.

The total number of points is limited to 60 points.

Annotation
The event is based on an interactive combination of lecture parts and seminar parts. In the seminar part, the participants are asked to independently prepare and present individual topics of the course in small groups. These contributions are evaluated and the students receive bonus points for this. The bonus points are added to the points achieved in the written exam. The sum of the points gives the module grade.

Workload
1. attendance times in the lectures: 30 h.

2. preparation and follow-up of lectures and bonus tasks. 30 h

3. preparation and participation in the exam: 30 h

Total effort approx. 90 hours = 3 LP

Recommendation

- Basics in physiology (module "Physiology and Anatomy for Biomedical Engineering")
- Basics in physical measurement technology,
- Basics in medical measurement technology (Module "Biomedical Measurement Technology I")
- Good prior knowledge of analog circuit technology and digital signal processing

6.21 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)
Field of Specialization / Field of Specialization: Medical 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-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

6.22 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)
Field of Specialization / Field of Specialization: Medical 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

M 6.23 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)
Field of Specialization / Field of Specialization: Medical 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

6.24 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)
Field of Specialization / Field of Specialization: Medical 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

6.25 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)
Field of Specialization / Field of Specialization: Medical 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-106877	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV	4 CR	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

6.26 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 6.27 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

6.28 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

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
The module can be started for the first time in summer term2020. Please note: The German course "Nachrichtentechnik II" takes place every summer term(starting summer term 2020) and the English version "Communications Engineering II" takes place every winter term (starting winter term 2020/2021).

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 6.29 Module: Communications Engineering Laboratory [M-ETIT-100442]

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	4	1

Mandatory			
T-ETIT-100746	Communications Engineering Laboratory	6 CR	Jäkel

Prerequisites
none

M 6.30 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
A performance assessment is obligatory and can be oral, a written exam, or of another kind.

Prerequisites
None

Competence Goal
The students are able to apply the 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

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

Learning type
Lecture

6.31 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

M 6.32 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.

M 6.33 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

6.34 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

6.35 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

M 6.36 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 6.37 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)
Field of Specialization / Field of Specialization: Medical 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

6.38 Module: Cyber Physical Production Systems [M-ETIT-106039]

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: 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	English	4	1

Mandatory			
T-ETIT-112223	Cyber Physical Production Systems	4 CR	

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

Prerequisites
none

Competence Goal

- The students are familiar with the aspects of Industrie 4.0 and the associated cyber-physical production systems.
- Students will be able to network machines and industrial control systems with each other.
- Students understand the need for advanced methods and services in the field of industrial automation.
- Students are able to model mechatronic production systems and form digital assets.
- Students are able to validate different information models and ontologies for their applicability.
- Students will be able to model data, information and knowledge or extract them from existing systems.
- Students are able to apply artificial intelligence methods in the domain of systems engineering.
- Students are able to conceptualize the networking of machines.
- The students know suitable modeling tools and their application.

Content

- This module is designed to teach students the theoretical and practical aspects of Industrie 4.0.
- This module further provides a definition of the asset admibistration shell as well as other information models in industrial application.
  - AutomationML
  - Petri nets
  - PLCOpenXML
- Aspects of Cyper Physical Production Systems will be covered as well as their networking in the Industrial Internet of Things.
- Students will learn common IoT protocols such as OPC UA and MQTT.
- The module aims to provide students with an understanding of the basic principles and limitations of artificial intelligence in industrial automation technology.
- The module shows the relevance of the digital twin and the information modeling behind it.
- The module teaches the aspects of the Semantic Web including ontologies and RDF.
- The students learn formal description languages of automation technology.
- The students learn the aspects of the reliability of networked automation systems regarding functional and IT security.
- The module teaches advanced methods of software engineering and architectures for automation technology.

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

Workload
The workload includes:

1. attendance in lectures an exercises: 15*2 h = 30 h
2. preparation / follow-up: 15*4 h = 60 h
3. Preparation of the CPS-Demos: 30 h
4. preparation of and attendance in the final presentation: included in preparation and follow-up.

A total of 120 h = 4 CR

Recommendation
Enjoyment and interest in industrial production and automation. Fun with digitalization and virtual engineering in particular. No inhibitions about software and data models.

M 6.39 Module: Decentrally Controlled Intralogistic Systems [M-MACH-102687]

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	German	4	4

Mandatory			
T-MACH-105230	Decentrally Controlled Intralogistic Systems	4 CR	Furmans, Hochstein

Competence Certificate
The success control takes place as a study achievement in the form of the presentation of the work results (Lego robot and code) as well as a presentation of five to ten minutes and following discussion.

Prerequisites
None

Competence Goal
Students are able to:

- Name and explain the basics of intralogistic conveyor systems
- Describe and explain communication types between decentralized systems
- Apply the basics of project management in subsequent projects
- Developing constructive solutions for mechanical problems
- Applying the theory learned to a practical problem
- Evaluate solutions developed through group discussions and presentations
- Use the ROS (Robot Operating System) software framework
- Evaluate the solutions developed using logistical key figures

Content
Hard skills

- Introduction to the basics of technical logistics
- Development of a heterogeneous, integrated, mechatronic, decentralised intralogistics system
- Evaluation of the technical realisation based on logistical key figures
- Practical application of the content using various industry-related hardware components
- Use of various sensor systems
- Prototyping of a mobile robot with LEGO Mindstorms
- Planning and implementation of a control system using the ROS software framework and the object-orientated programming language Python

Soft skills

- Presentation of the work results
  Hardware and software development in teamwork (including tools such as git, Scrum, ...)

Annotation
number of participants limited

participants will be selected

Workload
Attendance time: 90 hours (laboratory practical)

Self-study: 30 hours

Recommendation
Basic knowledge of Python programming and basic knowledge of technical logistics of advantage

Learning type
Seminar

M 6.40 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	German	4	1

Mandatory			
T-INFO-109124	Deep Learning and Neural Networks	6 CR	Niehues

6.41 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 6.42 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 6.43 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 6.44 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)

6.45 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.

6.46 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

M 6.47 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.

M 6.48 Module: Digital Hardware Design Laboratory [M-ETIT-102266]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: 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.

6.49 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

6.50 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 6.51 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 6.52 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, Wydra

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.

6.53 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 6.54 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
5	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-105226	Dynamics of the Automotive Drive Train	5 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: 90 h

total 150 h - 5 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 6.55 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

6.56 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

M 6.57 Module: Energy Informatics 1 [M-INFO-101885]

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
5	Grade to a tenth	Each winter term	1 term	German/English	4	2

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

6.58 Module: Energy Informatics 2 [M-INFO-103044]

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
5	Grade to a tenth	Each summer term	1 term	German/English	4	3

Mandatory			
T-INFO-106059	Energy Informatics 2	5 CR	Hagenmeyer

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-INFO-101885 - Energy Informatics 1 must have been passed.

M 6.59 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	4

Mechanical Engineering (Election: at least 5 credits)			
T-MACH-105209	Introduction to Multi-Body Dynamics	5 CR	Römer
T-MACH-105274	Engineering Mechanics IV	5 CR	Proppe
T-MACH-110375	Mathematical Methods in Continuum Mechanics	4 CR	Böhlke
T-MACH-110376	Tutorial Mathematical Methods in Continuum Mechanics	2 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
Application and exam is allowed only in one lecture of this modul (M-MACH-103205 - Technische Mechanik). "T-MACH-105209 - Einführung in die Mehrkörperdynamik", "T-MACH-105274 - Technische Mechanik IV" or "T-MACH-110375 - Mathematische Methoden der Kontinuumsmechanik".

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 6.60 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 6.61 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	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 6.62 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

M 6.63 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

6.64 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

6.65 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 6.66 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

M 6.67 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

M 6.68 Module: Hardware Modeling and Simulation [M-ETIT-100449]

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

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: 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

M 6.69 Module: Hardware Synthesis and Optimisation [M-ETIT-100452]

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-100673	Hardware Synthesis and Optimisation	6 CR	Becker

Competence Certificate
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

M 6.70 Module: Hardware/Software Co-Design [M-ETIT-100453]

Responsible: Dr.-Ing. Oliver Sander
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	Sander

Competence Certificate
Achievement will be examined in an oral examination (approx. 20 minutes).

Prerequisites
none

6.71 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

6.72 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 6.73 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

6.74 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: Field of Specialization / Field of Specialization: Medical Technology (Complementary Modules)
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 6.75 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

M 6.76 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.

M 6.77 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.

6.78 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

6.79 Module: Information Processing in Sensor Networks [M-INFO-100895]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Microsystems Technology (Complementary Modules)
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-INFO-101466	Information Processing in Sensor Networks	6 CR	Hanebeck

M 6.80 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

6.81 Module: Information Technology in Industrial Automation Systems [M-ETIT-100367]

Responsible: Dr.-Ing. Peter-Axel Bort
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: 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

6.82 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	1

Mandatory			
T-MACH-113068	Innovation and Project Management in Rail Vehicle Engineering	4 CR	Cichon

Competence Certificate
Presentation (duration approx. 20 minutes) and colloquium

Prerequisites
none

Competence Goal
Students will learn the basics of innovation and project management in the context of rail vehicle development. Using the case study of a practical vehicle development in the context of the "European Railway Challenge" competition, students will experience the various organizational, systemic, economic and technological challenges of an innovation project, namely the new construction of a prototype rail vehicle.

Content

- Basics of innovation management
- Creativity techniques and idea selection
- Basics and methods of project management
- Practical challenges in project management
- Product development processes
- Team organization
- Case study "innovative rail vehicle" based on the Railway Challenge requirements

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

6.83 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 6.84 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

6.85 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

M 6.86 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

6.87 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	4

Mandatory			
T-WIWI-102746	Introduction to Energy Economics	5 CR	Fichtner

Competence Certificate
The assessment consists of a written exam according to Section 4(2), 1 of the examination regulation.

Prerequisites
None

Competence Goal
The student is able to

- characterize and judge the different energy carriers and their peculiarities,
- understand contexts related to energy economics.

Content
1. Introduction: terms, units, conversions
2. The energy carrier gas (reserves, resources, technologies)
3. The energy carrier oil (reserves, resources, technologies)
4. The energy carrier hard coal (reserves, resources, technologies)
5. The energy carrier lignite (reserves, resources, technologies)
6. The energy carrier uranium (reserves, resources, technologies)
7. The final carrier source electricity
8. The final carrier source heat
9. Other final energy carriers (cooling energy, hydrogen, compressed air)

Workload
The total workload for this course is approximately 165.0 hours. For further information see German version.

M 6.88 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 third	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-111807	Introduction to Bionics	4 CR	Hölscher

Competence Certificate
The successfull attandence of the lecture is controlled by a written examination.

Prerequisites
Basic knowledge in physics and chemistry

Competence Goal
The students should be able analyze, judge, plan and develop biomimetic strategies and products.

Content
Bionics focuses on the design of technical products following the example of nature. For this purpose we have to learn from nature and to understand its basic design rules. Therefore, the lecture focuses on the analysis of the fascinating effects used by many plants and animals. Possible implementations into technical products are discussed in the end.

Module grade calculation
The module grade corresponds to the grade of the partial performance.

Workload
30 h attendance time

90 h self-study.

Learning type
Lecture

Literature
Slides and literature are provided byILIAS.

6.89 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	1

Mandatory			
T-MACH-105182	Introduction to Microsystem Technology I	4 CR	Badilita, Jouda, 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

6.90 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	Jouda, 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 6.91 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

M 6.92 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, ZAK or SPZ the courses ('Teilleistungen') with the title 'Self Assignment-HOC-SPZ-ZAK ...' 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	Albers, Matthiesen
T-WIWI-100796	Industrial Business Administration	3 CR	Fichtner
T-MACH-105442	Intellectual Property Rights and Strategies in Industrial Companies	4 CR	Düser, Zacharias
T-MACH-106738	ProVIL - Product Development in a Virtual Idea Laboratory	4 CR	Albers
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-ZAK-graded	2 CR	
T-ETIT-111527	Self Assignment-HOC-SPZ-ZAK-graded	2 CR	
T-ETIT-111528	Self Assignment-HOC-SPZ-ZAK-graded	2 CR	
T-ETIT-111530	Self Assignment-HOC-SPZ-ZAK-ungraded	2 CR	
T-ETIT-111531	Self Assignment-HOC-SPZ-ZAK-ungraded	2 CR	
T-ETIT-111532	Self Assignment-HOC-SPZ-ZAK-ungraded	2 CR	

6.93 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	Klemp, 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

6.94 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)
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	4	1

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

Prerequisites
none

6.95 Module: Lab Course Electrical Power Engineering [M-ETIT-100419]

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	4	1

Mandatory			
T-ETIT-100728	Lab Course Electrical Power Engineering	6 CR	Badent, Doppelbauer, Leibfried

Prerequisites
none

6.96 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.

M 6.97 Module: Laboratory Biomedical Engineering [M-ETIT-100389]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Medical Technology (mandatory)
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-101934	Laboratory Biomedical Engineering	6 CR	Nahm

Prerequisites
Passed exam of the module "Biomedizinische Messtechnik I".

Modeled Conditions
The following conditions have to be fulfilled:

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

6.98 Module: Laboratory FPGA Based Circuit Design [M-ETIT-100470]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: 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 6.99 Module: Laboratory Information Systems in Power Engineering [M-ETIT-100415]

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	4	1

Mandatory			
T-ETIT-100727	Laboratory Information Systems in Power Engineering	6 CR	Leibfried

Prerequisites
none

M 6.100 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	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 6.101 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

6.102 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

Prerequisites
none

6.103 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

Prerequisites
none

6.104 Module: Laboratory Solar Energy [M-ETIT-102350]

Responsible: Dr.-Ing. Bernd Pätzold
Prof. Dr. Bryce Sydney Richards
Dr.-Ing. Klaus Trampert

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

Prerequisites
none

6.105 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

M 6.106 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

M 6.107 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	1

Mandatory			
T-INFO-101377	Localization of Mobile Agents	6 CR	Hanebeck

M 6.108 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

6.109 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

6.110 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, aufgeteilt in:
- ca 45h Vorlesungsbesuch
- ca 15h Übungsbesuch
- ca 90h Nachbearbeitung und Bearbeitung der Übungsblätter
- ca 30h Prüfungsvorbereitung

Recommendation
See partial achivements (Teilleistung)

6.111 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.

6.112 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 6.113 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

M 6.114 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 6.115 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.

M 6.116 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

M 6.117 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.

6.118 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	3

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

Competence Certificate
oral examination (60 minutes)

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 6.119 Module: Manufacturing Measurement Technology [M-ETIT-103043]

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 (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-106057	Manufacturing Measurement Technology	3 CR	Heizmann

Prerequisites
none

M 6.120 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).

6.121 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 6.122 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 6.123 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).

6.124 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 6.125 Module: Mechanics in Microtechnology [M-MACH-102713]

Responsible: Prof. Dr. Christian Greiner
Dr. Patric Gruber

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-105334	Mechanics in Microtechnology	4 CR	Greiner, Gruber

Competence Certificate
oral exam ca. 30 minutes

Prerequisites
none

Competence Goal
The students know and understand size and scaling effects in micro- and nanosystems. They understand the impact of mechanical phenomena in small dimensions. Based on this they can judge how they determine material processing as well as working principles and design of microsensors and microactuators.

Content
1. Introduction: Application and Processing of Microsystems
2. Scaling Effects
3. Fundamentals: Stress and Strain, (anisotropic) Hooke's Law
4. Fundamentals: Mechanics of Beams and Membranes
5. Thin Film Mechanics: Origin and Role of Mechanical Stresses
6. Characterization of Mechanical Properties of Thin Films and Small Structures: Measurement of Stresses and Mechnical Parameters such as Young'sModulus and YieldDtrength; Thin Film Adhesion and Stiction
7. Transduction: Piezo-resistivity, Piezo-electric Effect, Elektrostatics,...
8. Aktuation: Inverse Piezo-electric Effect, Shape Memory, Elektromagnetic Actuation,...

Workload
regular attendance: 22,5 hours
self-study: 97,5 hours

Learning type
lecture

Literature
Folien,
1. M. Ohring: „The Materials Science of Thin Films“, Academic Press, 1992
2. L.B. Freund and S. Suresh: „Thin Film Materials“
3. M. Madou: Fundamentals of Microfabrication“, CRC Press 1997
4. M. Elwenspoek and R. Wiegerink: „Mechanical Microsensors“ Springer Verlag 2000
5. Chang Liu: Foundations of MEMS, Illinois ECE Series, 2006

6.126 Module: Medical Image Processing for Guidance and Navigation [M-ETIT-106672]

Responsible: Prof. Dr. Maria Francesca Spadea
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-113425	Medical Image Processing for Guidance and Navigation	6 CR	Spadea

Competence Certificate
The examination takes place within the framework of an oral overall examination where also the project developed during the course will be discussed (approx. 30 minutes).

Prerequisites
none

Competence Goal

- 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 and motivation - Introduction to git and gitflow
    - Point based operations, Histograms and filters FFT
    - Mask based Operation Convolution and Deep learning
    - Dicom format simple ITK
    - Thresholding morphological filter
    - Image Registration
    - Segmentation
    - Features and Keypoints
    - Deep learning and Medical Imaging
    - Transformations
    - Surface registration
    - Path planning in 2D
    - Kinematics
    - Augmented reality in medicine

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

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*4 h = 60 h
2. preparation / follow-up: 15*6 h = 90 h
3. preparation of and attendance in examination: 30 h

A total of 180 h = 6 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” (1 SWS), Seminars in “In room imaging modalities” (1 SWS), Tutorials/ Demostrations in Medical image processing and navigation (2 SWS)

6.127 Module: Medical Imaging Technology I [M-ETIT-106449]

Responsible: Prof. Dr. Maria Francesca Spadea
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Medical Technology (mandatory)
Interdisciplinary Subject

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

Mandatory			
T-ETIT-113048	Medical Imaging Technology I	3 CR	Spadea

Competence Certificate
The examination takes place in form of a written examination lasting 60 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 students will be able to communicate in technical and clinical English languange.

Content
The module Medical Imaging Technology I provides knowledge on

- the basic knowledge of mathematical and physical principles of medical imaging formation, including X-ray based modalities, nuclear medicine imaging, magnetic resonance imaging and ultrasound
- 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

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

A total of 90 h = 3 CR

Recommendation
Basic knowledge in the field of physics and signal processing is helpful.

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

Responsible: Prof. Dr. Maria Francesca Spadea
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Medical Technology (Complementary Modules)
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-113421	Medical Imaging Technology II	3 CR	Spadea

Competence Certificate
The examination takes place in form of a written examination lasting 60 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.

M 6.129 Module: Methods of Signal Processing [M-ETIT-100540]

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 winter term	1 term	German	4	1

Mandatory			
T-ETIT-100694	Methods of Signal Processing	6 CR	Heizmann

Prerequisites
none

6.130 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)

Prerequisites
There are no requirements for background, however, I recommend that you have at least the following: Basic knowledge in engineering, physics, and mathematics.

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
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

6.131 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

6.132 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

Competence Certificate
Oral exam: 45 min

Prerequisites
none

Competence Goal
The students can:

- describe the energy conversion principles and exemplify them
- explain the underlying concepts of thermodynamics and materials science
- illustrate the layout, fabrication and function of the treated devices
- calculate important properties (time constants, power output, efficiency, etc.)
- develop a layout based on specifications

Content
- Basic physical principles of energy conversion - Layout and design optimization - Technologies - Selected devices - Applications

The lecture includes amongst others the following topics:

- Micro energy harvesting of vibrations using different conversion principles (piezo, electrostatic, electromagnetic, etc.)
- Thermoelectric energy generation
- Novel thermal energy conversion principles (thermomagnetic, pyroelectric)
- Miniature scale solar devices
- RF energy harvesting
- Miniature scale heat pumping
- Solid-state cooling technologies (magneto-, electro-, mechanocalorics)
- Power management
- Energy storage technologies (microbatteries, supercapacito4rs, fuel cells)

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

Workload
Time of attendance: 15 * 1,5 h = 22,5 h

Preparation and follow up: 15 * 5,5 h = 82,5 h

Exam Preaparation and Exam: 15 h

Total: 120 h = 4 LP

Literature

- Lecture notes (overhead transparencies) „Micro Energy Technologies“
- Stephen Beeby, Neil White, Energy Harvesting for Autonomous Systems, Artech House, 2010
- Shashank Priya, Daniel J. Inman, Energy Harvesting Technologies, Springer, 2009

M 6.133 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

6.134 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

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.

6.135 Module: Microwave Engineering Lab [M-ETIT-105300]

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	German	4	1

Mandatory			
T-ETIT-110789	Microwave Engineering Lab	6 CR	Zwick

Competence Certificate
To prepare the laboratory tests, each laboratory group has to do some homework together before the experiment and hand in a simple copy to the supervisor immediately before the start of the experiment. The tasks for the experiment as such are processed and logged during the implementation. The protocol should be handed over to the supervisor immediately after the experiment has been carried out. Before each experiment, there is a written exam or oral (approx. 20 min., No aids) the content of the experiment.

Prerequisites
none

Competence Goal
The students have in-depth knowledge of high-frequency components and systems as well as how the most important high-frequency measuring devices work (network analyzer, spectrum analyzer, noise measurement, power measurement, oscilloscope, antenna measurement). They are also familiar with handling high-frequency measuring devices and components. They are able to independently select and operate measuring devices based on the specific applications and to interpret the measurement results. In addition, they are able to work together in a team in a self-organized manner.

Content
Under the motto: "Practical relevance through state-of-the-art equipment and current problems", the 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 imparted in the lectures in practice and to train the use of high-frequency measuring devices and RF components. In groups of 2-4 students, various experiments are carried out and recorded on 8 afternoons. The order and topics of the experiments can vary.

Module grade calculation
The grade for the test execution consists of the preparation, the protocol and the written or oral learning objective control for the respective test. The final grade for the entire laboratory results from the overall impression of the performance. Students who appear unprepared for the respective experiment are not allowed to take part in the experiment. The attempt 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.

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

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 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 6.137 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 6.138 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 6.139 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.

6.140 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
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-100735	Modern Radio Systems Engineering	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
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 various radar modulation methods and the relationships to approval conditions and performance.

Content
The course gives a general overview of radio transmission systems and their components. 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 exam.

Workload
Each credit point corresponds to approximately 25-30 hours of work (of the student). This is based on the average student who achieves an average performance. The workload includes:
Attendance study time lecture: 30 h
Attendance study time computer exercise SystemVue ESL Design Software / MATLAB: 15 h
Self-study time including exam preparation: 75 h
A total of 120 h = 4 LP

Recommendation
Knowledge of the basics of radio frequency technology and communications technology is helpful.

M 6.141 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 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.

6.142 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

6.143 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.

6.144 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

6.145 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.

6.146 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 6.147 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, Plum, 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 6.148 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

6.149 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 6.150 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

6.151 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

6.152 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

6.153 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.

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)

6.154 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 6.155 Module: Optoelectronics [M-ETIT-100480]

Responsible: 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
4	Grade to a tenth	Each winter term	1 term	German	4	2

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

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

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

Part of: Field of Specialization / Field of Specialization: Medical 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-105228	Organ Support Systems	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 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 6.157 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 6.158 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 6.159 Module: Physical and Data-Based Modelling [M-ETIT-105468]

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
6	Grade to a tenth	Each summer term	1 term	English	4	4

Mandatory			
T-ETIT-111013	Physical and Data-Based Modelling	6 CR	Hohmann

Competence Certificate
Oral examination of approximately 20 minutes.

Prerequisites
none

Competence Goal

- The students understand the general model concept as well as the characteristics of physical and data-based modeling and can describe their differences.
- They are able to structure complex systems and systematically analyze dependencies of subsystems.
- They are able to explain the general procedure of physical and data-based modeling, apply it to technical systems, and analyze the results.
- They are able to 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 identify states and constraints.
- 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.
- They are able to explain different identification procedures for parametric models of static and dynamic systems, select, and apply appropriate procedures for given technical problems.
- Students know basic procedures of learning-based identification and can describe their limitations.
- The students can estimate and judge the effects of disturbances and real conditions on the identification results.

Content
In contrast to the former “Modellbildung und Identifikation”, this course requires a profound knowledge in multivariable systems and optimization. Thus, attendance of the lecture Optimization of Dynamic Systems (ODS) is an absolute precondition to appropriately follow the course! Prior knowledge about (linear) state space representations and realizations, the concept of “zeros” in the state space, and observability is highly recommended!

This course aims at engineering students that focus on a systemic and control engineering curriculum. It encompasses fundamental topics along the complete process of modeling technical systems. Particularly, 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.

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

Workload

Each credit point corresponds to 30 hours of workload (of the student). The workload includes:

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

Recommendation

In contrast to the former "Modellbildung und Identifikation", this course requires a profound knowledge in multivariable systems and optimization. Thus, attendance of the lecture Optimization of Dynamic Systems (ODS) is an absolute precondition to appropriately follow the course! Prior knowledge about (linear) state space representations and realizations, the concept of "zeros" in the state space, and observability is highly recommended (see e.g. Regelung linearer Mehrgrößensysteme (RLM))!

Furthermore, sound understanding of Higher Mathematics I-III, linear electrical network theory and engineering mechanics / physics is required to successfully attend the lecture, exercise tasks / case studies, and exam.

6.160 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: Field of Specialization / Field of Specialization: Medical Technology (Complementary Modules)
Interdisciplinary Subject

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.

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.

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

M 6.161 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

M 6.162 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/)

6.163 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

M 6.164 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)

6.165 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

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

Mandatory			
T-ETIT-104569	Power Electronics for Photovoltaics and Wind Energy	3 CR	Hiller

Prerequisites
none

M 6.166 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

6.167 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 6.168 Module: Power Transmission and Power Network Control [M-ETIT-100534]

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
5	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-101941	Power Transmission and Power Network Control	5 CR	Leibfried

Prerequisites
none

6.169 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 summer term	1 term	German	4	1

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.

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 6.170 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

6.171 Module: Practical Course: Smart Energy System Lab [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	German/English	4	1

Mandatory			
T-INFO-112030	Practical Course: Smart Energy System Lab	6 CR	Waczowicz

M 6.172 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
5	Grade to a tenth	Each summer term	1 term	German	4	1

Mandatory			
T-ETIT-113426	Practical Machine Learning	5 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.
- 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. 30 hours
- Team project during the semester: approx. 45 hours
- Peer review of the scientific essays
  and presentation of the team project: approx. 45 hours

Total: approx. 141 hours (5 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 1 SWS)

6.173 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 6.174 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.

6.175 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.

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

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

Part of: Field of Specialization / Field of Specialization: Medical 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-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.

6.177 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	Frech

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 6.178 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	Frech

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 6.179 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	2

Mandatory			
T-MACH-109192	Methods and Processes of PGE - Product Generation Engineering	6 CR	Albers, Burkardt, Matthiesen

Competence Certificate
Written examination (processing time: 120 min + 10 min reading time)

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

6.180 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 6.181 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 6.182 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

M 6.183 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

M 6.184 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

6.185 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

M 6.186 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 partial performance

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
See Calculation scheme

Annotation
None

Workload
120 hours, including 30 hours attendance

Recommendation
None

Learning type
Lecture, workshop and excursion

Literature
None

Base for
None

M 6.187 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)

6.188 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.

M 6.189 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 6.190 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	2

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 6.191 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 6.192 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)
Field of Specialization / Field of Specialization: Robotics (mandatory)
Interdisciplinary Subject

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 student is 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 student masters the kinematic and dynamic modeling of robot systems, as well as the modeling and design of simple controllers. The student knows the algorithmic basics of motion and grasp planning and can apply these algorithms to problems in robotics. He/she knows algorithms from the field of image processing and is able to apply them to problems in robotics. He/she is able to model and solve tasks as a symbolic planning problem. The student has knowledge about intuitive programming procedures for robots and knows 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 6.193 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.

M 6.194 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.

M 6.195 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 module grade is the grade of the brick. 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.

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 6.196 Module: Seminar Accessibility - Assistive Technologies for Visually Impaired Persons [M-INFO-102374]

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: Field of Specialization / Field of Specialization: Medical Technology (Complementary Modules)

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

Mandatory			
T-INFO-104742	Seminar Accessibility - Assistive Technologies for Visually Impaired Persons	3 CR	Stiefelhagen

M 6.197 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 term	1 term	German	4	1

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

M 6.198 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

6.199 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

6.200 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 6.201 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.

6.202 Module: Seminar on Quantum Detectors and Sensors [M-ETIT-105607]

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
3	Grade to a tenth	Each term	1 term	German	4	1

Mandatory			
T-ETIT-111235	Seminar on Quantum Detectors and Sensors	3 CR	Kempf

Prerequisites
none

M 6.203 Module: Seminar Radar and Communication Systems [M-ETIT-100428]

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 term	1 term	English	4	1

Mandatory			
T-ETIT-100736	Seminar Radar and Communication Systems	4 CR	Zwick

Competence Certificate
The performance evaluation takes place by means of an overall examination according to § 4 Paragraph 2 No. 3 SPO-MA-2015, 2018 of the selected courses, the sum total of which fulfills the minimum requirement of course credits.

The examination takes place in the form of submission of a written report (paper) along with an oral presentation of the individual work.

Both are taken into account, while grading the examination performance. The overall impression will be evaluated.

Prerequisites
none

Competence Goal
The students are provided with an overview of a broad range of topics in the field of radio frequency engineering. You are in a position to work independently in the following areas: carrying out literature research, the art of holding lectures and presentations and writing research papers. You can work in a self-organized manner and acquire communicative, organizational and initial-level didactic skills. You are given the opportunity to work independently on a radio frequency engineering topic, to analyze the topic and present it in front of an expert audience.

Content
The seminar in particular offers the opportunity to learn and sharpen the skills of holding lectures and oral presentations, conducting literature research and writing research papers. Although these skills constitute a decisive qualification in the professional life, they are seldom promoted in other courses. The seminar provides a remedial action in this regard: each participant works independently on a topic (predominantly in english language) and presents it in front of an expert audience. In the final discussion, besides technical aspects, presentation style and written report are also taken into consideration.

Apart from presenting the topic, the required written report in LaTeX provides an excellent preparation for fulfilling the requirements of scientific and technical thesis works.

Module grade calculation
The course grade is calculated on the basis of the presentation as well as the written report. Both are taken into account for the performance evaluation. An assessment will be made based on the overall impression.

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

Literature research: 40 h

Writing of the paper: 40 h

Presentation including preparation: 40 h

A total of 120 h = 4 LP

Recommendation
Knowledge of fundamentals of radio frequency engineering are helpful.

M 6.204 Module: Seminar: Energy Informatics [M-INFO-103153]

Responsible: TT-Prof. Dr. Thomas Bläsius
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	Bläsius

6.205 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 6.206 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.

6.207 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.

M 6.208 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	3

Mandatory			
T-ETIT-108347	Software Engineering	3 CR	Reichmann

Prerequisites
none

M 6.209 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 6.210 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 not allowed to take either of the following modules in addition to this one: „Solarenergie“ (M-ETIT-100476) and „Photovoltaik“ (M-ETIT-100513).

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 6.211 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**.

6.212 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

6.213 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 winter 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
An application is required to participate in this module. Information about the application: www.kit-student-innovation-lab.de/index.php/for-students/

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
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)

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.

M 6.214 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.

M 6.215 Module: Superconducting Power Systems [M-ETIT-106683]

Responsible: Prof. Dr. 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“

M 6.216 Module: Supplementary Studies on Culture and Society [M-ZAK-106235]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: Additional Examinations

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

Election notes
With the exception of the final oral exam and the practice module, students have to self-record the achievements obtained in the Supplementary Studies on Culture and Society in their study plan. 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 ZAK homepage at https://www.zak.kit.edu/begleitstudium-bak.php. The title of the examination and the amount of credits override the modules placeholders.

If you want to use ZAK achievements **both for your interdisciplinary qualifications and for the supplementary studies**, please record them in the interdisciplinary qualifications first. You can then get in contact with the ZAK study services (stg@zak.kit.edu) to also record them in your supplementary studies.

In the in-depth module, achievements have to be obtained in three different areas. The areas are as follows:

- Technology & Responsibility
- Doing Culture
- Media & Aesthetics
- Spheres of Life
- Global Cultures

You have to obtain two achievements with 3 credits each and one achievement with 5 credits. To self-record achievements in the in-depth module, you first have to elect the matching partial achievement.

Note: If you registered for the Supplementary Studies on Sustainable Development before April 1st, 2023, self-recording an achievement in this module counts as a request in the sense of §20 (2) of the regulations for the Supplementary Studies on Culture and Society. Your overall grade for the supplementary studies will thus be calculated as the average of the examantion grades, not as the average of the module grades.

Mandatory			
T-ZAK-112653	Basics Module - Self Assignment BAK	3 CR	Mielke, Myglas
In-depth Module (Election: 3 items)			
T-ZAK-112654	In-depth Module - Technology & Responsibility - Self Assignment BAK	3 CR	Mielke, Myglas
T-ZAK-112655	In-depth Module - Doing Culture - Self Assignment BAK	3 CR	Mielke, Myglas
T-ZAK-112656	In-depth Module - Media & Aesthetics - Self Assignment BAK	3 CR	Mielke, Myglas
T-ZAK-112657	In-depth Module - Spheres of Life - Self Assignment BAK	3 CR	Mielke, Myglas
T-ZAK-112658	In-depth Module - Global Cultures - Self Assignment BAK	3 CR	Mielke, Myglas
Mandatory			
T-ZAK-112660	Practice Module	4 CR	Mielke, Myglas
T-ZAK-112659	Oral Exam - Supplementary Studies on Culture and Society	4 CR	Mielke, Myglas

Competence Certificate
The monitoring is explained in the respective partial achievement.

They are composed of:

- minutes
- presentations
- a seminar paper
- an internship report
- an oral examination

After successful completion of the supplementary studies, the graduates receive a graded certificate and a KIT certificate.

Prerequisites

The offer is study-accompanying and does not have to be completed within a defined period of time. Enrolment or acceptance for graduation must be present when registering for the final examination.

KIT students register for the supplementary studies by selecting this module in the student portal and self-checking a performance. In addition, registration for the individual courses is necessary, which is possible shortly before the beginning of each semester.

The course catalogue, statutes (study regulations), registration form for the oral exam, and guides for preparing the various written performance requirements can be found as downloads on the ZAK homepage at www.zak.kit.edu/begleitstudium-bak.

Competence Goal

Graduates of the Supplementary Studies on Culture and Society demonstrate a sound basic knowledge of conditions, procedures and concepts for analysing and shaping fundamental social development tasks in connection with cultural topics. They have gained a well-founded theoretical and practical insight into various cultural studies and interdisciplinary topics in the field of tension between culture, technology and society in the sense of an expanded concept of culture.

They are able to place the contents selected from the specialization module in the basic context as well as to analyse and evaluate the contents of the selected courses independently and exemplarily and to communicate about them scientifically in written and oral form. Graduates are able to analyse social topics and problem areas and critically reflect on them in a socially responsible and sustainable perspective.

Content

The Supplementary Studies on Culture and Society can be started from the 1st semester and is not limited in time. It comprises at least 3 semesters. The supplementary studies are divided into 3 modules (basics, in-depth studies, practice). A total of 22 credit points (ECTS) are earned.

The thematic elective areas of the supplementary studies are divided into the following 5 modules and their sub-topics:

Block 1Technology & Responsibility

Value change / ethics of responsibility, technology development / history of technology, general ecology, sustainability

Block 2Doing Culture

Cultural studies, cultural management, creative industries, cultural institutions, cultural policy

Block 3Media & Aesthetics

Media communication, cultural aesthetics

Block 4Spheres of Life

Cultural sociology, cultural heritage, architecture and urban planning, industrial science

Block 5Global Cultures

Multiculturalism / interculturalism / transculturalism, science and culture

Module grade calculation

The overall grade of the supplementary studies is calculated as an average of the grades of the examination performances weighted with credit points.

In-depth Module

- presentation 1 (3 ECTS)
- presentation 2 (3 ECTS)
- seminar paper incl. presentation (5 ECTS)
- oral examination (4 ECTS)

Annotation

With the Supplementary Studies on Culture and Society, KIT provides a multidisciplinary study offer as an additional qualification, with which the respective specialized study program is supplemented by interdisciplinary basic knowledge and interdisciplinary orientation knowledge in the field of cultural studies, which is becoming increasingly important for all professions.

Within the framework of the supplementary studies, students acquire in-depth knowledge of various cultural studies and interdisciplinary subject areas in the field of tension between culture, technology and society. In addition to high culture in the classical sense, other cultural practices, common values and norms as well as historical perspectives of cultural developments and influences are considered.

In the courses, conditions, procedures and concepts for the analysis and design of fundamental social development tasks are acquired on the basis of an expanded concept of culture. This includes everything created by humans - also opinions, ideas, religious or other beliefs. The aim is to develop a modern concept of cultural diversity. This includes the cultural dimension of education, science and communication as well as the preservation of cultural heritage. (UNESCO, 1982)

According to § 16 of the statutes, a reference and a certificate are issued by the ZAK for the supplementary studies. The achievements are also shown in the transcript of records of the degree program and, upon request, in the certificate. They can also be recognized in the interdisciplinary qualifications (see elective information).

Workload

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

- basic module approx. 90 h
- in-depth module approx. 340 h
- practical module approx. 120 h

total: approx. 550 h

Learning type

- lectures
- seminars
- workshops
- practical course

Literature

Recommended reading of primary and specialized literature will be determined individually by each instructor.

M 6.217 Module: Supplementary Studies on Sustainable Development [M-ZAK-106099]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: Additional Examinations

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

Election notes

With the exception of the final oral exam, students have to self-record the achievements obtained in the Supplementary Studies on Sustainable Development in their study plan. 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 ZAK homepage at https://www.zak.kit.edu/begleitstudium-bene. The title of the examination and the amount of credits override the modules placeholders.

If you want to use ZAK achievements **both for your interdisciplinary qualifications and for the supplementary studies**, please record them in the interdisciplinary qualifications first. You can then get in contact with the ZAK study services (stg@zak.kit.edu) to also record them in your supplementary studies.

In the elective module, you need to obtain 6 credits worth of achievements in two of the four areas:

- Sustainable Cities & Neighbourhoods
- Sustainable Assessment of Technology
- Subject, Body, Individual: The Other Side of Sustainability
- Sustainability in Culture, Economy & Society

Usually, two achievements with 3 credits each have to be obtained. To self-record achievements in the elective module, you first have to elect the matching partial achievement.

Note: If you registered for the Supplementary Studies on Sustainable Development before April 1st, 2023, self-recording an achievement in this module counts as a request in the sense of §19 (2) of the regulations for the Supplementary Studies on Sustainable Development. Your overall grade for the supplementary studies will thus be calculated as the average of the examantion grades, not as the average of the module grades.

Mandatory			
T-ZAK-112345	Basics Module - Self Assignment BeNe	3 CR	Myglas
Elective Module (Election: at least 6 credits)			
T-ZAK-112347	Elective Module - Sustainable Cities and Neighbourhoods - Self Assignment BeNe	3 CR	
T-ZAK-112348	Elective Module - Sustainability Assessment of Technology - Self Assignment BeNe	3 CR	
T-ZAK-112349	Elective Module - Subject, Body, Individual: the Other Side of Sustainability - Self Assignment BeNe	3 CR	
T-ZAK-112350	Elective Module - Sustainability in Culture, Economy and Society - Self Assignment BeNe	3 CR	
Mandatory			
T-ZAK-112346	Specialisation Module - Self Assignment BeNe	6 CR	Myglas
T-ZAK-112351	Oral Exam - Supplementary Studies on Sustainable Development	4 CR	

Competence Certificate
The monitoring is explained in the respective partial achievement .

They are composed of:

- protocols
- a reflection report
- presentations
- presentations
- the elaboration of a project work
- an individual term paper

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

Prerequisites
The course is offered during the course of study and does not have to be completed within a defined period of time. Enrolment is required for all performance assessments of the modules of 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 self-booking a performance. Registration for courses, performance assessments and examinations is regulated by § 6 of the Statutes and is usually possible shortly before the beginning of the semester.

The course catalogue, statutes (study regulations), registration form for the oral exam and guidelines for preparing the various written performance requirements can be found as downloads on the ZAK homepage at http://www.zak.kit.edu/begleitstudium-bene.

Competence Goal
Graduates of the supplementary studies in sustainable development acquire additional practical and professional competencies. Thus, the supplementary study program enables the acquisition of basics and initial experience in project management, trains teamwork skills, presentation skills and self-reflection, and also creates a fundamental understanding of sustainability that is relevant for all professional fields.

Graduates are able to analyse social topics and problem areas and critically reflect on them in a socially responsible and sustainable perspective. They are able to place the contents selected from the modules "Elective" and "Advanced" in the basic context as well as to independently and exemplarily analyse and evaluate the contents of the selected courses and to scientifically communicate about them in written and oral form.

Content
The supplementary study program Sustainable Development can be started from the 1st semester and is not limited in time. The wide range of courses offered by ZAK makes it possible to complete the program usually within three semesters. The supplementary studies comprise 19 credit points (LP). It consists of three modules: Basic Module, Elective Module and Advanced Module.

The thematic elective areas of the supplementary studies are divided into the following 4 modules and their subtopics in Module 2 (elective module):

Block 1 **Sustainable Cities and Neighbourhoods**

The courses provide an overview of the interaction of social, ecological, and economic dynamics in the microcosm of the city.

Block 2 **Sustainability Assessment of Technology**

Mostly based on ongoing research activities, methods and approaches of technology assessment are elaborated.

Block 3 **Subject, Body, Individual: The other Side of Sustainability**

Different approaches are presented to the individual perception, experience, shaping and responsibility of relationships to the environment and to oneself.

Block 4 **Sustainability in Culture, Economy & Society**

Courses usually have an interdisciplinary approach, but may also focus on one of the areas of culture, economics or society, both in application and in theory.

The core of the supplementary studies is a case study in the specialization area. In this project seminar, students conduct sustainability research with practical relevance themselves. The case study is supplemented by an oral examination with two topics from module 2 (elective module) and module 3 (in-depth module).

Module grade calculation
The overall grade of the supplementary studies is calculated as an average of the grades of the examination performances weighted with credit points.

Elective module

- Presentation 1 (3 ECTS)

- Presentation 2 (3 ECTS)

Advanced module

- individual term paper (6 ECTS)

- oral examination (4 ECTS)

Annotation
The Supplementary Studies on Sustainable Development at KIT is based on the conviction that a long-term socially and ecologically compatible coexistence in the global world is only possible if knowledge about necessary changes in science, economy and society is acquired and applied.

The interdisciplinary and transdisciplinary Studies on Sustainable Development enables diverse access to transformation knowledge as well as basic principles and application areas of sustainable development. According to the statutes § 16, a certificate is issued by the ZAK for the complementary studies.

The achievements are also shown in the transcript of records of the degree program and, upon request, in the certificate. They can also be recognized in the interdisciplinary qualifications (see elective information).
In the specialised studies, modules and partial achievements can be recognised within the framework of the additional achievements or e.g. the interdisciplinary qualifications. This must be regulated via the respective subject study programme.

The focus is on experience- and application-oriented knowledge and competences, but theories and methods are also learned. The aim is to be able to represent one's own actions as a student, researcher and later decision-maker as well as an individual and part of society under the aspect of sustainability.

Sustainability is understood as a guiding principle to which economic, scientific, social and individual actions should be oriented. According to this, the long-term and socially just use of natural resources and the material environment for a positive development of global society can only be addressed by means of integrative concepts. Therefore, "education for sustainable development" in the sense of the United Nations programme plays just as central a role as the goal of promoting "cultures of sustainability". For this purpose, practice-centred and research-based learning of sustainability is made possible and the broad concept of culture established at ZAK is used, which understands culture as habitual behaviour, lifestyle and changing context for social actions.

The supplementary study programme conveys the basics of project management, trains teamwork skills, presentation skills and self-reflection. Complementary to the specialised studies at KIT, it creates a fundamental understanding of sustainability, which is important for all professional fields. Integrative concepts and methods are essential: in order to use natural resources in the long term and to shape the global future in a socially just way, not only different disciplines, but also citizens, practitioners and institutions must work together.

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

- Basic module approx. 180 h
- Elective module approx. 150 h
- Consolidation module approx. 180 h

Total: approx. 510 h

Learning type

- lectures
- seminars
- workshops

Literature
Recommended reading of primary and specialist literature is determined individually by the respective lecturer.

6.218 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

6.219 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

6.220 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

6.221 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	1

Mandatory			
T-ETIT-100675	Systems and Software Engineering	5 CR	Sax

Competence Certificate
Written exam, approx. 120 minutes. (§4 (2), 1 SPO).

Prerequisites
none

Competence Goal
The students:

- know the most important Life Cycle and process models (including V-Model and agile methods).
- are capable of choosing a suitable method to design and evaluate complex systems.
- know the most important diagram types of hardware and software modeling languages and can design such diagrams from characterization of an application area.
- know the basic methods for quality assurance, which are needed during project development. They know the different test phases of a project and can evaluate the reliability of a system.
- They are familiar with the issues of functional safety and the standards of process evaluation.

Content
Major topics are techniques and methods for the design of complex electric, electronic and electronic programmable systems with software fragments and hardware fragments. The competences of the course comprise comprehensive knowledge and goal-oriented usage of state of the art modeling techniques, development processes, description techniques as well as specification languages.

Module grade calculation
Grades result from the written examination.

Workload
Each credit point (LP, Credit Points) corresponds around 25-30h of work effort of the student. Hereby we assume an average student with average performance. The workload is covered by: 1. Participating in lectures, tutorials and practical labs. 2. Preparing and wrap up of the above named units 3.Exam preparation and presence.

Recommendation
Participation in the lectures Digital System Design (23615) and Information Technology (23622) is advised

6.222 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.

Springer Vieweg Verlag (http://www.springer.com/de/book/9783662549476)

Hardcover ISBN: 978-3-662-54947-6 / eBook ISBN: 978-3-662-54948-3

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Industrial Design Engineering.

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ISBN: 3540236538

September 2005 - gebunden - 396 Seiten

6.223 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 6.224 Module: Thermal Solar Energy [M-MACH-102388]

Responsible: Prof. Dr. Robert Stieglitz
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-105225	Thermal Solar Energy	4 CR	N.N.

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.

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

6.225 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	German/English	4	1

Mandatory			
T-INFO-101326	Ubiquitous Computing	5 CR	Beigl

6.226 Module: Ultrasound Imaging [M-ETIT-100560]

Responsible: Dr. Nicole Ruiter
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Field of Specialization / Field of Specialization: Medical Technology (Complementary Modules)

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

Mandatory			
T-ETIT-100822	Ultrasound Imaging	3 CR	Ruiter

Prerequisites
none

M 6.227 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.

6.228 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

M 6.229 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

6.230 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	6

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	Ovtcharova
T-MACH-106743	IoT Platform for Engineering	4 CR	Ovtcharova
T-MACH-102181	PLM for Product Development in Mechatronics	4 CR	Eigner
T-MACH-106740	Virtual Engineering Lab	4 CR	Ovtcharova
T-MACH-106741	Virtual Training Factory 4.X	4 CR	Ovtcharova
T-MACH-111285	Virtual Solution Methods and Processes	4 CR	Maier, Ovtcharova

Competence Certificate
The assessment is carried out as partial exams (according to Section 4 (2), 1-3 SPO) of the core course and further single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module separately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None

Competence Goal
The students should:

- have basic knowledge about the industrial application of Information Technology in product development,
- have understanding about current and future application of information systems in product development processes in the context of Product Lifecycle Management and Virtual Engineering,
- be able to operate current CAx- and PLM-systems in the product development process
- understands demands and relevance of interconnected IT-systems and respective methods for product development

Content
The Module Virtual Engineering A gives an overview about product development processes, beginning with requirement engineering, verification of manufacturing feasibility and virtual operation in the scope of Digital Factory. The guest-lectures contained in this module complete the content of the lecture with introducing current product development processes focusing.

Workload

- regular attendance: 140 hours
- Preparation and reworking: 20 hours
- Exam and exam revision/preparation: 110 hours

Learning type
Lecture, exercise

M 6.231 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

M 6.232 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: Medical Technology (Complementary Modules)
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.

7 Courses

T 7.1 Course: Actuators and Sensors in Nanotechnology [T-MACH-105238]

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

Part of: M-MACH-102698 - Actuators and Sensors in Nanotechnology

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 23/24	2141866	Actuators and sensors in nanotechnology	2 SWS	Lecture /	Kohl, Sommer

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

Competence Certificate
oral exam

Prerequisites
none

T 7.2 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 2024	2400141	Advanced Artificial Intelligence	4 SWS	Lecture / 🗣	Niehues, 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.

T 7.3 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 23/24	2312664	Analog Circuit Design	2 SWS	Lecture / 🧩	Peric
WT 23/24	2312666	Tutorial for 2312664 Analog Circuit Design	1 SWS	Practice / 🖥	Peric

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

T 7.4 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 23/24	2308416	Antennas and Multiple Antenna Systems	2 SWS	Lecture / 🗣	Zwick
WT 23/24	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.

7.5 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	2	Grade to a third	Each summer term	3

Events					
ST 2024	2145164	Appliance and Power Tool Design	3 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 8 credits.

Prerequisites
The participationin “ Appliance and power tool design”” requires the concurrent project work.

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

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.

T 7.6 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	6	pass/fail	Each summer term	1 terms	2

Events					
ST 2024	2145165	Appliance and Power Tool Design Project Work	3 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
The participation in the project work requires the participation in “Appliance and power tool design”.
Due to organizational reasons, the number of participants is limited. At the beginning of august, a registration form will be available at the IPEK website. In the case of too many applicants, a selection process will be taking place. An early application is advantageous

7.7 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 23/24	2310537	Applied Information Theory	3 SWS	Lecture / 🗘	Jäkel
WT 23/24	2310539	Tutorial for 2310537 Applied Information Theory	1 SWS	Practice / 🗘	Jäkel

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

Prerequisites
none

T 7.8 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 23/24	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

T 7.9 Course: Automated Manufacturing Systems [T-MACH-108844]

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

Part of: M-MACH-105108 - Automated Manufacturing Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Each summer term	1

Events					
ST 2024	2150904	Automated 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-102162 - Automatisierte Produktionsanlagen" must not be commenced.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-102162 - Automated Manufacturing Systems must not have been started.

T 7.10 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 23/24	24169	Automated Visual Inspection and Image Processing	4 SWS	Lecture / 🗣	Beyerer, Zander

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

T 7.11 Course: Automotive Engineering I [T-MACH-100092]

Responsible: Prof. Dr. Frank Gauterin
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 23/24	2113805	Automotive Engineering I	4 SWS	Lecture / 🗣	Gauterin, Gießler
WT 23/24	2113809	Automotive Engineering I	4 SWS	Lecture / 🗣	Gauterin, 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.

7.12 Course: Automotive Engineering II [T-MACH-102117]

Responsible: Prof. Dr. Frank Gauterin
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 2024	2114835	Automotive Engineering II	2 SWS	Lecture / 🗣	Gießler
ST 2024	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

T 7.13 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	2

Events					
ST 2024	2138340	Automotive Vision	3 SWS	Lecture / 🗣	Lauer, Fehler

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

Competence Certificate
Type of Examination: written exam

Duration of Examination: 60 minutes

Prerequisites
none

T 7.14 Course: Basics Module - Self Assignment BAK [T-ZAK-112653]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Completed coursework	3	pass/fail	1

Competence Certificate

The monitoring in this module includes a course credit according to § 5 section 4 in the form of minutes of which two are to be handed in freely chosen topics of the lecture series " Introduction to Applied Studies on Culture and Society ". Length: approx. 6,000 characters each (incl. spaces).

Self service assignment of supplementary stdues

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation

Fjordevik, Anneli und Jörg Roche: Angewandte Kulturwissenschaften. Vol. 10. Narr Francke Attempto Verlag, 2019.

Annotation

The Basic Module consists of the lecture “Introduction to Supplementary Studies on Culture and Society”, which is offered only in the winter semester. It is therefore recommended that students start their studies in the winter semester and complete them before module 2.

T 7.15 Course: Basics Module - Self Assignment BeNe [T-ZAK-112345]

Responsible: Christine Myglas
Organisation:
Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Completed coursework	3	pass/fail	1

Competence Certificate
The monitoring in this module includes a course credit according to § 5 section 4:

Introduction to Sustainable Development in the form of minutes of which two are to be handed in freely chosen topics of the lecture series "Introduction to Sustainable Development". Length: approx. 6,000 characters each (incl. spaces).

or

Sustainability Spring Days at KIT in the form of a reflection report on all components of the project days "Sustainability Spring Days at KIT". Length approx. 12,000 characters (incl. spaces).

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:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
Kropp, Ariane: Grundlagen der Nachhaltigen Entwicklung: Handlungsmöglichkeiten und Strategien zur Umsetzung. Springer-Verlag, 2018.

Pufé, Iris: Nachhaltigkeit. 3. überarb. Edition, UTB, 2017.

Roorda, Niko, et al.: Grundlagen der nachhaltigen Entwicklung. Springer-Verlag, 2021.

Annotation
Module Basics consists of the lecture " Introduction to Sustainable Development ", which is only offered in the summer semester or alternatively of the project days " Sustainability Spring Days at KIT ", which is only offered in the winter semester. It is recommended to complete the course before Elective Module an Specialisation Module.

In exceptional cases, Elective Module or Specialisation Module can also be completed simultaneously with Basics Module. However, the prior completion of the advanced modules Elective and Specialisation should be avoided.

T 7.16 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 23/24	2117098	Basics of Technical Logistics II	3 SWS	Lecture / Practice (/ 🗣	Oellerich

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.

T 7.17 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 23/24	2304207	Batteries and Fuel Cells	2 SWS	Lecture / 🔀	Krewer
WT 23/24	2304213	Batteries and Fuel Cells (Exercise to 2304207)	1 SWS	Practice / 🗣	Krewer, Lindner

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, x Cancelled

Prerequisites
none

T 7.18 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 23/24	2304235	Batteries and Fuel Cells Laboratory	4 SWS	Practical course / 🗣	Weber

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

T 7.19 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 2024	2304214	Batterie- und Brennstoffzellensysteme	2 SWS	Lecture / 🗣	Weber

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

T 7.20 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 2024	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 7.21 Course: Biologically Inspired Robots [T-INFO-101351]

Responsible: Dr.-Ing. Arne Rönnau
Organisation: KIT Department of Informatics
Part of: M-INFO-100814 - Biologically Inspired Robots

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Each summer term	1

Events					
ST 2024	24619	Biologisch Motivierte Roboter	2 SWS	Lecture /	Rönnau

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

T 7.22 Course: Biomedical Measurement Techniques I [T-ETIT-106492]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100387 - Biomedical Measurement Techniques I

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each winter term	1

Events					
WT 23/24	2305269	Biomedical Measurement Techniques I	2 SWS	Lecture / 🧩	Nahm, Schaufelberger

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

Prerequisites
The earlier version "T-ETIT-101928 - Biomedizinische Messtechnik I" may not have been started or completed.

T 7.23 Course: Biomedical Measurement Techniques II [T-ETIT-106973]

Responsible: Prof. Dr. Werner Nahm
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100388 - Biomedical Measurement Techniques II

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	2

Events					
ST 2024	2305270	Biomedical Measurement Techniques II	2 SWS	Lecture / 🗣	Nahm

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

Competence Certificate
Success is checked in the form of a written test of 60 minutes. The module grade is the grade of the written exam.

Bonus points can also be awarded. You can find information on this under "Module grade".

Prerequisites
none

Recommendation

- Basics in physiology (module "Physiology and Anatomy for Biomedical Engineering")
- Basics in physical measurement technology,
- Basics in medical measurement technology (Module "Biomedical Measurement Technology I")
- Good prior knowledge of analog circuit technology and digital signal processing

Annotation
The event is based on an interactive combination of lecture parts and seminar parts. In the seminar part, the participants are asked to independently prepare and present individual topics of the course in small groups. These contributions are evaluated and the students receive bonus points for this. The bonus points are added to the points achieved in the written exam. The sum of the points gives the module grade.

T 7.24 Course: BioMEMS - Microfludic Chipsystems V [T-MACH-111069]

Responsible: Prof. Dr. Andreas Guber
Dr. Taleieh Rajabi

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105484 - BioMEMS - Microfludic Chipsystems V

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each winter term	1 terms	2

Competence Certificate
oral exam (appr. 20 Min.)

Prerequisites
none

T 7.25 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I [T-MACH-100966]

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

Part of: M-MACH-100489 - BioMEMS - Microsystems Technologies for Life Sciences and Medicine I

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each winter term	2

Events					
WT 23/24	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

T 7.26 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II [T-MACH-100967]

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

Part of: M-MACH-100490 - BioMEMS - Microsystems Technologies for Life Sciences and Medicine II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	2

Events					
ST 2024	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

T 7.27 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III [T-MACH-100968]

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

Part of: M-MACH-100491 - BioMEMS - Microsystems Technologies for Life Sciences and Medicine III

Type	Credits	Grading scale	Recurrence	Version
Written examination	4	Grade to a third	Each summer term	2

Events					
ST 2024	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

T 7.28 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV [T-MACH-106877]

Responsible: 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 23/24	2141102	BioMEMS IV - Microsystems technology for Life Sciences and Medicine	2 SWS	Lecture / 🗣	Guber, Ahrens, Länge
ST 2024	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

T 7.29 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 23/24	2123380	Advanced CATIA	3 SWS	Project (P /	Ovtcharova, Mitarbeiter
ST 2024	2123380	CATIA advanced	3 SWS	Project (P /	Meyer, 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

7.30 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 23/24	2123358	CATIA CAD training course	2 SWS	Practical course /	Ovtcharova, Mitarbeiter
ST 2024	2123358	CATIA CAD training course	2 SWS	Practical course /	Meyer, 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.

T 7.31 Course: Channel Coding: Algebraic Methods for Communications and Storage [T-ETIT-111244]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105616 - Channel Coding: Algebraic Methods for Communications and Storage

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Each summer term	1 terms	1

Events					
ST 2024	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 7.32 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 2024	2311616	Communication Systems and Protocols	2 SWS	Lecture / 🗣	Becker, Becker
ST 2024	2311618	Tutorial for 2311616 Communication Systems and Protocols	1 SWS	Practice / 🗣	Stammler

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

Prerequisites
none

T 7.33 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 23/24	2310509	Communications Engineering II	2 SWS	Lecture /	Jäkel
WT 23/24	2310510	Übung zu 2310509 Communications Engineering II	1 SWS	Practice /	Jäkel
ST 2024	2310511	Communications Engineering II	2 SWS	Lecture /	Jäkel
ST 2024	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 7.34 Course: Communications Engineering Laboratory [T-ETIT-100746]

Responsible: Dr.-Ing. Holger Jäkel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100442 - Communications Engineering Laboratory

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

Events					
WT 23/24	2310517	Communication Engineering Laboratory	4 SWS	Practical course / 🧩	Schmalen, Jäkel, Edelmann
ST 2024	2310517	Communication Engineering Laboratory	4 SWS	Practical course / 🧩	Schmalen, Jäkel, Edelmann

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

Prerequisites
none

T 7.35 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	2

Events					
ST 2024	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
none

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-100531 - Systematic Materials Selection must not have been started.

7.36 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 23/24	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

T 7.37 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	5

Events					
WT 23/24	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.

T 7.38 Course: Control of Linear Multivariable Systems [T-ETIT-100666]

Responsible: Dr.-Ing. Mathias Kluwe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100374 - Control of Linear Multivariable Systems

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

Events					
WT 23/24	2303177	Control of Linear Multivariable Systems	3 SWS	Lecture /	Kluwe
WT 23/24	2303179	Control of Linear Multivariable Systems (Tutorial to 2303177)	1 SWS	Practice /	Piscol

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 7.39 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. The preexamination with the code 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.

T 7.40 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 7.41 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	Version
Oral examination	6	Grade to a third	1

Events					
ST 2024	2306337	Control of Power-Electronic Systems	3 SWS	Lecture / 🔀	Liske, Göhner
ST 2024	2306338	Tutorial for 2306337 Control of Power-Electronic Systems	1 SWS	Practice / 🔀	Liske, Göhner

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

T 7.42 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 2024	2150683	Control Technology	2 SWS	Lecture / 🗣	Gönnheimer

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

Competence Certificate
Written Exam (60 min)

Prerequisites
none

T 7.43 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 23/24	2303169	Control Theory Laboratory	4 SWS	Block / 🗣	Hohmann
ST 2024	2303169	Control Theory Laboratory	4 SWS	Practical course / 🗣	Kluwe

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

Prerequisites
none

7.44 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 23/24	2143873	Actual topics of BioMEMS	2 SWS	Seminar / Blended	Guber, Ahrens
ST 2024	2143873	Actual topics of BioMEMS	2 SWS	Seminar / Blended	Guber, Ahrens

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

Competence Certificate
active participation and own presentation (30 Min.)

Prerequisites
none

T 7.45 Course: Cyber Physical Production Systems [T-ETIT-112223]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106039 - Cyber Physical Production Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2024	2303301	Cyber Physical Production Systems	2 SWS	Lecture / 🗣	Barth

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

Competence Certificate

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

The module grade is the grade of the oral exam.

Prerequisites

none

T 7.46 Course: Decentrally Controlled Intralogistic Systems [T-MACH-105230]

Responsible: Prof. Dr.-Ing. Kai Furmans
Dr.-Ing. Maximilian Hochstein

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102687 - Decentrally Controlled Intralogistic Systems

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each term	4

Events					
WT 23/24	2117084	Decentrally controlled intralogistic systems	2 SWS	Practical course / 🗣	Furmans, Sperling, Arndt
ST 2024	2117084	Decentrally controlled intralogistic systems	2 SWS	Practical course / 🗣	Furmans, Sperling, Arndt, Enke, Schumacher, Pang

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
None

Recommendation
Basic knowledge of Python programming and basic knowledge of technical logistics of advantage

T 7.47 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 2024	2400024	Deep Learning and Neural Networks	4 SWS	Lecture / 🗣	Niehues, Waibel

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

T 7.48 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 2024	2400007	Deep Learning for Computer Vision I: Basics	2 SWS	Lecture / 🗣	Stiefelhagen

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 7.49 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 23/24	2400258	Deep Learning for Computer Vision II: Advanced Topics	2 SWS	Lecture / 🗣	Stiefelhagen, Sarfraz, Reiß

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

T 7.50 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 23/24	2306324	Design of Electrical Machines	2 SWS	Lecture /	Doppelbauer
WT 23/24	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 7.51 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 2024	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

T 7.52 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 23/24	2308450	Digital Beam-Forming for Imaging Radar	2 SWS	Lecture / 🗣	Younis
WT 23/24	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 7.53 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 2024	2312683	Digital Circuit Design	2 SWS	Lecture /	Peric
ST 2024	2312685	Übungen zu 2312683 Design digitaler Schaltkreise	1 SWS	Practice /	Peric

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

T 7.54 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 2024	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 7.55 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 2024	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 7.56 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 23/24	2301486	Digital Twin Engineering	2 SWS	Lecture / 🗣	Barth, Witucki

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

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

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

Prerequisites
none

T 7.57 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

7.58 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 23/24	2115920	Railway System Digitalisation	2 SWS	Lecture / 🗣	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.

7.59 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 2024	2302106	Verteilte ereignisdiskrete Systeme	2 SWS	Lecture / 🧩	Heizmann
ST 2024	2302108	Übungen zu 2302106 Verteilte ereignisdiskrete Systeme	1 SWS	Practice / 🗣	Hoffmann

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

Prerequisites
none

7.60 Course: Drive Train of Mobile Machines [T-MACH-105307]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Marco Wydra

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 23/24	2113077	Drive Train of Mobile Machines	2 SWS	Lecture / 🗣	Geimer
WT 23/24	2113078	Übung zu 'Antriebsstrang mobiler Arbeitsmaschinen'	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.

T 7.61 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

Events					
ST 2024	2162210	Dynamics of electro-mechanical systems	2 SWS	Lecture / ✕	Fidlin
ST 2024	2162211	Dynamics of electro-mechanical systems (Tutorial)	2 SWS	Practice / ✕	Fidlin, Altoé

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

Competence Certificate
Written exam, 180 minutes

Prerequisites
None

7.62 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	5	Grade to a third	Each winter term	2

Events					
WT 23/24	2163111	Dynamics of the Automotive Drive Train	2 SWS	Lecture / 🗣	Fidlin
WT 23/24	2163112	Übungen zu Dynamik des Kfz-Antriebsstrangs	2 SWS	Practice	Fidlin, Gießler

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

Competence Certificate
Oral examination, 30 min.

Prerequisites
none

Recommendation
Powertrain Systems Technology A: Automotive SystemsMachine DynamicsVibration Theory

T 7.63 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

Competence Certificate

Success monitoring consists of participation in attendance modules (attendance requirement of 80%) and submission of a written reflection portfolio.

Attendance is required both to perform the work as a team on-site and to provide practical techniques and skills that cannot be learned in pure self-study.

Prerequisites

Part-time work as a tutor at KIT during program participation.

T 7.64 Course: Elective Module - Subject, Body, Individual: the Other Side of Sustainability - Self Assignment BeNe [T-ZAK-112349]

Organisation:

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
Examination of another kind according to § 7 section 7 in the form of a presentation in the selected course.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
The content of the Basics Module is helpful.

T 7.65 Course: Elective Module - Sustainability Assessment of Technology - Self Assignment BeNe [T-ZAK-112348]

Organisation:

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate

Examination of another kind according to § 7 section 7 in the form of a presentation in the selected course.

Prerequisites

Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation

The content of the Basics Module is helpful.

T 7.66 Course: Elective Module - Sustainability in Culture, Economy and Society - Self Assignment BeNe [T-ZAK-112350]

Organisation:

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
Examination of another kind according to § 7 section 7 in the form of a presentation in the selected course.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
The content of the Basics Module is helpful.

T 7.67 Course: Elective Module - Sustainable Cities and Neighbourhoods - Self Assignment BeNe [T-ZAK-112347]

Organisation: University

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
Examination of another kind according to § 7 section 7 in the form of a presentation in the selected course.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
The content of the Basics Module is helpful.

T 7.68 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 23/24	2312700	Electrical Engineering Components	3 SWS	Lecture / 🗣	Kempf, Lemmer
WT 23/24	2312701	Tutorial for 2312700 Electrical Engineering Components	1 SWS	Practice / 🗣	Wünsch

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 7.69 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.

T 7.70 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.

7.71 Course: Energy Informatics 1 [T-INFO-103582]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: M-INFO-101885 - Energy Informatics 1

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	2

Events					
WT 23/24	2400058	Energy Informatics 1	4 SWS	Lecture / Practice (	Hagenmeyer, Süß, Bauer, Geiges, Werling

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 7.72 Course: Energy Informatics 1 - Preliminary Work [T-INFO-110356]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: M-INFO-101885 - Energy Informatics 1

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	0	pass/fail	Each term	1

T 7.73 Course: Energy Informatics 2 [T-INFO-106059]

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: M-INFO-103044 - Energy Informatics 2

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each summer term	2

Events					
ST 2024	2400017	Energy Informatics 2	4 SWS	Lecture / Practice (/ 🗣	Hagenmeyer, Förderer, Stucky, Bao, Elbez, Kühnapfel, Schäfer, Mikut, Cakmak

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 7.74 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	1

Events					
ST 2024	2162231	Engineering Mechanics IV	2 SWS	Lecture / 🗣	Proppe
ST 2024	2162232	Engineering Mechanics IV (Tutorial)	2 SWS	Practice / 🗣	Proppe, Gießler, Kaupp

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

Competence Certificate
Written examination

Prerequisites
Application and exam is allowed only in one lecture of this modul (M-MACH-103205 - Technische Mechanik). "T-MACH-105209 - Einführung in die Mehrkörperdynamik", "T-MACH-105274 - Technische Mechanik IV" or "T-MACH-100297 - Mathematische Methoden der Festigkeitslehre".

7.75 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 2024	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

T 7.76 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 23/24	2545001	Entrepreneurship	2 SWS	Lecture / Blended	Terzidis
ST 2024	2545001	Entrepreneurship	2 SWS	Lecture / Blended	Terzidis, Dang

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

Competence Certificate
The assessment consists of a written exam (60 minutes) (following §4(2), 1 of the examination regulation).

Students are offered the opportunity to earn a grade bonus through separate assignments. If the grade of the written exam is between 4.0 and 1.3, the bonus improves the grade by a maximum of one grade level (0.3 or 0.4). The exact criteria for awarding a bonus will be announced at the beginning of the lecture.

Prerequisites
None

Recommendation
None

T 7.77 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 23/24	9003013	ARS REFLECTIONIS. Thinking and Acting Responsibly in Engineering, Science, and Innovation		Block / 🖥	Kühler, Does
ST 2024	9003013	ARS REFLECTIONIS. Thinking and Acting Responsibly in Engineering, Science, and Innovation		Block / 🖥	Kühler, Does

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

Prerequisites
none

T 7.78 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 23/24	2143882	Fabrication Processes in Microsystem Technology	2 SWS	Lecture / Blended	Bade
ST 2024	2143882	Fabrication Processes in Microsystem Technology	2 SWS	Lecture / On-Site	Bade

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

Competence Certificate
Oral examination, 20 minutes

Prerequisites
none

T 7.79 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 23/24	2309466	Field Propagation and Coherence	2 SWS	Lecture /	Freude, Maier, Reichenbacher
WT 23/24	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 7.80 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	Expansion	Version
Oral examination	4	Grade to a third	see Annotations	2 terms	2

Events					
WT 23/24	2113812	Fundamentals in the Development of Commercial Vehicles I	1 SWS	Lecture / 🗣	Weber
ST 2024	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

T 7.81 Course: Fundamentals of Automobile Development I [T-MACH-105162]

Responsible: Prof.Dipl.-Ing. Rolf Frech
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 23/24	2113810	Fundamentals of Automobile Development I	1 SWS	Lecture / 🗣	Frech
WT 23/24	2113851	Principles of Whole Vehicle Engineering I	1 SWS	Lecture / 🗣	Frech

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

Competence Certificate
Written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
none

T 7.82 Course: Fundamentals of Automobile Development II [T-MACH-105163]

Responsible: Prof.Dipl.-Ing. Rolf Frech
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 2024	2114842	Principles of Whole Vehicle Engineering II	1 SWS	Block / 🗣	Frech
ST 2024	2114860	Principles of Whole Vehicle Engineering II	1 SWS	/ 🗣	Frech

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

Competence Certificate
Written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
none

T 7.83 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	1

Events					
WT 23/24	2165515	Fundamentals of Combustion I	2 SWS	Lecture / 🗣	Maas, Shrotriya, Zenk
WT 23/24	2165517	Fundamentals of Combustion I (Tutorial)	1 SWS	Practice / 🗣	Bykov
WT 23/24	3165016	Fundamentals of Combustion I	2 SWS	Lecture / 🗣	Maas
WT 23/24	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
none

T 7.84 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 2024	2130927	Fundamentals of Energy Technology	3 SWS	Lecture / 🗣	Cheng, Badea
ST 2024	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

T 7.85 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

T 7.86 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 23/24	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

T 7.87 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 23/24	2311608	Hardware Modeling and Simulation	2 SWS	Lecture / 🗣	Becker, Becker
WT 23/24	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 7.88 Course: Hardware Synthesis and Optimisation [T-ETIT-100673]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100452 - Hardware Synthesis and Optimisation

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

Events					
ST 2024	2311619	Hardware Synthesis and Optimisation	3 SWS	Lecture / 🗣	Becker
ST 2024	2311621	Tutorial for 2311619 Hardware Synthesis and Optimisation	1 SWS	Practice / 🗣	Schmidt

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 7.89 Course: Hardware/Software Co-Design [T-ETIT-100671]

Responsible: Dr.-Ing. Oliver Sander
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 23/24	2311620	Hardware/Software Co-Design	2 SWS	Lecture / 🗣	Harbaum, Becker, Sander
WT 23/24	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 7.90 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 23/24	2165512	Heat and mass transfer	2 SWS	Lecture / 🗣	Yu, Maas
ST 2024	3122512	Heat and Mass Transfer	2 SWS	Lecture / 🗣	Maas

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

Competence Certificate
Written exam, approx. 3 h

Prerequisites
none

T 7.91 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 23/24	2307360	High-Voltage Technology	2 SWS	Lecture / 🗣	Badent
WT 23/24	2307362	Tutorial for 2307362High-Voltage Technology	1 SWS	Practice / 🗣	Badent, Zajadatz

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

T 7.92 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 23/24	2307392	High-Voltage Test Technique	2 SWS	Lecture / 🗣	Badent
WT 23/24	2307394	Tutorial for 2307392 High-Voltage Test Technique	2 SWS	Practice / 🗣	Gielnik

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

Prerequisites
none

T 7.93 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 23/24	24139	Human Brain and Central Nervous System: Anatomy, Information Transfer, Signal Processing, Neurophysiology and Therapy	2 SWS	Lecture / 🗣	Spetzger
ST 2024	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 7.94 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
Oral examination	6	Grade to a third	Each winter term	2

Events					
WT 23/24	24890	Humanoid Robotics Laboratory	4 SWS	Practical course / 🗣	Asfour

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, x 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 7.95 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 23/24	2400048	Seminar Humanoid Robots	2 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 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 7.96 Course: In-depth Module - Doing Culture - Self Assignment BAK [T-ZAK-112655]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation
The content of the Basic Modul is helpful.

T 7.97 Course: In-depth Module - Global Cultures - Self Assignment BAK [T-ZAK-112658]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation
The content of the Basic Modul is helpful.

T 7.98 Course: In-depth Module - Media & Aesthetics - Self Assignment BAK [T-ZAK-112656]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate

At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites

Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation

The content of the Basic Modul is helpful.

T 7.99 Course: In-depth Module - Spheres of Life - Self Assignment BAK [T-ZAK-112657]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate

At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites

Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation

The content of the Basic Modul is helpful.

T 7.100 Course: In-depth Module - Technology & Responsibility - Self Assignment BAK [T-ZAK-112654]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate

At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites

Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation

The content of the Basic Modul is helpful.

T 7.101 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 23/24	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 7.102 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 23/24	2306327	Industrial Circuitry	2 SWS	Lecture /	Liske

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

Prerequisites
none

T 7.103 Course: Information Engineering [T-MACH-102209]

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	3	Grade to a third	Each term	2

Events					
ST 2024	2122014	Information Engineering	2 SWS	Seminar / Blended	Meyer, Mitarbeiter

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

Competence Certificate
Alternative exam assessment (written composition and speech)

Prerequisites
None

7.104 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 23/24	2302139	Information Fusion	2 SWS	Lecture / 🔀	Heizmann
WT 23/24	2302141	Erxercize for 2302139 Information Fusion	1 SWS	Practice / 🗣	Heizmann, Bihler

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

Prerequisites
none

T 7.105 Course: Information Processing in Sensor Networks [T-INFO-101466]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: M-INFO-100895 - Information Processing in Sensor Networks

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each winter term	1

T 7.106 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

T 7.107 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 2024	2302144	Informationstechnik in der industriellen Automation	2 SWS	Lecture / 🗣	Bort

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

Prerequisites
none

T 7.108 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	Version
Examination of another type	4	Grade to a third	3

Events					
WT 23/24	2115921	Innovation and Project Management with Case Study "Innovative Rail Vehicle"	2 SWS	Lecture / 🗣	Cichon
ST 2024	2115921	Innovation and Project Management with Case Study "Innovative Rail Vehicle"	2 SWS	Lecture / 🗣	Cichon, Berthold

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

Competence Certificate
Presentation (duration approx. 20 minutes) and colloquium

T 7.109 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 winter term	2 terms	1

Events					
WT 23/24	2303192	Innovation Lab	2 SWS	Project (P / 🗣	Hohmann, Zwick, Sax, Stork, Nahm
ST 2024	2303192	Innovation Lab	2 SWS	Project (P / 🗣	Hohmann, Zwick, Sax, Stork, Terzidis

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

Competence Certificate
see module description

T 7.110 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
Oral examination	4	Grade to a third	Each summer term	1

Events					
ST 2024	24179	Innovative Concepts for Programming Industrial Robots	2 SWS	Lecture / 🗣	Hein

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

T 7.111 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 2024	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 7.112 Course: Integrated Product Development [T-MACH-105401]

Responsible: Prof. Dr.-Ing. Albert Albers
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	2

Events					
WT 23/24	2145156	Lecture: IP – Integrated Product Development	4 SWS	Lecture / 🗣	Albers
WT 23/24	2145157	Workshop: IP – Integrated Product Development	4 SWS	Practice / 🗣	Albers
WT 23/24	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 (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 Prof. Albers in personal interviews.

7.113 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 2024	2312688	Integrated Systems and Circuits	2 SWS	Lecture / 🗣	Ilin
ST 2024	2312690	Tutorial for 2312688 Integrated Systems and Circuits	1 SWS	Practice / 🗣	Wünsch

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

Prerequisites
none

T 7.114 Course: Intellectual Property Rights and Strategies in Industrial Companies [T-MACH-105442]

Responsible: Prof. Dr.-Ing. Tobias Düser
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 23/24	2147161	Intellectual Property Rights and Strategies in Industrial Companies	2 SWS	Block / 🗣	Zacharias
ST 2024	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

T 7.115 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 2024	2150600	International Production Engineering A	2 SWS	Lecture / 🧩	Fleischer

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

Competence Certificate
Alternative test achievement (graded):
- Result of the project work and final presentation with weighting 65%
- Oral exam (ca. 15 min) with weighting 35%

Prerequisites
One of the following courses must be started:

- T-MACH-108844 - Automated Manufacturing Systems
- T-MACH-110962 - Machine Tools and High-Precision Manufacturing Systems

Modeled Conditions
You have to fulfill one of 2 conditions:

1. The course T-MACH-108844 - Automated Manufacturing Systems must have been started.
2. The course T-MACH-110962 - Machine Tools and High-Precision Manufacturing Systems must have been started.

Recommendation
This course should be attended in combination with International Production Engineering B in the next winter semester.

T 7.116 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 23/24	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.

T 7.117 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 2024	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 7.118 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	6

Events					
ST 2024	2581010	Introduction to Energy Economics	2 SWS	Lecture / 🗣	Fichtner
ST 2024	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.

7.119 Course: Introduction to Microsystem Technology I [T-MACH-105182]

Responsible: Dr. Vlad Badilita
Dr. Mazin Jouda
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 23/24	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
none

T 7.120 Course: Introduction to Microsystem Technology II [T-MACH-105183]

Responsible: Dr. Mazin Jouda
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	1

Events					
ST 2024	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
none

T 7.121 Course: Introduction to Multi-Body Dynamics [T-MACH-105209]

Responsible: Dr.-Ing. Ulrich Römer
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

Events					
ST 2024	2162235	Introduction to Multibody Dynamics	3 SWS	Lecture / 🧩	Römer

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

Competence Certificate
Written examination, 180 min.

Prerequisites
Application and exam is allowed only in one lecture of this modul (M-MACH-103205 - Technische Mechanik). "T-MACH-105209 - Einführung in die Mehrkörperdynamik", "T-MACH-105274 - Technische Mechanik IV" or "T-MACH-100297 - Mathematische Methoden der Festigkeitslehre".

Recommendation
Engineering Mechanics III/IV

T 7.122 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 23/24	2305504	Einführung in die wissenschaftliche Methode	1 SWS	Seminar / 🗣	Nahm
ST 2024	2305744	Einführung in die wissenschaftliche Methode	1 SWS	Seminar / 🗣	Nahm

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

Prerequisites
none

T 7.123 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 23/24	2123352	IoT platform for engineering	3 SWS	Project (P / 🗣	Ovtcharova, Maier
ST 2024	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 7.124 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

T 7.125 Course: Lab Computer-Aided Methods for Measurement and Control [T-MACH-105341]

Responsible: Marvin Klemp
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 23/24	2137306	Lab Computer-aided methods for measurement and control	3 SWS	Practical course / 🗣	Stiller, Immel

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

Competence Certificate
Colloquia

Prerequisites
none

T 7.126 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 2024	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

7.127 Course: Lab Course Electrical Power Engineering [T-ETIT-100728]

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-100419 - Lab Course Electrical Power Engineering

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each winter term	2

Events					
WT 23/24	2307398	Lab Course Electrical Power Engineering	4 SWS	Practical course / 🗣	Badent, Brodatzki, N.N.

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

Prerequisites
none

T 7.128 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 23/24	2312669	Laboratory Nanoelectronics	4 SWS	Practical course / 🗣	Kempf, weitere Mitarbeitende
ST 2024	2312669	Laboratory Nanoelectronic Technology	4 SWS	Practical course / 🗣	Kempf

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

Prerequisites
none

T 7.129 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	3

Events					
ST 2024	2305276	Laboratory Biomedical Engineering	4 SWS	Practical course / 🗣	Nahm

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

Prerequisites
Passed exam of the module "Biomedizinische Messtechnik I".

Modeled Conditions
You have to fulfill one of 2 conditions:

1. The course T-ETIT-106492 - Biomedical Measurement Techniques I must have been passed.
2. The course T-ETIT-101928 - Biomedical Measurement Techniques I must have been passed.

7.130 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 23/24	2312674	Laboratory FPGA Based Circuit Design	4 SWS	Practical course / 🗣	Kempf, Wünsch
ST 2024	2312674	Laboratory FPGA Based Circuit Design	4 SWS	Practical course / 🗣	Kempf, Wünsch

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

Prerequisites
none

T 7.131 Course: Laboratory Information Systems in Power Engineering [T-ETIT-100727]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100415 - 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 2024	2307388	Praktikum: Informationssysteme in der elektrischen Energietechnik	4 SWS	Practical course / 🗣	Leibfried, und Mitarbeiter

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

Prerequisites

none

T 7.132 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 23/24	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 7.133 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 23/24	2105014	Laboratory mechatronics	3 SWS	Practical course / 🗣	Fidlin, Hagenmeyer, Böhland, Stiller, Chen, Orth, Immel

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

7.134 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 23/24	2313714	Laboratory Nanotechnology	4 SWS	Practical course / 🗣	Lemmer, Trampert
ST 2024	2313714	Laboratory Nanotechnology	4 SWS	Practical course / 🗣	Trampert, Lemmer

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

Prerequisites
none

T 7.135 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 23/24	2313712	Laboratory Optoelectronics	4 SWS	Practical course / 🗣	Kling, Trampert
ST 2024	2313712	Laboratory Optoelectronics	4 SWS	Practical course / 🗣	Trampert, Kling

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

Prerequisites
none

T 7.136 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 23/24	2313716	Laboratory Solar Energy	4 SWS	Practical course / 🗣	Richards, Trampert, Paetzold
ST 2024	2313708	Laboratory Solar Energy	4 SWS	Practical course / 🗣	Trampert, Paetzold, Richards

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

Prerequisites
none

T 7.137 Course: Leadership in Interdisciplinary Teams [T-MACH-106460]

Responsible: Prof. Dr.-Ing. Albert Albers
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 23/24	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

7.138 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 23/24	2313739	Lighting Engineering	2 SWS	Lecture / 🗣	Neumann
WT 23/24	2313741	Lighting Engineering (Tutorial to 2313739)	1 SWS	Practice	Neumann

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

Prerequisites
none

T 7.139 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 2024	2146190	Lightweight Engineering Design	2 SWS	Lecture / 🗣	Düser, Ott

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

Competence Certificate
Written examination (90 min)

Prerequisites
None

7.140 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	1

Events					
ST 2024	24613	Localization of Mobile Agents	3 SWS	Lecture / 🗣	Hanebeck

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

T 7.141 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	4

Events					
ST 2024	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.

T 7.142 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 23/24	2161224	Machine Dynamics	2 SWS	Lecture /	Proppe
ST 2024	2161224	Machine Dynamics	2 SWS	Lecture /	Proppe
ST 2024	2161225	Machine Dynamics (Tutorial)	1 SWS	Practice /	Proppe, Fischer

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

Competence Certificate
written exam, 180 min.

Prerequisites
none

T 7.143 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 2024	2400018	Machine Learning – Foundations and Algorithms	3 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 7.144 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 23/24	2511500	Machine Learning 1 - Fundamental Methods	2 SWS	Lecture / 🗣	Zöllner
WT 23/24	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.

T 7.145 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 2024	2511502	Machine Learning 2 - Advanced methods	2 SWS	Lecture / 🗣	Zöllner, Fechner, Polley
ST 2024	2511503	Exercises for Machine Learning 2 - Advanced Methods	1 SWS	Practice / 🗣	Zöllner, Fechner, Polley

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.

7.146 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	3

Events					
WT 23/24	2581050	Machine Learning and Optimization in Energy Systems	3 SWS	Lecture / Practice (/	Dengiz, Yilmaz, Perau

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.

T 7.147 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 23/24	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.

T 7.148 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 2024	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.

T 7.149 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 23/24	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.

T 7.150 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 23/24	2137308	Machine Vision	4 SWS	Lecture / Practice (/ 🗣	Lauer, Klemp

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

Competence Certificate

Type of Examination: written exam

Duration of Examination: 60 minutes

Prerequisites

None

T 7.151 Course: Manufacturing Measurement Technology [T-ETIT-106057]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103043 - Manufacturing Measurement Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each summer term	1

Events					
ST 2024	2302116	Fertigungsmesstechnik	2 SWS	Lecture / 🧩	Heizmann

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

7.152 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 7.153 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).

T 7.154 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	1

Events					
ST 2024	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
none

Recommendation
Materials Science I/II

T 7.155 Course: Mathematical Methods in Continuum Mechanics [T-MACH-110375]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103205 - Engineering Mechanics

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

Events					
WT 23/24	2161254	Mathematical Methods in Continuum Mechanics	2 SWS	Lecture / 🗣	Böhlke

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

Competence Certificate
written exam (90 min). Additives as announced.

Prerequisites
Passing the Tutorial to Mathematical Methods of Continuum Mechanics (T-MACH-110376)

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-110376 - Tutorial Mathematical Methods in Continuum Mechanics must have been passed.

7.156 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	Version
Written examination	5	Grade to a third	1

Events					
WT 23/24	2302117	Measurement Technology	2 SWS	Lecture / 🧩	Heizmann
WT 23/24	2302118	Exercise for 2302117 Measurement Technology	1 SWS	Practice / 🗣	Heizmann, Panther

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 7.157 Course: Mechanics in Microtechnology [T-MACH-105334]

Responsible: Prof. Dr. Christian Greiner
Dr. Patric Gruber

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102713 - Mechanics in Microtechnology

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 23/24	2181710	Mechanics in Microtechnology	2 SWS	Lecture / 🗣	Gruber, Greiner

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

Competence Certificate
Oral examination, ca. 30 min

Prerequisites
none

T 7.158 Course: Medical Image Processing for Guidance and Navigation [T-ETIT-113425]

Responsible: Prof. Dr. 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	Version
Oral examination	6	Grade to a third	1

Events					
ST 2024	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 where also the project developed during the course will be discussed (approx. 30 minutes).

The module grade is the grade of the oral exam.

Prerequisites
none

T 7.159 Course: Medical Imaging Technology I [T-ETIT-113048]

Responsible: Prof. Dr. Maria Francesca Spadea
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106449 - Medical Imaging Technology I

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	Each winter term	1

Events					
WT 23/24	2305261	Medical Imaging Technology I	2 SWS	Lecture	Spadea

Competence Certificate
The examination takes place in form of a written examination lasting 60 minutes. The course grade is the grade of the written exam.

Prerequisites
none

T 7.160 Course: Medical Imaging Technology II [T-ETIT-113421]

Responsible: Prof. Dr. 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 2024	2305262	Medical Imaging Technology II	2 SWS	Lecture / 🗣	Spadea

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

Competence Certificate
The examination takes place in form of a written examination lasting 60 minutes. The course grade is the grade of the written exam.

Prerequisites
none

7.161 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 2024	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.

T 7.162 Course: Methods of Signal Processing [T-ETIT-100694]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100540 - Methods of Signal Processing

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

Events					
WT 23/24	2302113	Methods of Signal Processing	2 SWS	Lecture /	Wahls, Heizmann
WT 23/24	2302115	Methods of Signal Processing (Tutorial to 2302113)	1+1 SWS	Practice /	Wahls, Heizmann, Diaz Ocampo

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

Prerequisites
none

T 7.163 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	2

Events					
ST 2024	2142881	Microactuators	2 SWS	Lecture / 🗣	Kohl

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

Competence Certificate
written exam, 60 min.

Prerequisites
none

T 7.164 Course: Microenergy Technologies [T-MACH-105557]

Responsible: Prof. Dr. Manfred Kohl
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 2024	2142897	Microenergy Technologies	2 SWS	Lecture / 🗣	Kohl

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

Competence Certificate
Oral examination (30 Min.)

Prerequisites
none

T 7.165 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	1

Competence Certificate
written exam

Prerequisites
none

T 7.166 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 23/24	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 7.167 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 23/24	2308407	Microwave Engineering	2 SWS	Lecture / 🗣	Pauli
WT 23/24	2308409	Tutorial for 2308407 Microwave Engineering	1 SWS	Practice / 🗣	Bhutani
ST 2024	2308407	Microwave Engineering	2 SWS	Lecture / 🗣	Pauli
ST 2024	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.

7.168 Course: Microwave Engineering Lab [T-ETIT-110789]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105300 - Microwave Engineering Lab

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

Events					
WT 23/24	2308415	Microwave Engineering Lab	4 SWS	Practical course / 🗣	Pauli
ST 2024	2308415	Microwave Engineering Lab	4 SWS	Practical course / 🗣	Pauli

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

Competence Certificate
To prepare the laboratory tests, each laboratory group has to do some homework together before the experiment and hand in a simple copy to the supervisor immediately before the start of the experiment. The tasks for the experiment as such are processed and logged during the implementation. The protocol should be handed over to the supervisor immediately after the experiment has been carried out. Before each experiment, there is a written exam or oral (approx. 20 min., No aids) the content of the experiment.

Prerequisites
none

Recommendation
Knowledge of microwave measurement technology and RF components and systems is helpful.

T 7.169 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 2024	2308420	Microwaves Measurement Techniques	2 SWS	Lecture / 🗣	Pauli
ST 2024	2308422	Übungen zu 2308420 Mikrowellenmesstechnik	1 SWS	Practice / 🗣	Pauli

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

Prerequisites
none

7.170 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 2024	2105024	Modern Control Concepts I	2 SWS	Lecture / Blended	Matthes, Groell
ST 2024	2106020	Tutorial on Modern Control Concepts I	2 SWS	Practice / Online	Matthes

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

Competence Certificate

Written exam (Duration: 1 h)

Prerequisites

none

7.171 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 23/24	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

T 7.172 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 2024	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

T 7.173 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	4	Grade to a third	Each summer term	1

Events					
ST 2024	2308430	Modern Radio Systems Engineering	2 SWS	Lecture / 🗣	Zwick
ST 2024	2308431	Tutorial 2308430 Modern Radio Systems Engineering	1 SWS	Practice / 🗣	Bhutani

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

Prerequisites
none

7.174 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 2024	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.

7.175 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
Written examination	4	Grade to a third	Each term	3

Events					
WT 23/24	2115808	Motor Vehicle Laboratory	2 SWS	Practical course / 🗣	Frey
ST 2024	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

7.176 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 2024	2312668	Nano- and Quantum Electronics	3 SWS	Lecture / 🗣	Kempf
ST 2024	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 7.177 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 2024	2303173	Nichtlineare Regelungssysteme	2 SWS	Lecture / 🗣	Kluwe

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

Prerequisites
none

7.178 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 2024	2309468	Nonlinear Optics	2 SWS	Lecture / 🗣	Koos
ST 2024	2309469	Nonlinear Optics (Tutorial)	2 SWS	Practice / 🗣	Koos

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

Prerequisites
none

T 7.179 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	3

Events					
WT 23/24	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
none

T 7.180 Course: Numerical Methods - Exam [T-MATH-111700]

Responsible: apl. Prof. Dr. Peer Kunstmann
Prof. Dr. Michael Plum
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 2024	0180300	Numerical Methods (Electrical Engineering, Meteorology, Remote Sensing, Geoinformatics)	2 SWS	Lecture	Liao
ST 2024	0180400	Tutorial for 0180300	1 SWS	Practice	Liao

Competence Certificate
Success control takes the form of a written examination (120 minutes).

Prerequisites
none

T 7.181 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 2024	2309490	Photonics and Communications Lab	4 SWS	Practical course / 🗣	Koos, Freude, Randel

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

Prerequisites
none

7.182 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 2024	2311647	Optical Design Lab	4 SWS	Practical course / 🗣	Stork

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

Prerequisites
none

7.183 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 23/24	2309460	Optical Transmitters and Receivers	2 SWS	Lecture /	Freude, Bremauer, Mahmud
WT 23/24	2309461	Tutorial for 2309460 Optical Transmitters and Receivers	2 SWS	Practice /	Freude, N.N., Mahmud

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

Prerequisites
none

T 7.184 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 23/24	2309464	Optical Waveguides and Fibers	2 SWS	Lecture / 🗣	Koos, N.N., Bao, Kelany
WT 23/24	2309465	Tutorial for 2309464 Optical Waveguides and Fibers	1 SWS	Practice / 🗣	Koos, N.N., Bao

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

Prerequisites
none

T 7.185 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 2024	2303162	Optimale Regelung und Schätzung	2 SWS	Lecture / 🗣	Kluwe

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

Prerequisites
none

7.186 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 23/24	2303183	Optimization of Dynamic Systems	2 SWS	Lecture /	Hohmann
WT 23/24	2303185	Optimization of Dynamic Systems (Tutorial to 2303183)	1 SWS	Practice /	N.N.
WT 23/24	2303851	Accompanying group tutorial for 2303183 Optimization of Dynamic Systems	1 SWS	Tutorial (/	N.N.

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 7.187 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 2024	2313736	Optoelectronic Measurement Engineering	2 SWS	Lecture / 🗣	Trampert

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

Prerequisites
none

T 7.188 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 winter term	2

Events					
WT 23/24	2313726	Optoelectronics	2 SWS	Lecture / 🧩	Lemmer
WT 23/24	2313728	Übungen zu 2313726 Optoelektronik	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 7.189 Course: Oral Exam - Supplementary Studies on Culture and Society [T-ZAK-112659]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Competence Certificate
An oral examination according to § 7 section 6 of approx. 45 minutes on the contents of two courses from In-depth Module.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

T 7.190 Course: Oral Exam - Supplementary Studies on Sustainable Development [T-ZAK-112351]

Organisation:

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Competence Certificate

An oral examination according to § 7 section 6 of approx. 45 minutes on the contents of two courses from Elective Module.

Prerequisites

A requirement for the Supplementary Course: Oral examination is the successful completion of the modules Basics Module and Specialisation Module and the required electives of Elective Module.

T 7.191 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 2024	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

7.192 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 2024	24675	Pattern Recognition	4 SWS	Lecture / Practice (/ 🗣	Beyerer

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

7.193 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 2024	2313737	Photovoltaics	3 SWS	Lecture / 🗣	Powalla, Lemmer
ST 2024	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.

T 7.194 Course: Physical and Data-Based Modelling [T-ETIT-111013]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105468 - Physical and Data-Based Modelling

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each summer term	2

Events					
ST 2024	2303166	Physical and Data-Based Modelling	3 SWS	Lecture / 🗣	Hohmann, Gießler
ST 2024	2303167	Tutorial for zu 2303166 Physical and Data-Based Modelling	1 SWS	Practice / 🗣	Gießler

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

Competence Certificate
Oral examination of approximately 20 minutes.

Prerequisites
none

T 7.195 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 23/24	2305281	Physiology and Anatomy for Engineers I	2 SWS	Lecture / Blended	Nahm
ST 2024	2305282	Physiology and Anatomy for Engineers II	2 SWS	Lecture / On-Site	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 7.196 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 23/24	2313729	Plasma Sources	3 SWS	Lecture / 🗣	Kling

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

Prerequisites
none

7.197 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 23/24	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 7.198 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

Events					
WT 23/24	2122376	PLM for product development in mechatronics	2 SWS	Lecture / 🗣	Eigner
ST 2024	2122376	PLM for product development in mechatronics	2 SWS	Lecture / 🗣	Eigner

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

Competence Certificate
Oral examination 20 min.

Prerequisites
none

T 7.199 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	Version
Oral examination	6	Grade to a third	1

Events					
WT 23/24	2306357	Power Electronic Systems in Energy applications	3 SWS	Lecture / 🧩	Hiller
WT 23/24	2306358	Power Electronic Systems in Energy applications	1 SWS	Practice / 🧩	Hiller

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

Prerequisites
none

T 7.200 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 2024	2300004	Ausweich- und Praktikumstermin für ETI-Vorlesungen	2 SWS	Practical course /	Hiller, Thönelt
ST 2024	2306323	Power Electronics	2 SWS	Lecture /	Hiller
ST 2024	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 7.201 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 2024	2306347	Power Electronics for Photovoltaics and Wind Energy	2 SWS	Lecture	Burger

Prerequisites
none

T 7.202 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 23/24	2307371	Power Network	2 SWS	Lecture / 🗣	Leibfried
WT 23/24	2307373	Tutorial for 2307371 Power Network	1 SWS	Practice / 🗣	Leibfried, Geis-Schroer

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

T 7.203 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 23/24	2307383	Power Systems and Economy	2 SWS	Lecture / 🗣	Weissmüller

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

Prerequisites
none

T 7.204 Course: Power Transmission and Power Network Control [T-ETIT-101941]

Responsible: Prof. Dr.-Ing. Thomas Leibfried
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100534 - Power Transmission and Power Network Control

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	1

Events					
ST 2024	2307372	Power Transmission and Power Network Control	2 SWS	Lecture / 🗣	Leibfried
ST 2024	2307374	Übungen zu 2307372 Energieübertragung und Netzregelung	1 SWS	Practice / 🗣	Bisseling

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

Prerequisites
none

T 7.205 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 summer term	1

Events					
ST 2024	2306311	Practical Aspects of Electrical Drives	2 SWS	Lecture / 🧩	Doppelbauer
ST 2024	2306313	Übungen zu 2306311 Praxis elektrischer Antriebe	1 SWS	Practice / 🧩	Doppelbauer

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

Prerequisites
none

T 7.206 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 2024	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 7.207 Course: Practical Course: Smart Energy System Lab [T-INFO-112030]

Responsible: Dr.-Ing. Simon Waczowicz
Organisation: KIT Department of Informatics
Part of: M-INFO-105955 - Practical Course: Smart Energy System Lab

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	1

Events					
WT 23/24	2400159	Laboratory: Smart Energy System Lab	4 SWS	Practical course / 🗣	Hagenmeyer, Süß, Grafenhorst, Waczowicz
ST 2024	2400082	Laboratory: Smart Energy System Lab	4 SWS	Practical course / 🗣	Hagenmeyer, Waczowicz, Süß

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

T 7.208 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	Version
Examination of another type	5	Grade to a third	1

Events					
ST 2024	2302200	Praktisches Machine Learning	3 SWS	Lecture / 🗣	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

7.209 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

Events					
WT 23/24	24282	Project practical Robotics and Automation I (Software)	4 SWS	Practical course	Hein, Längle

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 7.210 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

Events					
WT 23/24	24290	Robotics and Automation II (Hardware)	4 SWS	Practical course	Hein, Längle

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.

7.211 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 23/24	2143875	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last
WT 23/24	2143877	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last
ST 2024	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

T 7.212 Course: Practice Module [T-ZAK-112660]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Completed coursework	4	pass/fail	1

Competence Certificate

Internship (3 ECT)
Report within the framework of the practical training (Length approx. 18,000 characters (incl. spaces) (1 ECT)

Prerequisites

none

Annotation

Knowledge from the Basic Module and the Elective Module is helpful.

T 7.213 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 23/24	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

T 7.214 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	3

Events					
ST 2024	2110678	Production Techniques Laboratory	4 SWS	Practical course / 🧩	Deml, Fleischer, Furmans, Meyer

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

Competence Certificate

Advanced Internship: Participate in practicle exercise courses and complete the colloquia successfully.

Elective Subject: Participate in practicle exercise courses and complete the colloquia successfully and presentation of a specific topic.

Prerequisites

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.

7.215 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 23/24	2311641	Project Management in the Development of Products for Safety-Critical Applications	2 SWS	/	Nolle
WT 23/24	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 7.216 Course: ProVIL - Product Development in a Virtual Idea Laboratory [T-MACH-106738]

Responsible: Prof. Dr.-Ing. Albert Albers
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 summer term	1

Events					
ST 2024	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

7.217 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 23/24	2149667	Quality Management	2 SWS	Lecture / Blended	Lanza

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].

T 7.218 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	2

Events					
WT 23/24	2115919	Rail System Technology	2 SWS	Lecture / 🗣	Cichon, Heckele
ST 2024	2115919	Rail System Technology	2 SWS	Lecture / 🗣	Cichon

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

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

T 7.219 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	2

Events					
WT 23/24	2115996	Rail Vehicle Technology	2 SWS	Lecture / 🗣	Cichon, Reimann
ST 2024	2115996	Rail Vehicle Technology	2 SWS	Lecture / 🗣	Cichon

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

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

T 7.220 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 2024	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

T 7.221 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	Version
Oral examination	6	Grade to a third	1

Events					
WT 23/24	2306353	Real Time Control of Electrical Drives	3 SWS	Lecture / 🧩	Liske
WT 23/24	2306354	Tutorial for 2306353 Real Time Control of Electrical Drives	1 SWS	Practice / 🧩	Liske

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

T 7.222 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 23/24	2400163	Reinforcement Learning	SWS: 4 / ECTS: 6 SWS	Lecture / Practice (/ 🗣	Neumann, Lioutikov, Celik, Freymuth, 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 7.223 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	1

Events					
WT 23/24	2145350	Reliability and Test Engineering (Lecture)	2 SWS	Lecture / Blended	Gwosch
WT 23/24	2145351	Workshop Reliability and Test Engineering	2 SWS	Practical course / On-Site	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
We strongly recommend the attendance of the MSuP lectures. Students who have not (yet) attended are recommended to learn the contents in advance.

7.224 Course: Renewable Energy-Resources, Technologies and Economics [T-WIWI-100806]

Responsible: PD 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	7

Events					
WT 23/24	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 7.225 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 2024	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 7.226 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	1

Events					
WT 23/24	2424152	Robotics I - Introduction to Robotics	3/1 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.

T 7.227 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 2024	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 7.228 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 2024	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 7.229 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 23/24	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.

T 7.230 Course: Self Assignment-HOC-SPZ-ZAK-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
- Zentrum für Angewandte Kulturwissenschaft und Studium Generale

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 7.231 Course: Self Assignment-HOC-SPZ-ZAK-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
- Zentrum für Angewandte Kulturwissenschaft und Studium Generale

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 7.232 Course: Self Assignment-HOC-SPZ-ZAK-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
- Zentrum für Angewandte Kulturwissenschaft und Studium Generale

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 7.233 Course: Self Assignment-HOC-SPZ-ZAK-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
- Zentrum für Angewandte Kulturwissenschaft und Studium Generale

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 7.234 Course: Self Assignment-HOC-SPZ-ZAK-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
- Zentrum für Angewandte Kulturwissenschaft und Studium Generale

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 7.235 Course: Self Assignment-HOC-SPZ-ZAK-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
- Zentrum für Angewandte Kulturwissenschaft und Studium Generale

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 7.236 Course: Seminar Accessibility - Assistive Technologies for Visually Impaired Persons [T-INFO-104742]

Responsible: Prof. Dr.-Ing. Rainer Stiefelhagen
Organisation: KIT Department of Informatics
Part of: M-INFO-102374 - Seminar Accessibility - Assistive Technologies for Visually Impaired Persons

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	2

T 7.237 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 2024	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.

7.238 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 2024	2311633	Seminar Creating a Patent Specification	2 SWS	Seminar / 🗣	Stork

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

Prerequisites
none

T 7.239 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 term	1

Events					
WT 23/24	2151643	Seminar Data Mining in Production	2 SWS	Seminar / 🗣	Lanza
ST 2024	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.

T 7.240 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	Version
Examination of another type	4	Grade to a third	3

Events					
WT 23/24	2311627	Seminar Embedded Systems	2 SWS	Seminar / 🗣	Becker, Sax, Stork
ST 2024	2311627	Seminar Embedded Systems	2 SWS	Seminar / 🧩	Becker, Sax, Stork

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

Prerequisites
none

T 7.241 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 23/24	2115009	Seminar for Rail System Technology	2 SWS	Seminar / 🗣	Cichon
ST 2024	2115009	Seminar for Rail System Technology	2 SWS	Seminar / 🗣	Cichon, Ziesel

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

Competence Certificate
Examination: Writing a Seminararbeit, final presentation

Prerequisites
none

T 7.242 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

Events					
WT 23/24	24785	Intelligent Industrial Robots	2 SWS	Seminar	Hein

T 7.243 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 2024	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 7.244 Course: Seminar on Quantum Detectors and Sensors [T-ETIT-111235]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105607 - Seminar on Quantum Detectors and Sensors

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Each term	1 terms	1

Events					
WT 23/24	2312716	Seminar on Quantum Detectors and Sensors	2 SWS	Seminar / 🗣	Kempf, Ilin, Wünsch
ST 2024	2312679	Seminar on Quantum Detectors and Sensors	2 SWS	Seminar / 🗣	Kempf

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

Prerequisites
none

T 7.245 Course: Seminar Project Management for Engineers [T-ETIT-100814]

Responsible: Prof. Dr. 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

7.246 Course: Seminar Project Management for Engineers [T-ETIT-108820]

Responsible: Dr. Christian Day
Prof. Dr. 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 2024	2312684	Project Management for Engineers	2 SWS	Seminar / 🗣	Noe

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

Prerequisites
none

T 7.247 Course: Seminar Radar and Communication Systems [T-ETIT-100736]

Responsible: Prof. Dr.-Ing. Thomas Zwick
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100428 - Seminar Radar and Communication Systems

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	1

Competence Certificate
The performance evaluation takes place by means of an overall examination of the selected courses, the sum total of which fulfills the minimum requirement of course credits.

The examination takes place in the form of submission of a written report (paper) along with an oral presentation of the individual work. Both are taken into account, while grading the examination performance. The overall impression will be evaluated.

Prerequisites
none

Recommendation
Knowledge of fundamentals of radio frequency engineering are helpful.

T 7.248 Course: Seminar: Energy Informatics [T-INFO-106270]

Responsible: TT-Prof. Dr. Thomas Bläsius
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 23/24	2400013	Seminar: Energy Informatics	2 SWS	Seminar / 🗣	Hagenmeyer, Fichtner, Bläsius, Göttlicher, Yi, Süß, An

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

7.249 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 2024	2304231	Sensors	2 SWS	Lecture / 🗣	Menesklou

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

T 7.250 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 2024	2302134	Signal Processing Lab	4 SWS	Practical course / Blended	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.

7.251 Course: Signal Processing with Nonlinear Fourier Transforms and Koopman Operators [T-ETIT-113428]

Responsible: Prof. Dr.-Ing. Sander Wahls
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106675 - Signal Processing with Nonlinear Fourier Transforms and Koopman Operators

Type	Credits	Grading scale	Version
Written examination	6	Grade to a third	1

Events					
ST 2024	2302135	Signal Processing with Nonlinear Fourier Transforms and Koopman Operators	2 SWS	Lecture / 🗣	Wahls
ST 2024	2302136	Practice to 2303135 Signal Processing with Nonlinear Fourier Transforms and Koopman Operators	2 SWS	Practice / 🗣	Wahls

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 7.252 Course: SIL Entrepreneurship Project [T-WIWI-110166]

Responsible: Prof. Dr. Orestis Terzidis
Organisation: KIT Department of Economics and Management
Part of: M-ETIT-105073 - Student Innovation Lab

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 23/24	2545082	SIL Entrepreneurship Project	2-4 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

7.253 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
Written examination	3	Grade to a third	Each summer term	3

Events					
ST 2024	2311611	Software Engineering	2 SWS	Lecture / 🗣	Reichmann

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

Prerequisites
none

T 7.254 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 23/24	2313745	Solar Energy	3 SWS	Lecture / 🗣	Richards, Paetzold
WT 23/24	2313750	Tutorial 2313745 Solar Energy	1 SWS	Practice / 🗣	Richards, Paetzold

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

Prerequisites
Students not allowed to take either of the following modules in addition to this one: „Solarenergie" (M-ETIT-100476) and „Photovoltaik" (M-ETIT-100513).

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-ETIT-101939 - Photovoltaics must not have been started.

T 7.255 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 2024	2308428	Spaceborne Radar Remote Sensing	2 SWS	Lecture / 🗣	Prats, Moreira
ST 2024	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).

7.256 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 2024	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 7.257 Course: Specialisation Module - Self Assignment BeNe [T-ZAK-112346]

Responsible: Christine Myglas
Organisation:
Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	6	Grade to a third	1

Competence Certificate

The monitoring occurs in the form of several supplementary courses, which usually comprise a presentation of the (group) project, a written elaboration of the (group) project as well as an individual term paper, if necessary with appendices (examination performances of other kind according to statutes § 5 section 3 No. 3 or § 7 section 7).

The presentation is usually with the accompanying practice partners, as well as the written paper.

Prerequisites

Active participation in all three mandatory components.

Self service assignment of supplementary stdues

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

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation

Knowledge from 'Basic Module ' and 'Elective Module ' is helpful.

T 7.258 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 23/24	24113	Stochastic Information Processing	3 SWS	Lecture / 🗣	Hanebeck, Frisch

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

T 7.259 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 23/24	2314010	Strategy Derivation for Engineer	2 SWS	Seminar /	Arndt

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

Prerequisites
none

T 7.260 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 2024	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 7.261 Course: Superconducting Power Systems [T-ETIT-113439]

Responsible: Prof. Dr. 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 23/24	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 7.262 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 2024	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

T 7.263 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 23/24	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

T 7.264 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 2024	2174576	Systematic Materials Selection	3 SWS	Lecture / 🗣	Dietrich
ST 2024	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.

T 7.265 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 23/24	2311612	Laboratory System-on-Chip	4 SWS	Practical course / 🗣	Becker, Peric

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

Prerequisites

none

T 7.266 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	1

Events					
WT 23/24	2311605	Systems and Software Engineering	2 SWS	Lecture / 🧩	Sax
WT 23/24	2311607	Tutoral for 2311605 Systems and Software Engineering	1 SWS	Practice / 🧩	Nägele

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

Competence Certificate
Written exam, approx. 120 minutes. (§4 (2), 1 SPO).

Prerequisites
none

Recommendation
Participation in the lectures Digital System Design and Information Technologyis advised

T 7.267 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

Events					
ST 2024	2146179	Technical Design in Product Development	2 SWS	Lecture / ✕	Schmid

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

Competence Certificate

Written exam (60 min)

Only dictionnary is allowed

T 7.268 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 23/24	2313720	Technical Optics	2 SWS	Lecture / 🗣	Neumann
WT 23/24	2313722	Technical Optics (Tutorial to 2313720)	1 SWS	Practice / 🗣	Neumann

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

Prerequisites
none

T 7.269 Course: Thermal Solar Energy [T-MACH-105225]

Responsible: N.N.
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	1

Events					
WT 23/24	2169472	Thermal Solar Energy	2 SWS	Lecture / 🗣	Stieglitz, Dagan

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

Competence Certificate
Oral examination of about 30 minutes

Prerequisites
none

T 7.270 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 23/24	2161253	Tutorial Continuum mechanics of solids and fluids	1 SWS	Practice / 🗣	Dyck, Karl, 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.

7.271 Course: Tutorial Mathematical Methods in Continuum Mechanics [T-MACH-110376]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-103205 - Engineering Mechanics

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

Events					
WT 23/24	2161255	Tutorial Mathematical Methods in Continuum Mechanics	2 SWS	Practice / 🗣	Lauff, Sterr, Böhlke

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

Competence Certificate
successfully solving the homework sheets. Details are announced in the first lecture.

Prerequisites
None

T 7.272 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 23/24	24146	Ubiquitäre Informationstechnologien	2+1 SWS	Lecture / Practice (	Beigl

T 7.273 Course: Ultrasound Imaging [T-ETIT-100822]

Responsible: Dr. Nicole Ruiter
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100560 - Ultrasound Imaging

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Each summer term	1

Events					
ST 2024	2305295	Ultrasound Imaging	2 SWS	Lecture / 🗣	Ruiter

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

Prerequisites
none

T 7.274 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	1

Events					
WT 23/24	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
none

Recommendation
none

T 7.275 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 23/24	2115922	Vehicle Systems for Urban Mobility	2 SWS	Lecture / 🗣	Cichon
ST 2024	2115922	Vehicle Systems for Urban Mobility	2 SWS	Lecture / 🗣	Cichon, Berthold

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.

T 7.276 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 23/24	2121352	Virtual Engineering I	2 SWS	Lecture / 🗣	Ovtcharova
WT 23/24	2121353	Exercises Virtual Engineering I	2 SWS	Practice / 🗣	Ovtcharova, Mitarbeiter

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

Competence Certificate
Writen examination 90 min.

Prerequisites
None

7.277 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 23/24	2123350	Virtual Engineering Lab	3 SWS	Project (P /	Ovtcharova, Häfner
ST 2024	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 7.278 Course: Virtual Solution Methods and Processes [T-MACH-111285]

Responsible: Dipl.-Ing. Thomas Maier
Prof. Dr.-Ing. Jivka Ovtcharova

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 term	1 terms	1

Events					
WT 23/24	2121003	Virtual Solution Methods and Processes	4 SWS	Project (P / 🗣	Meyer, Ovtcharova
ST 2024	2121003	Virtual Solution Methods and Processes	4 SWS	Project (P / 🗣	Meyer

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

Competence Certificate
Graded examination performance of another type weighted according to: 30% project documentation, 30% colloquium and 40% successfully completed project task.

Prerequisites
None

Recommendation
None

7.279 Course: Virtual Training Factory 4.X [T-MACH-106741]

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 23/24	2123351	Virtual training factory 4.X		/ 🗣	Ovtcharova, Mitarbeiter

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

Competence Certificate
Assessment of another type (graded), Group project (project work, final presentation) for the modeling of production plants in VR

Prerequisites
none

T 7.280 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 2024	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.