Karlsruher Institut für Technologie

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

SPO 2015

Winter term 2022/23

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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 courses of the Master’s degree programs in Electrical Engineering and Information Technology, Mechanical Engineering, or Informatics/Computer Science. 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-102569	Praxis leistungselektronischer Systeme	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-104983	Plug-and-Play Fördertechnik	4 CR other type
VF: M-MACH-105281	Informationssysteme in Logistik und Supply Chain Management	3 CR oral
VF: M-MACH-105286	BUS-Steuerungen	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: -

Totel 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 neu	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

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 neu	9 CR
M-MACH-106050	Reliability and Test Engineering neu	5 CR
Complementary Modules (Election: between 8 and 11 credits)		
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-102700	Dynamics of the Automotive Drive Train	5 CR
M-MACH-102692	Electric Rail Vehicles	4 CR
M-ETIT-100515	Design of Electrical Machines	5 CR
M-MACH-105288	Handling Characteristics of Motor Vehicles I	4 CR
M-MACH-102703	Vehicle Lightweight Design - Strategies, Concepts, Materials	4 CR
M-MACH-102693	Automotive Vision	6 CR
M-MACH-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-INFO-105623	Reinforcement Learning neu	5 CR

3.3.2 Field of Specialization: Power Engineering

Part of: Field of Specialization

Credits
35

Mandatory		
M-ETIT-100534	Power Transmission and Power Network Control	5 CR
M-MACH-102690	Fundamentals of Energy Technology	8 CR
M-ETIT-104567	Power Electronics neu	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 neu	6 CR
M-ETIT-102350	Laboratory Solar Energy	6 CR
M-MACH-105725	Seamless Engineering neu	9 CR
Complementary Modules (Election: 11 credits)		
M-ETIT-100532	Batteries and Fuel Cells	5 CR
M-WIWI-100498	Introduction into Energy Economics	5 CR
M-ETIT-100572	Power Network	6 CR
M-INFO-101885	Energy Informatics 1	5 CR
M-INFO-103044	Energy Informatics 2	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 neu	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

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 neu	9 CR
Complementary Modules (Election: between 10 and 12 credits)		
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	3 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

Mandatory		
M-ETIT-100384	Medical Imaging Techniques I	3 CR
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-100389	Laboratory Biomedical Engineering	6 CR
Complementary Modules (Election: 11 credits)		
M-INFO-103294	Wearable Robotic Technologies	4 CR
M-MACH-105485	Current Topics on BioMEMS	4 CR
M-ETIT-100385	Medical Imaging Techniques II	3 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-ETIT-105874	Physiology and Anatomy for Biomedical Engineering neu	6 CR
M-INFO-102374	Seminar Accessibility - Assistive Technologies for Visually Impaired Persons	3 CR

3.3.5 Field of Specialization: Industrial Automation

Part of: Field of Specialization

Credits
35

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-MACH-104983	Plug-and-Play Material Handling	4 CR
M-ETIT-103448	Laboratory Mechatronic Measurement Systems	6 CR
M-MACH-105725	Seamless Engineering neu	9 CR
M-MACH-106050	Reliability and Test Engineering neu	5 CR
Complementary Modules (Election: between 11 and 13 credits)		
M-MACH-105108	Automated Manufacturing Systems	8 CR
M-MACH-105286	BUS-Controls	4 CR
M-ETIT-106039	Cyber Physical Production Systems neu *First usage possible from 4/1/2023.*	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-105283	Basics of Technical Logistics I	4 CR
M-MACH-105281	Information Systems and Supply Chain Management	3 CR
M-ETIT-100367	Information Technology in Industrial Automation Systems	3 CR
M-MACH-105282	IT-Fundamentals of Logistics: Opportunities for Digital Transformation	4 CR
M-MACH-105968	Artificial Intelligence in Production neu	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-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

Mandatory		
M-INFO-100819	Cognitive Systems	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 neu	9 CR
M-MACH-106050	Reliability and Test Engineering neu	5 CR
Complementary Modules (Election: between 14 and 17 credits)		
M-INFO-104460	Deep Learning and Neural Networks	6 CR
M-MACH-105612	Dynamics of Electro-Mechanical Systems	5 CR
M-INFO-100803	Real-Time Systems	6 CR
M-INFO-105778	Machine Learning - Foundations and Algorithms	5 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 neu	6 CR
M-INFO-105623	Reinforcement Learning	5 CR
M-INFO-100829	Stochastic Information Processing	6 CR

3.3.7 Field of Specialization: Robotics

Part of: Field of Specialization

Credits 35

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-104983	Plug-and-Play Material Handling	4 CR
M-ETIT-100364	Laboratory Digital Signal Processing neu	6 CR
M-MACH-105291	Lab Computer-Aided Methods for Measurement and Control neu	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 neu	9 CR
M-MACH-106050	Reliability and Test Engineering neu	5 CR
Complementary Modules (Election: between 12 and 15 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-105296	Computational Intelligence	4 CR
M-ETIT-100453	Hardware/Software Co-Design neu	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-INFO-100824	Human-Machine-Interaction in Anthropomatics: Basics	3 CR
M-MACH-100487	Microactuators	4 CR
M-INFO-102555	Motion in Man and Machine - Seminar	3 CR
M-ETIT-100371	Nonlinear Control Systems	3 CR
M-INFO-102212	Seminar Intelligent Industrial Robots	3 CR
M-MACH-105348	Control Technology neu	4 CR

3.3.8 Field of Specialization: Design of Mechatronic Systems

Part of: Field of Specialization

Credits 35

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-102684	CAE-Workshop	4 CR
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 neu	9 CR
M-MACH-105475	Virtual Engineering Lab	4 CR
M-MACH-106050	Reliability and Test Engineering neu	5 CR
Complementary Modules (Election: between 7 and 11 credits)		
M-MACH-105286	BUS-Controls	4 CR
M-ETIT-106039	Cyber Physical Production Systems neu *First usage possible from 4/1/2023.*	4 CR
M-MACH-105612	Dynamics of Electro-Mechanical Systems	5 CR
M-INFO-100753	Design Principles for Interactive Real-Time Systems	3 CR
M-ETIT-103264	Information Fusion	4 CR
M-MACH-102696	Lightweight Engineering Design	4 CR
M-MACH-105968	Artificial Intelligence in Production neu	8 CR
M-MACH-102694	Machine Dynamics	5 CR
M-MACH-105332	Quality Management	4 CR
M-MACH-105318	Technical Design in Product Development	4 CR
M-MACH-101283	Virtual Engineering A	9 CR
M-ETIT-105915	Control of Power-Electronic Systems neu	6 CR

3.4 Interdisciplinary Subject

Credits
17

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-ETIT-100444	Applied Information Theory	6 CR
M-ETIT-100565	Antennas and Multiple Antenna Systems	5 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-100384	Medical Imaging Techniques I	3 CR
M-ETIT-100385	Medical Imaging Techniques II	3 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-105286	BUS-Controls	4 CR
M-MACH-102684	CAE-Workshop	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 neu *First usage possible from 4/1/2023.*	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 neu	4 CR
M-ETIT-105415	Digital Beam-Forming for Imaging Radar	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 neu	6 CR
M-INFO-100803	Real-Time Systems	6 CR
M-WIWI-100498	Introduction into Energy Economics	5 CR
M-ETIT-100572	Power Network	6 CR
M-MACH-102692	Electric Rail Vehicles	4 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-WIWI-100499	Energy Systems Analysis	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-ETIT-103043	Manufacturing Measurement Technology	3 CR
M-ETIT-100566	Field Propagation and Coherence	4 CR
M-MACH-102705	Appliance and Power Tool Design	8 CR
M-INFO-100753	Design Principles for Interactive Real-Time Systems	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-105283	Basics of Technical Logistics I	4 CR
M-MACH-105302	Basics of Technical Logistics II	5 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-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-INFO-100819	Cognitive Systems	6 CR
M-MACH-102712	Design with Plastics	4 CR
M-MACH-102696	Lightweight Engineering Design	4 CR
M-MACH-105180	Continuum Mechanics	5 CR
M-MACH-102695	Motor Vehicle Laboratory	4 CR
M-MACH-105968	Artificial Intelligence in Production neu	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 neu	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-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-INFO-100757	Mechano-Informatics and Robotics	4 CR
M-MACH-102699	Laboratory Mechatronics	4 CR
M-INFO-100729	Human Computer Interaction	6 CR
M-INFO-100824	Human-Machine-Interaction in Anthropomatics: Basics	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-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 Man 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 neu	6 CR
M-ETIT-100481	Plasma Sources	4 CR
M-ETIT-100475	Plastic Electronics / Polymerelectronics	3 CR
M-MACH-104983	Plug-and-Play Material Handling	4 CR
M-ETIT-104567	Power Electronics neu	6 CR
M-ETIT-100360	Predictive Driver Assistance Systems	3 CR
M-ETIT-100381	Batteries and Fuel Cells Laboratory	6 CR
M-ETIT-100389	Laboratory Biomedical Engineering	6 CR
M-ETIT-100364	Laboratory Digital Signal Processing	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 neu	6 CR

M-ETIT-100470	Laboratory FPGA Based Circuit Design	6 CR
M-ETIT-100394	Practical Aspects of Electrical Drives	4 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 neu	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 neu	6 CR
M-ETIT-100374	Control of Linear Multivariable Systems	6 CR
M-WIWI-100500	Renewable Energy-Resources, Technologies and Economics	4 CR
M-INFO-102522	Robotics - Practical Course	6 CR
M-INFO-100893	Robotics I - Introduction to Robotics	6 CR
M-INFO-102756	Robotics II - Humanoid Robotics	3 CR
M-INFO-104897	Robotics III - Sensors and Perception in Robotics	3 CR
M-INFO-100820	Medical 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-104197	Seminar for Rail System Technology	3 CR
M-ETIT-100428	Seminar Radar and Communication Systems	4 CR
M-INFO-102211	Seminar Robotics and Medicine neu	3 CR
M-ETIT-100378	Sensors	3 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-INFO-100829	Stochastic Information Processing	6 CR
M-ETIT-105073	Student Innovation Lab	15 CR
M-MACH-105315	System Integration in Micro- and Nanotechnology	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-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

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-INFO-100803	Real-Time Systems	6 CR
M-MACH-102692	Electric Rail Vehicles	4 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-INFO-100753	Design Principles for Interactive Real-Time Systems	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-105283	Basics of Technical Logistics 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-MACH-105302	Basics of Technical Logistics II	5 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-104985	Logistics - Organisation, Design and Control of Logistic Systems	6 CR
M-MACH-104984	Material Flow in Logistic Systems	9 CR
M-MACH-102714	Microenergy Technologies	4 CR
M-MACH-100487	Microactuators	4 CR
M-MACH-105308	Modern Control Concepts I	4 CR
M-MACH-105313	Modern Control Concepts II	4 CR
M-MACH-105314	Modern Control Concepts III	4 CR
M-MACH-105292	Novel Actuators and Sensors	4 CR
M-ETIT-100513	Photovoltaics	6 CR
M-MACH-104983	Plug-and-Play Material Handling	4 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-ETIT-105916	Real Time Control of Electrical Drives neu	6 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Microsystems Technology (Complementary Modules)

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

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

Competence Certificate
oral exam: 45 min

Prerequisites
keine

Competence Goal

- Knowledge of the principles of actuation and sensing
- Knowledge of important fabrication technologies
- Explanation of typical properties (time constants, sensitivities, forces, etc.)
- Explanation of layout and function of the actuators and sensors

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

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: 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 6.3 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	3

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

Competence Certificate
The success control is carried out as part of a written overall examination (120 minutes) of the selected courses, with which the minimum requirement for LP is met.

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 written exam.

Workload
Each credit corresponds to approximately 30 hours of work (of the student). This is based on the preferred student who achieves an average performance. 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

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

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

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

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

Mandatory			
T-MACH-105229	Appliance and Power Tool Design	2 CR	Matthiesen
T-MACH-110767	Appliance and Power Tool Design Project Work	6 CR	Matthiesen

Competence Certificate
Oral exam: Duration ca. 40 min.

Final presentation with the results of the project work. 15 min. presentation, 10 min discussion

Prerequisites
None

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 is composed of:
1. Grade of the oral exam (25%)
2. Grade of project work (75%)

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
Präsenzzeit Vorlesung: 21 h

Projektarbeit: 195 h

Klausurvorbereitung und Präsenz in selbiger: 24 h

Recommendation
None

Learning type
Lecture, exercise, project work

6.5 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 6.6 Module: Artificial Intelligence in Production [M-MACH-105968]

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

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

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

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

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

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

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

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 provides an overview of the structure and functioning of automated manufacturing systems. In the introduction chapter the basic elements for the realization of automated manufacturing systems are given. This includes:

- Drive and control technology
- Handling technology for handling work pieces and tools
- Industrial Robotics
- Quality assurance in automated manufacturing
- automatic machines, cells, centers and systems for manufacturing and assembly
- structures of multi-machine systems
- planning of automated manufacturing systems

In the second part of the module, the basics are illustrated using implemented manufacturing processes for the production of automotive components (chassis and drive technology).The analysis of automated manufacturing systems for manufacturing of defined components is also included. In the field of vehicle power train both, the automated manufacturing process for the production of the conventional internal-combustion engine and the automated manufacturing process for the production of the prospective electric power train (electric motor and battery) are considered. In the field of car body, the focus is on the analysis of the process chain for the automated manufacturing of conventional sheet metal body parts, as well as for automated manufacturing of body components made out of fiber-reinforced plastics. Within tutorials, the contents from the module are advanced and applied to specific 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 6.8 Module: Automated Visual Inspection and Image Processing [M-INFO-100826]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
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 6.9 Module: Automotive Engineering I [M-MACH-100501]

Responsible: Prof. Dr. Frank Gauterin
Organisation: KIT Department of Mechanical Engineering

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

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

Responsible: Prof. Dr. Frank Gauterin
Dr.-Ing. Hans-Joachim Unrau

Organisation: KIT Department of Mechanical Engineering

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

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'

M 6.11 Module: Automotive Vision [M-MACH-102693]

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

Organisation: KIT Department of Mechanical Engineering

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

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 6.12 Module: Basics of Technical Logistics I [M-MACH-105283]

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

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
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-109919	Basics of Technical Logistics I	4 CR	Mittwollen, Oellerich

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

Prerequisites
none

Competence Goal
Students are able to:

- Describe processes and machines of technical logistics,
- Model the fundamental structures and the impacts of material handling machines with mathematical models,
- Refer to industrially used machines
- Model real machines applying knowledge from lessons and calculate their dimensions.

Content

- effect model of conveyor machines
- elements for the change of position and orientation
- conveyor processes
- identification systems
- drives
- mechanical behaviour of conveyors
- structure and function of conveyor machines
- elements of intralogistics
- sample applications and calculations in addition to the lectures inside practical lectures

Workload
presence: 48h

rework: 72h

Recommendation
Basics knowledge of technical mechanics is preconditioned

Learning type
Lectures

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

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

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 mechanics is preconditioned

Learning type
Lectures

M 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Automotive Engineering (mandatory)
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	4	1

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

Prerequisites
none

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

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

M 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Automotive Engineering (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-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: Interdisciplinary Subject
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-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

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

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

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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Medical Technology (mandatory)

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

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

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 total number of points remains limited to 60 points.

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: Interdisciplinary Subject
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	2

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
The successful participation in the module Biomedical Measurement Techniques I is a prerequisite.

Competence Goal
The students analyzed medical issues and identified measurement tasks. You have proposed a suitable combination of analog circuit technology and digital signal processing and used it to solve the measurement task. They have identified the sources of biosignals and explained the underlying physiological mechanisms. You have analyzed the signal properties and derived the resulting requirements for the measuring system. The students have broken down the measurement chain from the acquisition of the physical measurement variable to the presentation of the medically relevant information and compared alternative concepts.

Content
- physiology
- Sensor technology, physical / chemical measurement technology
- Analog amplification and filtering
- disturbance variables, measurement errors
- Analog-digital conversion, digital signal processing, user interface
- Patient safety, standards, norms

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

Attendance time in lectures: 2 hours per 15 appointments = 30 hours

Preparation / post-processing of the substance: 4 h each 15 appointments = 60 h

Total effort approx. 90 hours = 3 LP

Recommendation
Basics in physiology. Basics in physical measurement technology, good previous knowledge of analog circuit technology and in 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)

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

M 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Microsystems Technology (mandatory)
Field of Specialization / Field of Specialization: Medical Technology (mandatory)
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

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

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

M 6.26 Module: BUS-Controls [M-MACH-105286]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)

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

Mandatory			
T-MACH-102150	BUS-Controls	4 CR	Becker, Geimer
T-MACH-108889	BUS-Controls - Advance	0 CR	Geimer

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
Required for the participation in the examination is the preparation of a report during the semester. The partial service with the code T-MACH-108889 must have been passed.

Competence Goal
The students will get an overview of the theoretic and practical functioning of different bus systems.

After the practical oriented lessons the students will be able to visualize the communication structure of different applications, design basic systems and evaluate the complexity of programming of the complete system.
Hereunto the students program in the practical orientated lessons IFM-controllers using the programming environment CoDeSys.

Content

- Knowledge of the basics of data communication in networks
- Overview of the operating mode of current field buses
- Explicit observation of the operating mode and application areas of CAN buses
- Practical programming of an example application (hardware is provided)

Workload

1. Regular attendance: 21 hours
2. Self-study: 9 hours
3. programming: 50 hours
4. Exam and preparation: 40 hours

Recommendation
Basic knowledge of electrical engineering is recommended. Programming skills are also helpful.

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

Learning type
Lecture, Tutorial

Literature

- Etschberger, K.: Controller Area Network, Grundlagen, Protokolle, Bausteine, Anwendungen; München, Wien: Carl Hanser Verlag, 2002.
- Engels, H.: CAN-Bus - CAN-Bus-Technik einfach, anschaulich und praxisnah dargestellt; Poing: Franzis Verlag, 2002.

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

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

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

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

Mandatory			
T-MACH-105212	CAE-Workshop	4 CR	Albers, Matthiesen

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

Prerequisites
None

Competence Goal
The students are able to ...

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

Content

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

Workload
regular attendance: 31.5 h

self-study: 88,5 h

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

discussing and presenting results in small groups

Learning type
Seminar

Literature
The workshop script will be allocated at Ilias.

M 6.28 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 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
Knowledge of basic engineering as well as basic knowledge of communications engineering.

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

M 6.29 Module: Cognitive Systems [M-INFO-100819]

Responsible: Prof. Dr. Gerhard Neumann
Prof. Dr. Alexander Waibel

Organisation: KIT Department of Informatics

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

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

Mandatory			
T-INFO-101356	Cognitive Systems	6 CR	Neumann, Waibel

M 6.30 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
Participants know basic procedures and methods for developing and operating electronic communication systems. Participants know about current communication systems and know about their applications. Boundary conditions of such systems are known and their relevance for a given problem can be assessed. Given the boundary conditions and specifications, the students are able to design communication system by choosing suitable processes, methods, components and subsystems.

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.

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

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

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

Recommendation
Knowledge of the basics from the lecture „Digitaltechnik" (Lehrveranstaltung Nr. 23615) is helpful.

M 6.31 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 6.32 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 6.33 Module: Computational Intelligence [M-MACH-105296]

Responsible: apl. Prof. Dr. Ralf Mikut
Organisation: KIT Department of Mechanical Engineering
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Industrial Automation (mandatory)
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
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	Mikut, Reinartz, 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

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

Learning type
Lecture

M 6.34 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	1

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

6.35 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
Each credit point corresponds to 30 hours of work (of the student). Fall under the workload

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

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

M 6.37 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)

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

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

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Internships)

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 6.39 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)

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

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

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

Prerequisites
none

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

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

Workload
Literature: 19 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Learning type
Project Work

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

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

M 6.40 Module: Cyber Physical Production Systems [M-ETIT-106039]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Interdisciplinary Subject (Usage from 4/1/2023)
Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules) (Usage from 4/1/2023)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules) (Usage from 4/1/2023)

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.

Annotation
Module responsibility: Prof. Mike Barth

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

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

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

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	pass/fail	Each term	1 term	German	4	3

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
- Implementing designed behavior patterns in a graphical programming language
- Applying the theory learned to a practical problem
- Evaluate solutions developed through group discussions and presentations

Content
This module is designed to teach students theoretical and practical aspects of automated, decentralized intralogistics. Theoretical basics of mechanical engineering and automation technology will be experienced in practice by implementing a model with Lego Mindstorms. In addition, the basics of control engineering are taught and joint development work in small groups as well as thinking with system boundaries are practised. The students plan self-contained parts of an intralogistic circuit that must interact with other systems in order to master a given transport task. This requires a well thought-out design as well as suitable programming and the coordination of common interfaces.

Annotation
number of participants limited

participants will be selected

One course during summer semester in english

Workload
Time of attendance : 2x5x8h = 80h
Self-study: 40h
Total: 120h

Learning type
Seminar

M 6.42 Module: Deep Learning and Neural Networks [M-INFO-104460]

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

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	Waibel

M 6.43 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 6.44 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 6.45 Module: Design of Electrical Machines [M-ETIT-100515]

Responsible: Prof. Dr. Martin Doppelbauer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules)
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	4	2

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

Prerequisites
none

Recommendation
Modul: Elektrische Maschinen und Stromrichter

M 6.46 Module: Design Principles for Interactive Real-Time Systems [M-INFO-100753]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
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-101290	Design Principles for Interactive Real-Time Systems	3 CR	Beyerer

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

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

Part of: Interdisciplinary Subject

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

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

Competence Certificate
Oral exam, about 20 minutes

Prerequisites
none

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

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

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

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

Recommendation
Polymerengineering I

Learning type
Lectures (Obligatory)

M 6.48 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
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.).

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 how to combine news and radar technology using digital beam shaping. The basic knowledge required for antennas and antenna groups, wave propagation, radar ambiguities and noise are explained in the lecture. This is followed by a detailed presentation of the various radiation shaping algorithms, each with reference to communication and radar systems and with application examples from satellite-based radar systems. Aspects such as digital and hybrid beam shaping, as well as MIMO and equivalent virtual antenna configuration are explained. Accompanying the lecture, exercises on the lecture material are given. These are discussed in a room exercise and the associated solutions are presented in detail. The voluntary computer internship (not relevant to grades) is closely linked to the lecture and the accompanying tutorial. It is based on the theory developed in the lecture and supplements this with practical experience. The tasks calculated in the tutorial as well as the further explanations are reproduced in the computer internship using simulations.

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

Recommendation
Basics of signal processing and radar techniques are useful.

M 6.49 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

6.50 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.

6.51 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.

M 6.52 Module: Digital Twin Engineering [M-ETIT-106040]

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.

Annotation
Module responsibility: Prof. Mike Barth

Workload
The workload includes:

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

A total of 120 h = 4 CR

M 6.53 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)

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

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

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (mandatory)

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 6.55 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)

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.

M 6.56 Module: Dynamics of Electro-Mechanical Systems [M-MACH-105612]

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

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)
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 6.57 Module: Dynamics of the Automotive Drive Train [M-MACH-102700]

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

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

6.58 Module: Electric Rail Vehicles [M-MACH-102692]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Prof. Dr.-Ing. Peter Gratzfeld

Organisation: KIT Department of Mechanical Engineering

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules)
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-102121	Electric Rail Vehicles	4 CR	Geimer, Gratzfeld

Competence Certificate
Oral examination

Duration ca. 20 minutes

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

Prerequisites
none

Competence Goal

- The students know the history of electric traction in railway transportation from the very beginning to modern vehicles with three-phase traction drives and understand their economic impact.
- They know the basics of railway transportation, wheel-rail-contact and vehicle dynamics and can deduct the requirements for electric rail vehicles out of it.
- They understand purpose, design and functionality of electric traction drives.
- They know the basic setup of train control management system and understand the most important functions.
- They are informed about actual concepts and new developments in the field of electric railway vehicles.
- They learn about the different systems of traction power supply with its advantages and disadvantages.

Content

1. Introduction: history of electric traction in railways, economic impact
2. Wheel-rail-contact: carrying of vehicle mass, adhesion, current return
3. Vehicle dynamics: tractive and brake effort, driving resistance, inertial force, load cycles
4. Electric drives: purpose of electric drive and basic configurations, traction motors, converters, drives for vehicles at dc and ac lines and without contact wire, multi-system, dual power and hybrid vehicles, conventional drives for existing vehicles
5. Train control management system: definitions, bus systems, components, network architectures, examples, future trends
6. Vehicle concepts: modern vehicle concepts for mass transit and electric main line
7. Traction power supply: power supply of railway vehicles, comparison electric traction and diesel traction, dc and ac networks, system pantograph and contact wire

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

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

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

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

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

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

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

Prerequisites
none

Competence Goal
Students are able to:

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

Content
material flow systems and their (conveying) technical components

mechanical behaviour of conveyors;

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

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

Workload
Lecture and exercise: 4 LP = 120 h

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

M 6.60 Module: Elements of Technical Logistics incl. Project [M-MACH-105015]

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

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
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 6.61 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

M 6.62 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 6.63 Module: Energy Systems Analysis [M-WIWI-100499]

Responsible: Dr. Valentin Bertsch
Organisation: KIT Department of Economics and Management
Part of: 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-WIWI-102830	Energy Systems Analysis	3 CR	Ardone, 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

- has the ability to understand and critically reflect the methods of energy system analysis, the possibilities of its application in the energy industry and the limits and weaknesses of this approach
- can use select methods of the energy system analysis by her-/himself

Content
1. Overview and classification of energy systems modelling approaches
2. Usage of scenario techniques for energy systems analysis
3. Unit commitment of power plants
4. Interdependencies in energy economics
5. Scenario-based decision making in the energy sector
6. Visualisation and GIS techniques for decision support in the energy sector

Workload
The total workload for this course is approximately 90 hours. For further information see German version.

M 6.64 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	Seemann
T-MACH-105274	Engineering Mechanics IV	5 CR	Seemann
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 6.65 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

6.66 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)

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 6.67 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 6.68 Module: Fundamentals in the Development of Commercial Vehicles [M-MACH-105824]

Responsible: Dr. Christof Weber
Organisation: KIT Department of Mechanical Engineering

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

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

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

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

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

6.70 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Power Engineering (mandatory)
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 6.71 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 6.72 Module: Handling Characteristics of Motor Vehicles I [M-MACH-105288]

Responsible: Dr.-Ing. Hans-Joachim Unrau
Organisation: KIT Department of Mechanical Engineering

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Automotive Engineering (Complementary Modules)
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-105152	Handling Characteristics of Motor Vehicles I	4 CR	Unrau

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2) of the examination regulation) of the 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 seperately.

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 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

Literature
1. Willumeit, H.-P.: Modelle und Modellierungsverfahren in der Fahrzeugdynamik,
B. G. Teubner Verlag, 1998

2. Mitschke, M./Wallentowitz, H.: Dynamik von Kraftfahrzeugen, Springer-Verlag, Berlin, 2004

3. Gnadler, R.; Unrau, H.-J.: Reprint collection to the lecture Handling Characteristics of Motor Vehicles I

M 6.73 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	1

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 know the specific challenges of an embedded system. They will have basic and detailed knowledge of the hardware description language VHDL. They are able to model circuit parts and taking into account the characteristics of the time behavior of modeled components. They are able to create test benches for models in order to perform the functional and timing verification. Furthermore, students will have a basic understanding about the principles of simulators, both for digital as well as analog circuit elements. Similarly, they have knowledge about cross-domain models in VHDL-AMS, that include mixed digital, analog and/or mechanical parts. Students understand the basics of fault simulations for the testability of fabricated circuits and are able to derive test vectors. They know the methods of formal verification

Content
Through the support of CAE tools, which spread out quickly in the recent years, the design process of embedded systems could be accelerated significantly. The basic design of embedded systems using CAE tools and hardware description languages is being learned in this lecture. Knowledge about methods for testing and checking the correctness of designs will be received as well as requirements for industrial design automation systems.

Module grade calculation
Grades result from the written respectively the oral examination.

Annotation
During semester written, otherwise oral examination.

From WS 19/20 the module will be managed by Prof. Jürgen Becker and Dr. Jens Becker.

From WS 19/20 the module is offered in WS.

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
Lecture „Systems and Software Engineering“ (23605)

6.74 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 6.75 Module: Hardware/Software Co-Design [M-ETIT-100453]

Responsible: Dr.-Ing. Oliver Sander
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)

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

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

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

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

6.77 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 6.78 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

6.79 Module: Human Computer Interaction [M-INFO-100729]

Responsible: Prof. Dr.-Ing. Michael Beigl
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-101266	Human-Machine-Interaction	6 CR	Beigl
T-INFO-106257	Human-Machine-Interaction Pass	0 CR	Beigl

M 6.80 Module: Human-Machine-Interaction in Anthropomatics: Basics [M-INFO-100824]

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

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

Mandatory			
T-INFO-101361	Human-Machine-Interaction in Anthropomatics: Basics	3 CR	Beyerer, Geisler

M 6.81 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

6.82 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	German/English	4	1

Mandatory			
T-INFO-105144	Humanoid Robots - Seminar	3 CR	Asfour

Competence Goal
The students gained experience with literature research on a current research topic. They explored, understood and compared different approaches to a selected scientific problem. The students are able to write a summary of their literature research in the form of a scientific publication in English and give a scientific talk on it.

Content
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 an elaboration in English in the form of a scientific publication.

M 6.83 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	Becker

Prerequisites
none

Module grade calculation
Die Modulnote ist die Note der mündlichen Prüfung.

6.84 Module: Information Fusion [M-ETIT-103264]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Complementary Modules)

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

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

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

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

Mandatory			
T-INFO-101466	Information Processing in Sensor Networks	6 CR	Hanebeck

M 6.86 Module: Information Systems and Supply Chain Management [M-MACH-105281]

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

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

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

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

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

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

Mandatory			
T-INFO-101328	Innovative Concepts for Programming Industrial Robots	4 CR	Hein

M 6.89 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

6.90 Module: Integrated Systems and Circuits [M-ETIT-100474]

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

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

Mandatory			
T-ETIT-100972	Integrated Systems and Circuits	4 CR	Kempf

Prerequisites
none

M 6.91 Module: International Production Engineering [M-MACH-105109]

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

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

Mandatory			
T-MACH-110334	International Production Engineering A	4 CR	Fleischer
T-MACH-110335	International Production Engineering B	4 CR	Fleischer

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

Competence Goal
The students ...

- can develop ideas for technical solutions in the environment of production plants in a team and evaluate their feasibility according to technical and economic criteria,
- are capable of selecting the essential components and modules of a production plant and carrying out the necessary calculations,
- can use FEM simulations to predict and evaluate the static and dynamic behavior of an assembly,
- are able to present, plan and assess their own work and decision-making processes,
- are able to apply basic methods of project management in an international environment.

Content
The module “International Production Engineering” offers a practical insight into the development of production plants in an international environment. A student team works on a current and concrete problem in the field of production engineering, which is introduced into the project by an industrial partner who is operating as well in Germany as in China.

As part of the course "International Production Engineering A", the problem will initially be transferred into work packages. According to the elaborated project plan, ideas and concepts for a solution of the problem will be generated and developed. Based on the concepts, the selected solution approach is elaborated and validated, e.g. through simulation, programming and/or design, but always in the context of production technology. The practical implementation of the developed solution is part of the course "International Production Engineering B" during an eight-week research stay in China.

The project will be carried out by the students under the guidance of scientific staff and in cooperation with the industrial partner. The results of the project will be presented and discussed with the project partner in a final presentation (respectively IPE A and B).

More details about the course are discussed in an information event (always in January/February, the exact date is published on the homepage: www.wbk.kit.edu).

The project offers students ...

- the unique opportunity to put the contents of the accompanying lecture into practice in an interdisciplinary and creative context,
- to gain insights into a wide range of development activities relevant for their future careers,
- cooperation with an attractive industrial partner,
- work in a team with other students with competent support from scientific staff,
- first practical experience in project management
- international practical experience.

Workload

IPE A

1. Presence time lecture: 15 * 2 h = 30 h
2. Pre- and post-processing time lecture: 15 * 5 h = 75 h
3. Exam preparation and presence in the same: 15 h

In total: 120 h = 4 LP

IPE B

1. Presence time lecture: 15 * 2 h = 30 h
2. Pre- and post-processing time lecture: 15 * 5 h = 75 h
3. Exam preparation and presence in the same: 15 h

In total: 120 h = 4 LP

M 6.92 Module: Introduction into Energy Economics [M-WIWI-100498]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: Interdisciplinary Subject
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	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.

6.93 Module: Introduction to Microsystem Technology I [M-MACH-102691]

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

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

M 6.94 Module: Introduction to Microsystem Technology II [M-MACH-102706]

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

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Microsystems Technology (mandatory)
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 6.95 Module: IT-Fundamentals of Logistics: Opportunities for Digital Transformation [M-MACH-105282]

Responsible: Prof. Dr.-Ing. Kai Furmans
Prof. Dr.-Ing. Frank Thomas

Organisation: KIT Department of Mechanical Engineering

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
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 6.96 Module: Key Competences [M-ETIT-103248]

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Interdisciplinary Qualifications (Compulsory Elective Modules)

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

Election notes

For self assignment of taken interdisciplinary qualifications of HoC, 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	Albers, Matthiesen, 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	

M 6.97 Module: Lab Computer-Aided Methods for Measurement and Control [M-MACH-105291]

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

Organisation:

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

Competence Certificate
Successful passed Colloquia

Prerequisites
none

Competence Goal
Powerful and cheap computation resources have led to major changes in the domain of measurement
and control. Engineers in various fields are nowadays confronted with the application of computer-aided methods. This lab tries to give an insight into the modern domain of measurement and control by means of practically oriented and flexible experiments. Based on experiments
on measurement instrumentation and digital signal processing, elementary knowledge in the domain of visual inspection and image processing will be taught. Thereby, commonly used software like MATLAB/Simulink will be used in both simulation and realization of control loops. The lab closes with selected applications, like control of a robot or supersonic computer
tomography.

Content

1. Digital technology
2. Digital storage oscilloscope and digital spectrum analyzer
3. Supersonic computer tomography
4. Lighting and image acquisition
5. Digital image processing
6. Image interpretation
7. Control synthesis and simulation
8. Robot: Sensors
9 Robot: Actuating elements and path planning
The lab comprises 9 experiments.

Workload
120 hours

Recommendation
Basic studies and preliminary examination; basic lectures in automatic control

Learning type
Tutorial

Literature
Instructions to the experiments are available on the institute's website

M 6.98 Module: Lab Course Electrical Drives and Power Electronics [M-ETIT-100401]

Responsible: Dr.-Ing. Klaus-Peter Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Automotive Engineering (Internships)
Field of Specialization / Field of Specialization: Power Engineering (Internships)
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	Becker

Prerequisites
none

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

Responsible: Dr.-Ing. Rainer Badent
Dr.-Ing. Klaus-Peter Becker

Organisation: KIT Department of Electrical Engineering and Information Technology

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

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

Competence Certificate
Success is checked in the form of an oral examination. The overall grade results from the 8 attempts.

Prerequisites
none

6.100 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 6.101 Module: Laboratory Biomedical Engineering [M-ETIT-100389]

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

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.

6.102 Module: Laboratory Digital Signal Processing [M-ETIT-100364]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Robotics (Internships)

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

Mandatory			
T-ETIT-101935	Laboratory Digital Signal Processing	6 CR	Heizmann

Prerequisites
none

M 6.103 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

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

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

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

Prerequisites
none

M 6.105 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Industrial Automation (Internships)

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.

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

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, Seemann, Stiller

Competence Certificate
The laboratory course is offered exclusively as ungraded course work. The assessment consists of a group colloquium at the beginning of the individual specialization phases (Part 1). In addition, a robot control system for a pick-and-place task must be successfully implemented in the group phase (Part 2).

Prerequisites
None

Competence Goal
The students are able to put the knowledge from the specialization in mechatronics and microsystems technology into practice on an exemplary mechatronic system, a handling system. The students can create an automated object recognition, calculate kinematic systems and realize a communication between different systems (PC, CAN, USB).

Furthermore, the students can integrate the individual parts of a manipulator in teamwork to a functioning overall system.

Content
Part I
Control, programming and simulation of robots
CAN-Bus communication
Image processing / machine vision
Dynamic simulation of robots in ADAMS

Part II
In a group work, a kinematic system has to be programmed so that it is able to recognize and grip objects fully automatically.

Module grade calculation
The module is not graded. Passing the module is 100% tied to the performance assessment of the partial performance.

Workload

1. Attendance time Lecture: 15 * 2 h = 30h
2. self-study: 15 * 6 h = 90h

Total: 120h = 4 LP

Learning type
Seminar

M 6.107 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

M 6.108 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

M 6.109 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)

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

6.110 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 6.111 Module: Lightweight Engineering Design [M-MACH-102696]

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

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

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

Mandatory			
T-MACH-105221	Lightweight Engineering Design	4 CR	Albers, Burkardt

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

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

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

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

6.113 Module: Logistics - Organisation, Design and Control of Logistic Systems [M-MACH-104985]

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

Part of: 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-MACH-102089	Logistics - Organisation, Design and Control of Logistic Systems	6 CR	Furmans

Competence Certificate
The assessment consists of a 90 minutes written examination (according to §4(2), 1 of the examination regulation).

Prerequisites
None

Competence Goal
Students are able to:

- Describe logistical tasks,
- Design logistical systems suitable to the respective task,
- Dimension stocastical stock models,
- Determine essential influencing parameters on the bullwhip effect and
- Use optimizing solution methods.

Content
Introduction

- historical overview
- lines of development

Structure of logistics systems

Distribution logistics

- location planning
- Vehicle Routing Planning
- distribution centers

Inventory management

- demand forecasting
- Inventory management policies
- Bullwhip effect

Production logistics

- layout planning
- material handling
- flow control

Supply Managament

- information flow
- transportation organization
- controlling and development of a logistics system
- co-operation mechanisms
- Lean SCM
- SCOR model

Identification Technologies

Workload
regular attendance: 60 hours
self-study: 120 hours

Recommendation
Requied are lectures on “Linear Algebra” and “Stochastic”.

Learning type
Lecture, tutorial

Literature

- Arnold/Isermann/Kuhn/Tempelmeier. Handbuch Logistik, Springer Verlag, 2002 (Neuauflage in Arbeit)
- Domschke. Logistik, Rundreisen und Touren, Oldenbourg Verlag, 1982
- Domschke/Drexl. Logistik, Standorte, Oldenbourg Verlag, 1996
- Gudehus. Logistik, Springer Verlag, 2007
- Neumann-Morlock. Operations-Research, Hanser-Verlag, 1993
- Tempelmeier. Bestandsmanagement in Supply Chains, Books on Demand 2006
- Schönsleben. Integrales Logistikmanagement, Springer, 1998

6.114 Module: Logistics and Supply Chain Management [M-MACH-105298]

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

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

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

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.

Learning type
Lectures, tutorials, case studies.

Literature
Knut Alicke: Planung und Betrieb von Logistiknetzwerken: Unternehmensübergreifendes Supply Chain Management, 2003

Dieter Arnold et. al.: Handbuch Logistik, 2008

Marc Goetschalkx: Supply Chain Engineering, 2011

M 6.115 Module: Machine Dynamics [M-MACH-102694]

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

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

6.116 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)

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

Mandatory			
T-INFO-111558	Machine Learning - Foundations and Algorithms	5 CR	Neumann

M 6.117 Module: Machine Learning 1 [M-WIWI-105003]

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

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 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 1" covers both symbolic learning methods such as inductive learning (learning from examples, learning by observation), deductive learning (explanation-based learning) and learning from analogies, as well as subsymbolic techniques such as neural networks, support vector machines, genetics Algorithms and reinforcement learning. The lecture introduces the basic principles as well as fundamental structures of learning systems and the learning theory and examines the previously developed algorithms. The design and operation of learning systems is presented and explained in some examples, especially in the fields of robotics, autonomous mobile systems and image processing.

Workload
The total workload for this module is approximately 150 hours.

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

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

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 advanced methods of machine learning such as semi-supervised and active learning, deep neural networks (deep learning), pulsed networks, hierarchical approaches, e.g. As well as dynamic, probabilistic relational methods. 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 (robotics, neurorobotics, image processing, etc.).

Workload
The total workload for this module is approximately 150 hours.

M 6.119 Module: Machine Tools and Industrial Handling [M-MACH-105107]

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

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

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

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

Organisation: KIT Department of Mechanical Engineering

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

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

Mandatory			
T-MACH-105223	Machine Vision	8 CR	Lauer, Stiller

Competence Certificate
Type of Examination: written exam
Duration of Examination: 60 minutes

Prerequisites
None

Competence Goal
After having participated in th lecture the participants have gained knowledge on modern techniques of machine vision and pattern recognition which can be used to evaluatecamera images. This especially includes techniques in the areas of gray level image analysis, analysis of color images, segementation of images, describing the geometrical relationship between the image and the 3-dimensional world, and pattern recognition with various classification techniques. The participants have learned to analyze the algorithms mathematically, to implement them in software, and to apply them to tasks in video analysis. The participants are able to analyze real-world problems and to develop appropriate solutions.

Content

The lecture on machine vision covers basic techniques of machine vision. It focuses on the following topics:

image preprocessing

edge and corner detection

curve and parameter fitting

color processing

image segmentation

camera optics

pattern recognition

deep learning

Image preprocessing:

The chapter on image processing discusses techniques and algorithms to filter and enhance the image quality. Starting from an analysis of the typical phenomena of digital camera based image capturing the lecture introduces the Fourier transform and the Shannon-Nyquist sampling theorem. Furthermore, it introduces gray level histogram based techniques including high dynamic range imaging. The disussion of image convolution and typical filters for image enhancement concludes the chapter.

Edge and corner detection:

Gray level edges and gray level corners play an important role in machine vision since gray level edges often reveal valueable information about the boundaries and shape of objects. Gray level corners can be used as feature points since they can be identified easily in other images. This chapter introduces filters and algorithms to reveal gray level edges and gray level corners like the Canny edge detector and the Harris corner detector.

Curve and parameter fitting:

In order to describe an image by means of geometric primitives (e.g. lines, circles, ellipses) instead of just pixels robust curve and parameter fitting algorithms are necessary. The lecture introduces and discusses the Hough transform, total least sum of squares parameter fitting as well as robust alternatives (M-estimators, least trimmed sum of squares, RANSAC)

Color processing:

The short chapter on color processing discusses the role of color information in machine vision and introduces various models for color understanding and color representation. It concludes with the topic of color consistency.

Image Segmentation:

Image segmentation belongs to the core techniques of machine vision. The goal of image segmentation is to subdivide the image into several areas. Each area shares common properties, i.e. similar color, similar hatching, or similar semantic interpretation. Various ideas for image segmentation exist which can be used to create more or less complex algorithms. The lecture introduces the most important approaches ranging from the simpler algorithms like region growing, connected components labeling, and morphological operations up to highly flexible and powerful methods like level set approaches and random fields.

Camera optics:

The content of an image is related by the optics of the camera to the 3-dimensional world. In this chapter the lecture introduces optical models that describe the relationship between the world and the image including the pinhole camera model, the thin lens model, telecentric cameras, and catadioptric sensors. Furthermore, the lecture introduces camera calibration methods that can be used to determine the optical mapping of a real camera.

Pattern recognition:

Pattern recognition aims at recognizing semantic information in an image, i.e. not just analyzing gray values or colors of pixels but revealing which kind of object is shown by the pixels. This task goes beyond classical measurement theory and enters the large field of artificial intelligence. Rather than just being developped and optimized by a programmer, the algorithms are adapting themselves to their specific task using training algorithms that are based on large collections of sample images.

The chapter of pattern recognition introduces standard techniques of pattern recognition in the context of image understanding like the support vector machine (SVM), decision trees, ensemble and boosting techniques. It combines those classifiers with powerful feature representation techniques like the histogram of oriented gradients (HOG) features, locally binary patterns (LBP), and Haar features.

Deep learning:

Throughout recent years standard pattern recognition technqiues have more and more been outperformed by deep learning techniques. Deep learning is based on artificial neural networks, a very generic and powerful form of a classifier. The lecture introduces multi layer perceptrons as the most relevant form of artificial neural networks, discusses training algorithms and strategies to achieve powerful classifiers based on deep learning including deep auto encoders, convolutional networks, and multi task learning, among others.

Workload
240 hours, omposed out of

hours of lecture: 15*4 h = 60 h

preparation time prior to and after lecture: 15*6 h = 90 h

exam preparation and exam: 90 h

Learning type
Lecture

Literature
Main results are summarized in the slides that are made available as pdf-files. Further recommendations will be presented in the lecture.

M 6.121 Module: Major Field: Integrated Product Development [M-MACH-102626]

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

Part of: Interdisciplinary Subject

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

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

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

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Industrial Automation (Complementary Modules)
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 6.123 Module: Master's Thesis [M-ETIT-103253]

Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Master's Thesis

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

M 6.124 Module: Material Flow in Logistic Systems [M-MACH-104984]

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

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Industrial Automation (mandatory)
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 6.125 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 6.126 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	Elsner, Liebig

Competence Certificate
Oral exam, about 25 minutes

Prerequisites
none

Competence Goal
The students are capable to name different lightweight materials and can describe their composition, properties and fields of application. They can describe the hardening mechanisms of lightweight materials and can transfer this knowledge to applied problems.
The students can apply basic mechanical models of composites and can depict differences in the mechanical properties depending on composition and structure. The students can describe the basic principle of hybrid material concepts and can judge their advantages in comparison to bulk materials. The students can name special materials for lightweight design and depict differences to conventional materials. The students have the ability to present applications for different lightweight materials and can balance reasons for their use.

Content
Introduction

Constructive, production-orientied and material aspects of lightweight construction

Aluminium-based alloys
Aluminium wrought alloys
Aluminium cast alloys

Magnesium-based alloys
Magnesium wrought alloys
Magnesium cast alloys

Titanium-based alloys
Titanium wrought alloys
Titanium cast alloys

High-strength steels
High-strength structural steels
Heat-treatable and hardenable steels

Composites - mainly PMC
Matrices
Reinforcements

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

M 6.127 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 6.128 Module: Mechanics in Microtechnology [M-MACH-102713]

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

Organisation: KIT Department of Mechanical Engineering

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

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

M 6.129 Module: Mechano-Informatics and Robotics [M-INFO-100757]

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

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

Mandatory			
T-INFO-101294	Mechano-Informatics and Robotics	4 CR	Asfour

Competence Goal
Students understand the basics of the synergistic integration of methods from mechatronics, computer science and artificial intelligence using the example of humanoid robotics. They are acquainted with the basic concepts and methods of machine learning, the description of robot movements and actions as well as artificial neural networks and their application in robotics.

In particular, they are able to apply basic methods to problems and know relevant tools. Using research-oriented examples from humanoid robotics, students have learned – in an interactive way – to think analytically and to proceed in a structured and goal-oriented way when analyzing, formalizing and solving tasks.

Content
The lecture addresses topics at the interface between robotics and artificial intelligence, which are illustrated and explained based on examples from current research in the area of humanoid robotics. The lecture introduces fundamental algorithms in robotics and machine learning as well as methods for describing dynamical systems and representing robot motions and actions. This includes an introduction to artificial neural networks, the description of dynamical systems in state space as well as the learning of movement primitives. The topics and content are illustrated by practical examples from humanoid robotics.

Recommendation
Der Besuch des *Basispraktikums Mobile Roboter* wird empfohlen.

M 6.130 Module: Medical Imaging Techniques I [M-ETIT-100384]

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

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

Mandatory			
T-ETIT-101930	Medical Imaging Techniques I	3 CR	Dössel

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

Prerequisites
none

Competence Goal
Students have a thorough understanding of all methods of medical imaging with ionizing radiation. They know the physical basics, the technical solutions and the essential aspects when using imaging in medicine.

Content
- X-ray physics and technology of X-ray imaging
- Digital radiography, X-ray image intensifier, flat X-ray detectors
- Theory of imaging systems, modulation transfer function
- and quantum detection efficiency
- Computer tomography CT
- Ionizing radiation, dosimetry and radiation protection
- SPECT and PET

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

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

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

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

Preparation / post-processing = 20 h

Total effort approx. 95 hours = 3 LP

6.131 Module: Medical Imaging Techniques II [M-ETIT-100385]

Responsible: Prof. Dr. Olaf Dössel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
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-101931	Medical Imaging Techniques II	3 CR	Dössel

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

Prerequisites
none

Competence Goal
Students have a thorough understanding of all methods of medical imaging without ionizing radiation. They know the physical basics, the technical solutions and the essential aspects when using imaging in medicine.

Content
- Ultrasound imaging
- Thermography
- Optical tomography
- Impedance tomography
- Imaging of bioelectric sources
- Endoscopy
- Magnetic resonance imaging
- Multi-modal imaging
- Molecular imaging

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

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

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

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

Preparation / post-processing = 20 h

Total effort approx. 95 hours = 3 LP

Recommendation
The contents of the M-ETIT-100384 module are required.

6.132 Module: Medical Robotics [M-INFO-100820]

Responsible: Jun.-Prof. Dr. Franziska Mathis-Ullrich
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	4	1

Mandatory			
T-INFO-101357	Medical Robotics	3 CR	Kröger, Mathis-Ullrich

M 6.133 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

M 6.134 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)

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

M 6.135 Module: Microactuators [M-MACH-100487]

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

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

M 6.136 Module: Microenergy Technologies [M-MACH-102714]

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

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

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

Mandatory			
T-MACH-105557	Microenergy Technologies	4 CR	Kohl

Competence Certificate
Oral exam: 45 min

Prerequisites
none

Competence Goal
- Knowledge of the principles of energy conversion
- Knowledge of the underlying concepts of thermodynamics and materials science
- Explanation of layout, fabrication and function of the treated devices
- Calculation of important properties (time constants, forces, displacements, power, degree of efficiency, etc.)
- Development of 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

Thermal micro energy harvesting

Microtechnical applications of energy harvesting

Heat pumps in micro technology

Micro cooling

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 6.137 Module: Microsystem Technology [M-ETIT-100454]

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

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

Mandatory			
T-ETIT-100752	Microsystem Technology	3 CR	Stork

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

Prerequisites
none

M 6.138 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
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 / 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.

M 6.139 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
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 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.

M 6.140 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
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 / 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.

6.141 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
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 6.142 Module: Modern Control Concepts II [M-MACH-105313]

Responsible: apl. Prof. Dr. Lutz Groell
Organisation: KIT Department of Mechanical Engineering
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
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 6.143 Module: Modern Control Concepts III [M-MACH-105314]

Responsible: apl. Prof. Dr. Lutz Groell
Organisation: KIT Department of Mechanical Engineering
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
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.

M 6.144 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 6.145 Module: Motion in Man and Machine - Seminar [M-INFO-102555]

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

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

Mandatory			
T-INFO-105140	Motion in Man 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.

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.

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

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

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

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

Mandatory			
T-MACH-105222	Motor Vehicle Labor	4 CR	Frey

Competence Certificate
After completion of the experiments: written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
None

Competence Goal
The students have deepened their knowledge on motor vehicles acquired in lectures and can apply it practically. They have an overview of the applied measuring technique and can execute and analyse measurements for the handling of given problem definitions. They are ready to analyze and to judge measurement results.

Content
1. Determination of the driving resistances of a passenger vehicle on a roller dynamometer; measurement of the engine performance of the test vehicle

2. Investigation of a twin-tube and a single-tube shock absorber

3. Behavior of car tyres under longitudinal forces and lateral forces

4. Behavior of car tires on wet road surface

5. Rolling resistance, energy dissipation and high-speed strength of car tires

6. Investigation of the moment transient characteristic of a Visco clutch

Annotation
The admission is limited to 12 persons per group.

Workload
regular attendance: 31,5 hours
self-study: 103,5 hours

Literature
1. Matschinsky, W: Radführungen der Straßenfahrzeuge, Verlag TÜV Rheinland, 1998

2. Reimpell, J.: Fahrwerktechnik: Fahrzeugmechanik, Vogel Verlag, 1992

3. Gnadler, R.: Documents to the Motor Vehicle Laboratory

M 6.147 Module: Nano- and Quantum Electronics [M-ETIT-105604]

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

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

Mandatory			
T-ETIT-111232	Nano- and Quantum Electronics	6 CR	Kempf

Competence Certificate
The assessment of success takes place in the form of a written examination lasting 120min. The grade corresponds to the result of the written examination.

Prerequisites
none

Competence Goal
Students will understand the physical limits of CMOS scaling and will be able to analyze the function of conventional nanoelectronic devices. Students will also understand the operation of novel nanoelectronic and quantum electronic devices and will be able to design this kind of devices that are based on quantum mechanical effects. They develop the ability to design nanoelectronic sensors and devices and can understand and analyze the fabrication methods for nano- and quantum electronic devices.

Content
Nanoelectronics deals with integrated circuits whose typical length scale is well below 100nm. In this regime, physical effects, in particular of quantum mechanical origin, occur and strongly influence the scaling of classical microelectronic devices. This ultimately leads to a new form of electronic components as well as novel operation principles. A special form of nanoelectronics is quantum electronics in which quantum mechanical effects are exploited on purpose to build an entirely new class of devices whose performance reaches far beyond any other microelectronics devices. Well-known examples are superconducting digital electronics which enables to build, for example, microprocessors with clock rates exceeding several 100GHz, or the quantum computer, which will lead to a change of paradigms in the field of information processing.

Within this context, the module "Nano- and quantum electronics" intends to give students an overview of the theoretical and practical aspects of nano- and quantum electronics. In particular, it discusses the following topics:

- Limitations of conventional CMOS technology
- Quantum mechanical effects in the field of nano- and quantum electronics (quantized conductance, Coulomb blockade, tunnel effect, etc.)
- Hot-electron effect
- Nano- and quantum-technological manufacturing and analysis methods
- Nanostructure field-effect transistors
- Quantum dots
- Carbon nanotube field-effect transistor
- Resonant tunnel diodes
- Unipolar resonant tunnel transistor
- Single Electron Transistor (SET)
- Josephson junction based analog and digital electronics
- Quantum bits, quantum computers and quantum computing

The tutorial is closely linked to the lecture and deals with special aspects concerning the development of nano- and quantum electronics. In particular, the development and system integration of such devices for various applications is discussed by means of exercises.

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

Workload
A workload of approx. 175h is required for the successful completion of the module. This is composed as follows:

- Attendance time in lectures and exercises: 18*1.5h + 6*1.5h = 36h
- Preparation and follow-up of lectures: 21*3h= 54h
- Preparation and follow-up of tutorials: 7*5h= 35h
- Preparation for the exam: 50h

Recommendation
Successful completion of the modules "Superconductivity for Engineers" and „Einführung in die Quantentheorie für Elektrotechniker“ is recommended.

M 6.148 Module: Nonlinear Control Systems [M-ETIT-100371]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
Field of Specialization / Field of Specialization: Robotics (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-100980	Nonlinear Control Systems	3 CR	Kluwe

Prerequisites
none

6.149 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.

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

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

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (mandatory)
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 6.151 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 6.152 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

6.153 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 6.154 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

M 6.155 Module: Optical Waveguides and Fibers [M-ETIT-100506]

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

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

Mandatory			
T-ETIT-101945	Optical Waveguides and Fibers	4 CR	Koos

Competence Certificate
Type of Examination: Oral exam

Duration of Examination: approx. 20 minutes

Modality of Exam: The written exam is offered continuously upon individual appointment.

Prerequisites
None

Competence Goal
The students

- conceive the basic principles of light-matter-interaction and wave propagation in dielectric media and can explain the origin and the implications of the Lorentz model and of Kramers-Kronig relation,
- are able to quantitatively analyze the dispersive properties of optical media using Sellmeier relations and scientific databases,
- can explain and mathematically describe the working principle of an optical slab waveguide and the formation of guided modes,
- are able to program a mode solver for a slab waveguide in Matlab,
- are familiar with the basic principle of surface plasmon polariton propagation,
- know basic structures of planar integrated waveguides and are able to model special cases with semi-analytical approximations such as the Marcatili method or the effective-index method,
- are familiar with the basic concepts of numerical mode solvers and the associated limitations,
- are familiar with state-of-the-art waveguide technologies in integrated optics and the associated fabrication methods,
- know basic concepts of of step-index fibers, graded-index fibers and microstructured fibers,
- are able to derive and solve basic relations for step-index fibers from Maxwell's equations,
- are familiar with the concept of hybrid and linearly polarized fiber modes,
- can mathematically describe signal propagation in single-mode fibers design dispersion-compensated transmission links,
- conceive the physical origin of fiber attenuation effects,
- are familiar with state-of-the-art fiber technologies and the associated fabrication methods,
- can derive models for dielectric waveguide structures using the mode expansion method,
- conceive the principles of directional couplers, multi-mode interference couplers, and waveguide gratings,
- can mathematically describe active waveguides and waveguide bends.

Content

1. Introduction: Optical communications
2. Fundamentals of wave propagation in optics: Maxwell´s equations in optical media, wave equation and plane waves, material dispersion, Kramers-Kroig relation and Sellmeier equations, Lorentz and Drude model of refractive index, signal propagation in dispersive media.
3. Slab waveguides: Reflection from a plane dielectric boundary, slab waveguide eigenmodes, radiation modes, inter- and intramodal dispersion, metal-dielectric structures and surface plasmon polariton propagation.
4. Planar integrated waveguides: Basic structures of integrated optical waveguides, guided modes of rectangular waveguides (Marcatili method and effective-index method), basics of numerical methods for mode calculations (finite difference- and finite-element methods), waveguide technologies in integrated optics and associated fabrication methods
5. Optical fibers: Optical fiber basics, step-index fibers (hybrid modes and LP-modes), graded-index fibers (infinitely extended parabolic profile), microstructured fibers and photonic-crystal fibers, fiber technologies and fabrication methods, signal propagation in single-mode fibers, fiber attenuation, dispersion and dispersion compensation
6. Waveguide-based devices: Modeling of dielectric waveguide structures using mode expansion and orthogonality relatons, multimode interference couplers and directional couplers, waveguide gratings, material gain and absorption in optical waveguides, bent waveguides

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

There is, however, a bonus system based on the problem sets that are solved during the tutorials: During the term, 3 problem sets will be collected in the tutorial and graded without prior announcement. If for each of these sets more than 70% of the problems have been solved correctly, a bonus of 0.3 grades will be granted on the final mark of the oral exam.

Workload
Total 120 h, hereof 45 h contact hours (30 h lecture, 15 h tutorial) and 75 h homework and self-studies.

Recommendation
Solid mathematical and physical background, basic knowledge of electrodynamics

Literature
B.E.A. Saleh, M.C. Teich: Fundamentals of Photonics

G.P. Agrawal: Fiber-optic communication systems

C.-L. Chen: Foundations for guided-wave optics

Katsunari Okamoto: Fundamentals of Optical Waveguides

K. Iizuka: Elements of Photonics

M 6.156 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (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-104594	Optimal Control and Estimation	3 CR	Hohmann

Prerequisites
none

6.157 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: Interdisciplinary Subject
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)

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)

M 6.158 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

6.159 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

M 6.160 Module: Organ Support Systems [M-MACH-102702]

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

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Medical Technology (mandatory)
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 6.161 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 6.162 Module: Photovoltaics [M-ETIT-100513]

Responsible: Prof. Dr.-Ing. Michael Powalla
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
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 6.163 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)

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.

M 6.164 Module: Physiology and Anatomy for Biomedical Engineering [M-ETIT-105874]

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

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

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 (Wintersemester)

The lecture provides basic knowledge about the essential organ systems of humans and medical terminology. It is aimed at students of technical courses who are interested in physiological issues.

Thematic blocks:

- Introduction - organizational levels in the body
- Basics of biochemistry in the body
- Cell structure, cell physiology, tissue
- Transport mechanisms in the body
- Neurophysiology I (nerve cell, muscle cell, the autonomic nervous system)
- Heart and circulatory system with blood and lymph
- Breathing

Physiologie und Anatomie II (Sommersemester)

The lecture extends the knowledge imparted in the first part of the lecture and introduces other human organ systems.

Thematic blocks:

- Acid / base balance, water balance, kidney function
- Thermoregulation
- Digestive system and nutrition
- Hormonal System Neurophysiology II
- (Organization of the CNS, somatosensory, motor skills, integrative performance of the brain)

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

- Attendance time in lectures (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 6.165 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 6.166 Module: Plastic Electronics / Polymerelectronics [M-ETIT-100475]

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
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 written 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/)

6.167 Module: Plug-and-Play Material Handling [M-MACH-104983]

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

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

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

Mandatory			
T-MACH-106693	Plug-and-Play Material Handling	4 CR	Auberle, Furmans

Competence Certificate
The success control takes place as a study achievement in the form of a presentation of at least 10 minutes.

Prerequisites
None.

Competence Goal

- Naming and explaining the basics of plug-and-play conveyor technology
- Extend your knowledge of plug-and-play conveyor technology through independent research
- Applying the learned theory to a problem from practice
- Using the Software Framework ROS (Robot Operating System)
- Implementation of a decentralized communication protocol
- Designing components for additive manufacturing (3D printing)
- Evaluate developed solutions on the basis of logistical key figures

Content

- Theoretical basics and structure of plug-and-play conveyor technology
- Practical application of content in teamwork with mobile and stationary platforms
- Planning and implementation of a control system using the software framework ROS
- Definition, design and implementation of interfaces between teams and platforms
- Presentation of the work results and evaluation of these on the basis of logistical key figures

Workload
regular attendance: 80 hours
self-study: 40 hours

Learning type
seminar

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

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 6.169 Module: Power Electronics [M-ETIT-104567]

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

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

Mandatory			
T-ETIT-109360	Power Electronics	6 CR	Hiller

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

Prerequisites
None

Competence Goal
Students will be familiar with state-of-the-art power semiconductors including their application related features. Furthermore students will be familiar with the circuit topologies for DC/DC and DC/AC power conversion. They know the associated modulation and control methods and characteristics. They are able to analyze the circuit topologies with regard to harmonics and power losses. This also includes the thermal design of power electronic circuits. In addition, they are able to select and combine suitable circuits for given electrical energy conversion requirements.

Content
In the lecture, power electronic circuits for DC/DC and DC/AC power conversion using IGBTs and MOSFETs are presented and analyzed. First, the basic properties of self-commutated circuits under idealized
conditions are elaborated using the DC/DC converter as an example. Then, self-commutated power converters for three-phase applications are presented and analyzed with respect to modulation and their AC
and DC terminal behavior. Based on the real power semiconductor behavior in on- and off-state the device losses are calculated. Furthermore the thermal design of power converters is explained using thermal equivalent circuits of power devices and cooling equipment. The voltage and current stress on the power
semiconductors in switching operation is explained as well as protective snubber circuits allowing a reliable operation within the safe operating area of the devices.

In detail, the following topics are treated:

- Power Semiconductors
- Commutation principles
- DC/DC converters
- Self-commutated 1ph and 3ph DC/AC inverters
- Modulation methods (Fundamental frequency modulation, Pulse width modulation with 3rd harmonic injection, Space vector modulation)
- Multilevel inverters
- Switching behavior in hard and soft switching applications
- Loss calculation
- Thermal equivalent circuits, thermal design
- Snubber circuits.

The lecturer reserves the right to adapt the contents of the lecture to current needs without prior notice.

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

Workload
14x lecture and 14x exercise à 2 h = 56 h
14x wrap-up of the lecture à 1 h = 14 h
14x preparation of the exercise à 2 h = 28 h
Preparation for the exam = 75 h
Examination time = 2 h
Total = approx. 175 h (corresponds to 6 LP)

M 6.170 Module: Power Electronics for Photovoltaics and Wind Energy [M-ETIT-102261]

Responsible: Dr.-Ing. Klaus-Peter Becker
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-104569	Power Electronics for Photovoltaics and Wind Energy	3 CR	Becker

Prerequisites
none

M 6.171 Module: Power Network [M-ETIT-100572]

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

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

Mandatory			
T-ETIT-100830	Power Network	6 CR	Leibfried

6.172 Module: Power Systems and Economy [M-ETIT-100413]

Responsible: Dr.-Ing. Bernd Hoferer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
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 6.173 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Power Engineering (mandatory)

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

M 6.174 Module: Practical Aspects of Electrical Drives [M-ETIT-100394]

Responsible: Dr.-Ing. Klaus-Peter Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (mandatory)

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	Becker

Prerequisites
none

6.175 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

M 6.176 Module: Practical Course: Smart Energy System Lab [M-INFO-105955]

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

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

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

M 6.177 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Robotics (Internships)
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.

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

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

Mandatory			
T-INFO-104552	Practical Project Robotics and Automation II (Hardware)	6 CR	Hein, Längle

Modeled Conditions
You have to fulfill one of 2 conditions:

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

M 6.179 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)

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

Mandatory			
T-MACH-102164	Practical Training in Basics of Microsystem Technology	4 CR	Last

Competence Certificate
Written exam, 60 min.

Prerequisites
None

Competence Goal
Insight into the real, practical work at the Institute of Microstructure Technology.

Content
In the practical training includes nine experiments:
1. Hot embossing of plastics micro structures
2. Micro electroforming
3. X-ray optics
4. UV-lithography
5. Fluidic polymer components by example of a microfluidic mixer
6. Additive prototyping of microstructures
7. Introduction to SAW biosensors
8. Light diffraction at photomasks
9. Atomic force microscopy
10. Centrifugal microfluidics

Each student takes part in only five experiments.
The experiments are carried out at real workstations at the IMT and coached by IMT-staff.

Annotation
The internship takes place in the laboratories of the IMT at the CN. Meeting place: Building 307, room 322.

Participation requests to Mrs. Novotny, marie.nowotny@kit.edu

Workload
regular attendance: 20 hours
self-study: 100 hours, Preparation of the five experiments

Recommendation
Attend at least one of the lectures Micro System Technology I or II.

Read the practical course documents provided as pdf-file!

Learning type
Lab, Self-study of the internship documents and guided experiments during the course.

Literature
Madou, M. (2003). *Fundamentals of Microfabrication*. CRC. ISBN 978-0849308260.
Practical course documents provided as pdf-file.

M 6.180 Module: Predictive Driver Assistance Systems [M-ETIT-100360]

Responsible: Dr. Rüdiger Walter Henn
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-100692	Predictive Driver Assistance Systems	3 CR	Henn

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

Prerequisites
none

Competence Goal
The students got to know the sensors for environment detection of the motor vehicle and the driver assistance and safety systems based on them. Due to the broad, interfacultative material from the areas of electrics, electronics, physics, vehicle dynamics (mechanical engineering) and system technology, they are able to understand the complex relationships in the overall vehicle, to name the advantages and disadvantages of individual processes, using examples to clarify and in practice, for example to be implemented directly in industrial internships and later in work.

Content
The lecture first introduces the topic of “driver assistance systems”. After a definition and classification of these systems in the variety of automotive assistance systems, the assistance systems necessary for the implementation of the predictive driver assistance systems are first explained. The first part of the lecture concludes with the treatment of the necessary sensors for an all-round view of the vehicle. Afterwards, the important representatives of the predictive driver assistance systems are worked through, structured according to passive (informative), active (intervening) systems and safety systems. After considering the ergonomic requirements for driver assistance systems, the lecture closes with a view of future systems, right up to automatic vehicle guidance.

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

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

Attendance study time lecture / exercise: 30 h

Self-study time including exam preparation: 60 h

A total of 90 h = 3 LP

Recommendation
Bachelor's degree

M 6.181 Module: Principles of Medicine for Engineers [M-MACH-102720]

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

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Medical Technology (mandatory)
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.

M 6.182 Module: Principles of Whole Vehicle Engineering I [M-MACH-105289]

Responsible: Prof.Dipl.-Ing. Rolf Frech
Dr.-Ing. Hans-Joachim Unrau

Organisation: KIT Department of Mechanical Engineering

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

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

Mandatory			
T-MACH-105162	Fundamentals of Automobile Development I	2 CR	Frech

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2) of the examination regulation) of the 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 seperately.

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 have an overview of the fundamentals of the development of automobiles. They know the development process, the national and the international legal requirements that are to be met. They have knowledge about the thermo-management, aerodynamics and the design of an automobile. They are ready to judge goal conflicts in the field of automobile development and to work out approaches to solving a problem.

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 I

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

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

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

Mandatory			
T-MACH-105163	Fundamentals of Automobile Development II	2 CR	Frech

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2) of the examination regulation) of the 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 seperately.

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 are familiar with the selection of appropriate materials and the choice of adequate production technology. They have knowledge of the acoustical properties of the automobiles, covering both the interior sound and exterior noise. They have an overview of the testing procedures of the automobiles. They know in detail the evaluation of the properties of the complete automobile. They are ready to participate competently in the development process of the complete 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 6.184 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

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

M 6.185 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (Internships)

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

Responsible: Dr.-Ing. Manfred Nolle

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Design of Mechatronic Systems (mandatory)
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-ETIT-109148	Project Management in the Development of Products for Safety-Critical Applications	4 CR	Nolle

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

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

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

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a third	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

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

Responsible: Prof. Dr.-Ing. Marcus Geimer
Prof. Dr.-Ing. Peter Gratzfeld

Organisation: KIT Department of Mechanical Engineering

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

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

Mandatory			
T-MACH-106424	Rail System Technology	4 CR	Geimer, Gratzfeld

Competence Certificate
Oral examination

Duration ca. 20 minutes

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

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

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

Responsible: Prof. Dr.-Ing. Marcus Geimer
Prof. Dr.-Ing. Peter Gratzfeld

Organisation: KIT Department of Mechanical Engineering

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

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

Mandatory			
T-MACH-105353	Rail Vehicle Technology	4 CR	Geimer, Gratzfeld

Competence Certificate
Oral examination

Duration ca. 20 minutes

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

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

6.190 Module: Real Time Control of Electrical Drives [M-ETIT-105916]

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

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

Mandatory			
T-ETIT-111898	Real Time Control of Electrical Drives	6 CR	Liske

Workload
Jeder Leistungspunkt (Credit Point) entspricht ca. 25-30h Arbeitsaufwand (des Studierenden). Hierbei ist vom durchschnittlichen Studierenden auszugehen, der eine durchschnittliche Leistung erreicht.

56h = 22x V à 2h + 3x Ü à 4h

21h = 21x Nachbereitung von V à 1 h

12h = 3x Vorbereitung von Ü à 4 h

80h = Vorbereitung zur Prüfung

Summe = 169 h (entspricht 6 LP)

M 6.191 Module: Real-Time Systems [M-INFO-100803]

Responsible: Prof. Dr.-Ing. Thomas Längle
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Control Engineering in Mechatronics (Complementary Modules)
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-INFO-101340	Real-Time Systems	6 CR	Längle

6.192 Module: Reinforcement Learning [M-INFO-105623]

Responsible: 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)

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

Mandatory			
T-INFO-111255	Reinforcement Learning	5 CR	Neumann

M 6.193 Module: Reliability and Test Engineering [M-MACH-106050]

Responsible: Prof. Dr.-Ing. Albert Albers
Dr.-Ing. Thomas Gwosch

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)

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

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

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

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

Mandatory			
T-WIWI-100806	Renewable Energy-Resources, Technologies and Economics	3 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 6.195 Module: Robotics - Practical Course [M-INFO-102522]

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

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

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

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 language C++ 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 statecharts, collision-free motion planning, grasp planning, and robot vision.

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

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

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

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

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

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

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

Mandatory			
T-INFO-105723	Robotics II - Humanoid Robotics	3 CR	Asfour

Prerequisites
None

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, active perception, imitation learning and programming by demonstration; semantic representations of sensorimotor experience as well as cognitive software architectures of humanoid robots.

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

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

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-109931	Robotics III - Sensors and Perception in Robotics	3 CR	Asfour

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, simultaneous localization and mapping (SLAM) and semantic scene interpretation. 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, simultaneous localization and mapping (SLAM) and semantic scene interpretation.

M 6.199 Module: Seamless Engineering [M-MACH-105725]

Responsible: Prof. Dr.-Ing. Kai Furmans
Prof. Dr.-Ing. Eric Sax

Organisation: KIT Department of Mechanical Engineering

Part of: Interdisciplinary Subject
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)

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 6.200 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 6.201 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)

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

6.202 Module: Seminar Embedded Systems [M-ETIT-100455]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Prof. Dr.-Ing. Eric Sax
Prof. Dr. Wilhelm Stork

Organisation: KIT Department of Electrical Engineering and Information Technology

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

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

Mandatory			
T-ETIT-100753	Seminar Embedded Systems	3 CR	Becker, Sax, Stork

Competence Certificate
Type of examination: alternative exam assessment. The examination consists of a written report and an oral presentation. The overall impression is rated.

Prerequisites
none

6.203 Module: Seminar for Rail System Technology [M-MACH-104197]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Prof. Dr.-Ing. Peter Gratzfeld

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	Geimer, Gratzfeld

Competence Certificate
Examination: Writing an essay (Seminararbeit), final presentation

Prerequisites
None

Competence Goal

- The students become aware of the fundamental relations and interdependencies between rail vehicles, infrastructure and operation in a rail system.
- They overview the technical components of a rail system, in particular rail vehicle technology.
- They are able to use the essential elements of scientific work and present their results in written form and verbal presentation.

Content

1. Railway System: railway as a system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact
2. Operation: Transportation, public transport, regional transport, long-distance transport, freight service, scheduling
3. System structure of railway vehicles: structure and major systems of rail vehicles
4. Scientific working: structuring and writing of scientific papers, literature research, scheduling (mile stones), self-management, presentation skills, using the software Citavi for literature and knowledge management, working with templates in Word, giving and taking feedback
5. The learnt knowledge regarding scientific writing is used to elaborate a Seminararbeit. To this the students create a presentation, train and reflect it and finally present it to an auditorium.

Workload
Regular attendance: 21 hours

Self-study (writing Seminararbeit): 65 hours

Final presentation (including preparation): 4 hours

total: 90 hours = 3 ECTS

Learning type
Essay

M 6.204 Module: Seminar Intelligent Industrial Robots [M-INFO-102212]

Responsible: Prof. Dr.-Ing. Heinz Wörn
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	Wörn

M 6.205 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)

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

Mandatory			
T-ETIT-108344	Seminar Novel Concepts for Solar Energy Harvesting	3 CR	Richards

Competence Certificate
The examination consists of a written journal article and an oral presentation of the student's work, both given in English. The overall impression is rated.

Prerequisites
none

Competence Goal
After completion of the seminar, students are able to independently familiarize themselves with a new research topic, recapitulate the corresponding literature and present the topic in the form of a review journal article as well as an oral overview presentation. Besides the exposure to new scientific research topics, the students will develope their know-how in scientific presentations and scientific writing in English which are key competences for their future (e.g. MSc thesis projects and research).

Content
We are offering an advanced seminar on „ Novel Concepts for Solar Energy Harvesting" for students curious in latest research topics on devices, materials and physics of next generation solar energy harvesting. The students will get the opportunity to familiarize themselves with a state-of-the-art research topic of their choice under the guidance of a mentor and present the topic during the seminar. The students must attend the seminar regularly, present the research topic in a 30-min scientific talk and submit a short scientific paper (3-5 pages). The seminar addresses master students from electrical engineering, physics, mechanical engineering, material science, KSOP and related MSc programs.

Module grade calculation
The module grade results of the assessment of the written paper and the oral presentation. Details will be given during the lecture.

Workload

1. participation in the seminar lectures: 22,5 h
2. preparation of the seminar presentation: 50 h
3. preparation of the journal article: 47,5 h

Recommendation
Good knowledge of semiconductor components/optoelectronics is desirable.

M 6.206 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)

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 6.207 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.

6.208 Module: Seminar Robotics and Medicine [M-INFO-102211]

Responsible: Jun.-Prof. Dr. Franziska Mathis-Ullrich
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Subject

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

Mandatory			
T-INFO-104525	Seminar Robotics and Medicine	3 CR	Mathis-Ullrich

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

Responsible: Prof. Dr. Dorothea Wagner
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	Wagner

M 6.210 Module: Sensors [M-ETIT-100378]

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

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 6.211 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 winter term	1 term	German	4	2

Mandatory			
T-ETIT-108347	Software Engineering	3 CR	Reichmann

Prerequisites
none

6.212 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

6.213 Module: Solar Energy [M-ETIT-100524]

Responsible: Prof. Dr. Bryce Sydney Richards
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Power Engineering (Complementary Modules)

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

6.214 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	1

Mandatory			
T-ETIT-106056	Spaceborne Radar Remote Sensing	6 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.

Written

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
Reports (answers) that are submitted as part of the SAR calculator workshop (approx. Two weeks after the workshop) can improve the grade.

The grade formation results from the written exam and a grade bonus for the computer workshops.

Note bonuses

Reports (answers) that are submitted as part of the SAR calculator workshop (approx. Two weeks after the workshop) are evaluated and are included in the grade bonuses. The maximum grade is 0.4 grade points, but will only be taken into account when passing exams. The exact value of the grade bonus is calculated in proportion to the evaluated workshop reports. The evaluation of the reports and the award of the bonus performance is carried out by an examiner in the sense of. § 18 paragraphs 2 and 3 and is documented in ILIAS.

Annotation
Actual information can be found at the internet page of the IHE (www.ihe.kit.edu).

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
Material to the lecture can be found online at www.ihe.kit.edu/VorlesungenSS_892.php or ftp://sar-lectures@www.microwaves-and-radar.dlr.de (Password required).

M 6.215 Module: Stochastic Information Processing [M-INFO-100829]

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

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

Mandatory			
T-INFO-101366	Stochastic Information Processing	6 CR	Hanebeck

M 6.216 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 6.217 Module: System Integration in Micro- and Nanotechnology [M-MACH-105315]

Responsible: Dr. Ulrich Gengenbach
Organisation: KIT Department of Mechanical Engineering
Part of: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Microsystems Technology (Complementary Modules)
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

6.218 Module: System Integration in Micro- and Nanotechnology 2 [M-MACH-105316]

Responsible: Dr. Ulrich Gengenbach
Organisation: KIT Department of Mechanical Engineering
Part of: Field of Specialization / Field of Specialization: Microsystems Technology (Complementary Modules)

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

Election notes
Attention: The lecture and exam will be offered for the first time in WS20/21!

Mandatory			
T-MACH-110272	System Integration in Micro- and Nanotechnology 2	4 CR	Gengenbach

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

Prerequisites
None

Competence Goal
The students acquire knowledge of novel system integration technologies and their application in microoptic and microfluidic systems.

Content
Introduction to system integration (novel processes and applications)

Assembly of hybrid microsystems

Packaging processes

Applications:

- Micro process engineering
- Lab-on-chip systems
- Microoptical systems
- Silicon Photonics

Novel integration processes:

- Direct Laser Writing
- Self Assembly

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

Learning type
Lecture

Literature

- N.-T. Nguyen, Fundamentals and Applications of Microfluidics, Artech House
- G. T. Reed, Silicon Photonics: An Introduction, Wiley

M 6.219 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)

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

Mandatory			
T-ETIT-100798	System-on-Chip Laboratory	6 CR	Becker, Peric

Competence Certificate
Other types of examinations

Prerequisites
none

Competence Goal
Students can reproduce basic knowledge of digital and analog circuit design and hardware-related software programming. In practice, students are able to apply these methods in the following areas using a current system-on-chip architecture:

• Design of a system architecture for mixed-signal systems

• Simulation of the designed digital and analog circuits

• Debugging the implementations at the simulation and implementation level

• Verification of the overall system developed through test benches

In addition, they can apply the hardware / software code design approach and can evaluate implementation targets based on the given requirements (FPGA and ASIC).

Content
In the System-on-Chip Laboratory, a fully-fledged mixed-signal hardware architecture for audio playback based on a system-on-chip (SoC) is developed.

The system design includes the creation of necessary sub-components, their integration into an overall system, and the simulation and verification of the individual components and the overall system. A prototype is implemented and tested on an FPGA basis. The integration is then prepared for a possible ASIC production. Analog circuits are also considered and designed to build an audio amplifier.

Module grade calculation
The grade formation results from the combination of the processing of the exercise sheets, the evaluations during the internship and a final presentation including discussion of the results developed in the project.

Workload
1. Presence time in laboratory appointments: 15 * 4 = 60 hours

2. Preparation / post-processing: 15 * 4 = 60 hours

3. Demonstration and integration tests: 3 * 3 = 9 hours

4. Preparation of the final presentation: 15 hours

Recommendation

- Knowledge of Verilog Hardware Description Language, e.g. from Digital Circuit Design
- Knowledge in the design of analog circuits (amplifier circuits, stability considerations), e.g. from the Analog Circuit Design
- Knowledge of VHDL design, e.g. from Hardware Modeling and Simulation
- Knowledge of simulation of digital circuits, e.g. from Hardware Modeling and Simulation
- Knowledge of hardware design processes and algorithms, e.g. from Hardware Synthesis and Optimisation

M 6.220 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

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

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

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September 2005 - gebunden - 396 Seiten

6.222 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

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

Responsible: Prof. Dr. Robert Stieglitz
Organisation: KIT Department of Mechanical Engineering

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

Competence Certificate
A performance assessment is obligatory; oral exam about 30 minutes

Prerequisites
none

Competence Goal
Based on the elaboration of the basic physics knowledge of the solar irradiation, heat radiation, optics and thermal-hydraulics, the student will be able to

- select solar thermal components such as mirrors, glasses, selective absorbers and insulation materials and their manufacturing processes and to calculate and assess their performance,
- identify different collector types and to indicate their potential field of application,
- characterize the entire solar thermal collector system with respect to its performance and derive from the collector characteristics its suitability for different types of use,
- embed collectors into a technical overall system for heat (household, process heat, heat storage networks) or electricity generation (power plant), to calculate the system efficiency and independently develop the basics of its optimization.
- identify adequate thermal storage types for the temporal separation of generation and consumption, to dimension them appropriately and to integrate them into a system concept,
- evaluate solar thermal systems in their entirety (capacity, estimation of system dynamics, response behavior, efficiency) and know options for integration into networks (heat, cold, electricity).

Content
Fundamentals of thermal solar energy from solar irradiation (influence of time and place, modifications in the atmosphere) and their implementation in a collector to integration into a technical overall system. In detail:

1. introduction to the energy demand and evaluation of the application potential of solar thermal energy.

2. primary energy source SUN: Sun, solar constant, solar radiation (scattering, absorption in the atmosphere, direct-diffuse radiation, angular influences, radiation balance).

3. solar collectors: basic design of a collector, basics of determining the efficiency, significance of concentration and its limitations, solar thermal collector types (designs, efficiency, system technology).

4. passive mechanisms of solar thermal energy: heat conduction in solids and gases, radiation heat transport in transparent and opaque bodies Design requirements and physical principles of solar thermal glasses, mirrors and selective absorbers. Goal oriented selection of materials and manufacturing processes.

5. momentum and heat transport: basic equations of single- and multi-phase transport, basic ideas of local and system engineering calculation methods, stability limits.

Optional

6. solar thermal low-temperature systems: collector variants, methods for system simulation, planning and dimensioning of systems, system-related system design and stagnation scenarios and their handling.

7. solar thermal high-temperature systems: solar thermal power plants (classification of system components, loss mechanisms, upwind power plants), coupling of collector with energy generation process.

At the end:

8. Thermal energy storage: Explanation of terms (energy contents, storage forms and materials, potentials ...), storage concepts (system structure, design ratio), system integration.

9. Solar air conditioning: Determination of cooling capacity, indoor climate, solar cooling methods and evaluation of air conditioning.

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

6.224 Module: Vehicle Lightweight Design - Strategies, Concepts, Materials [M-MACH-102703]

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

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

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.

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

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

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

Mandatory			
T-MACH-102123	Virtual Engineering I	4 CR	Ovtcharova

Competence Certificate
Writen exam, graded, 90 min.

Competence Goal
After successful attendance of the course, students can:

- conceptualize complex systems with the methods of virtual engineering and continue the product development in different domains
- model the digital product with regard to planning, design, manufacturing, assembly and maintenance.
- use validation systems to validate product and production in an exemplary manner.
- Describe AI methods along the product creation process.

Content

- Conception of the product (system approaches, requirements, definitions, structure)
- Generation of domain-specific product data (CAD, ECAD, software, ...) and AI methods
- Validation of product properties and production processes through simulation
- Digital twin for optimization of products and processes using AI methods

Module grade calculation
Examination result "Virtual Engineering 1" 100%

Workload
120 h

Recommendation
None

Learning type
Lecture and exercises

Literature
Lecture slides

M 6.226 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)

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

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

6.227 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)

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 6.228 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: Interdisciplinary Subject
Field of Specialization / Field of Specialization: Medical Technology (Complementary Modules)
Field of Specialization / Field of Specialization: Robotics (Complementary Modules)
Additional Examinations

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

Mandatory			
T-INFO-106557	Wearable Robotic Technologies	4 CR	Asfour, Beigl

Competence Goal

The students have received fundamental knowledge about wearable robotic technologies and understand the requirements for the design, the interface to the human body and the control of wearable robots. They are able to describe methods for modelling the human neuromusculoskeletal system, the mechatronic design, fabrication and composition of interfaces to the human body. The students understand the symbiotic human–machine interaction as a core topic of Anthropomatics and have knowledge of state of the art examples of exoskeletons, ortheses and protheses.

Content

The lecture starts with an overview of wearable robot technologies (exoskeletons, prostheses and ortheses) and its potentials, followed by the basics of wearable robotics. In addition to 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 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.

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

Competence Certificate
oral exam

Prerequisites
none

T 7.2 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 22/23	2312664	Analog Circuit Design	2 SWS	Lecture /	Peric
WT 22/23	2312666	Tutorial for 2312664 Analog Circuit Design	1 SWS	Practice /	Peric

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

T 7.3 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
Written examination	5	Grade to a third	Each winter term	3

Events					
WT 22/23	2308416	Antennas and Multiple Antenna Systems	2 SWS	Lecture / 🗣	Zwick
WT 22/23	2308417	Workshop for 2308416 Antennas and Multiple Antenna Systems	2 SWS	Practice / 🧩	Zwick, Kretschmann, Bekker

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

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

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

7.4 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	2

Events					
ST 2022	2145164	Appliance and Power Tool Design	3 SWS	Lecture /	Matthiesen
ST 2022	2145165	Appliance and Power Tool Design Project Work	3 SWS	Project (P /	Matthiesen, Mitarbeiter

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

Competence Certificate
Oral examination (20 min)

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 7.5 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
Examination of another type	6	Grade to a third	Each summer term	1 terms	1

Events					
ST 2022	2145165	Appliance and Power Tool Design Project Work	3 SWS	Project (P / 🖥	Matthiesen, Mitarbeiter

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

Competence Certificate
Presentation of performed project and defense (30min) according to §4 (2), No. 3 of the examination regulation

Annotation
The participation in the project work requires the participation in "Appliance and power tool design".
Due to organizational reasons, the number of participants is limited. 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

T 7.6 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 22/23	2310537	Applied Information Theory	3 SWS	Lecture / 🧩	Jäkel
WT 22/23	2310539	Tutorial for 2310537 Applied Information Theory	1 SWS	Practice / 🧩	Jäkel

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

Prerequisites
none

T 7.7 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 22/23	2149921	Artificial Intelligence in Production	2 SWS	Lecture /	Fleischer, Schlagenhauf

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

Competence Certificate
Written Exam (90 min)

Prerequisites
none

T 7.8 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 2022	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 7.9 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

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

Responsible: Prof. Dr. Frank Gauterin
Dr.-Ing. Hans-Joachim Unrau

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 22/23	2113805	Automotive Engineering I	4 SWS	Lecture / 🗣	Gauterin, Unrau
WT 22/23	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.

T 7.11 Course: Automotive Engineering II [T-MACH-102117]

Responsible: Prof. Dr. Frank Gauterin
Dr.-Ing. Hans-Joachim Unrau

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 2022	2114835	Automotive Engineering II	2 SWS	Lecture / 🗣	Unrau
ST 2022	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 7.12 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 2022	2138340	Automotive Vision	3 SWS	Lecture / 🖥	Lauer

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

Competence Certificate
Type of Examination: written exam

Duration of Examination: 60 minutes

Prerequisites
none

T 7.13 Course: Basics of Technical Logistics I [T-MACH-109919]

Responsible: Dr.-Ing. Martin Mittwollen
Dr.-Ing. Jan Oellerich

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105283 - Basics of Technical Logistics I

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

Events					
WT 22/23	2117095	Basics of Technical Logistics I	3 SWS	Lecture / Practice (/	Mittwollen, 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 preconditioned.

T 7.14 Course: Basics of Technical Logistics II [T-MACH-109920]

Responsible: Dr.-Ing. Maximilian Hochstein
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 22/23	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 7.15 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	2

Events					
WT 22/23	2304207	Batteries and Fuel Cells	2 SWS	Lecture / 🧩	Krewer
WT 22/23	2304213	Batteries and Fuel Cells (Exercise to 2304207)	1 SWS	Practice / 🗣	Krewer, Lindner

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

Prerequisites
none

T 7.16 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 22/23	2304235	Batteries and Fuel Cells Laboratory	4 SWS	Practical course / 🗣	Weber

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

T 7.17 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 2022	2304214	Batterie- und Brennstoffzellensysteme	2 SWS	Lecture / 🗣	Weber

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

T 7.18 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 2022	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

7.19 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 2022	24619	Biologisch Motivierte Roboter	2 SWS	Lecture /	Rönnau

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

T 7.20 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 22/23	2305269	Biomedical Measurement Techniques I	2 SWS	Lecture / 🧩	Nahm, Schaufelberger

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

Prerequisites

T-ETIT-101928 - Biomedizinische Messtechnik I darf weder begonnen noch abgeschlossen sein.

T 7.21 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	1

Events					
ST 2022	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
The successful participation in the module Biomedical Measurement Techniques I is a prerequisite.

Recommendation
Basics in physiology. Basics in physical measurement technology, good previous knowledge of analog circuit technology and in 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.

7.22 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	1

Competence Certificate
oral exam (appr. 20 Min.)

Prerequisites
none

T 7.23 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

Competence Certificate
written exam (75 Min.)

Prerequisites
none

T 7.24 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 2022	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 7.25 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 2022	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 7.26 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					
ST 2022	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

7.27 Course: BUS-Controls [T-MACH-102150]

Responsible: Simon Becker
Prof. Dr.-Ing. Marcus Geimer

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105286 - BUS-Controls

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

Events					
ST 2022	2114080	Control of Mobile Machines	2 SWS	Lecture / Blended	Geimer, Becker

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

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

Prerequisites
Required for the participation in the examination is the preparation of a report during the semester. The partial service with the code T-MACH-108889 must have been passed.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-108889 - BUS-Controls - Advance must have been passed.

Recommendation
Basic knowledge of electrical engineering is recommended. Programming skills are also helpful.

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

Annotation
The students will get an overview of the theoretic and practical functioning of different bus systems.

After the practical oriented lessons the students will be able to visualize the communication structure of different applications, design basic systems and evaluate the complexity of programming of the complete system.
Hereunto the students program in the practical orientated lessons IFM-controllers using the programming environment CoDeSys.

Content:

- Knowledge of the basics of data communication in networks
- Overview of the operating mode of current field buses
- Explicit observation of the operating mode and application areas of CAN buses
- Practical programming of an example application (hardware is provided)

Literature:

- Etschberger, K.: Controller Area Network, Grundlagen, Protokolle, Bausteine, Anwendungen; München, Wien: Carl Hanser Verlag, 2002.
- Engels, H.: CAN-Bus - CAN-Bus-Technik einfach, anschaulich und praxisnah dargestellt; Poing: Franzis Verlag, 2002.

T 7.28 Course: BUS-Controls - Advance [T-MACH-108889]

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

Part of: M-MACH-105286 - BUS-Controls

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

Competence Certificate
Creation of control program

Prerequisites
none

T 7.29 Course: CAE-Workshop [T-MACH-105212]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Sven Matthiesen

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102684 - CAE-Workshop

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	2

Events					
ST 2022	2147175	CAE-Workshop	3 SWS	Block / 🗣	Albers, Mitarbeiter

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

Competence Certificate
Written test (with practical part on the computer), duration 60 min.

Prerequisites
None

Annotation
For a successful participation in the examination a continuous attendance at the workshop days is necessary. Limited number of participants. Selection is made according to a selection procedure.

T 7.30 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					
ST 2022	2123380	CATIA advanced	3 SWS	Project (P /	Ovtcharova, Mitarbeiter
WT 22/23	2123380	Advanced CATIA	3 SWS	Project (P /	Ovtcharova, 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

T 7.31 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					
ST 2022	2123358	CATIA CAD training course	2 SWS	Practical course / 🧩	Ovtcharova, Mitarbeiter
WT 22/23	2123358	CATIA CAD training course	2 SWS	Practical course / 🧩	Ovtcharova, 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 7.32 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 2022	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 7.33 Course: Cognitive Systems [T-INFO-101356]

Responsible: Prof. Dr. Gerhard Neumann
Prof. Dr. Alexander Waibel
Organisation: KIT Department of Informatics
Part of: M-INFO-100819 - Cognitive Systems

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

Events					
ST 2022	24572	Kognitive Systeme	4 SWS	Lecture / Practice (/ 🗣	Waibel, Neumann
WT 22/23	2400158	Introduction to Artificial Intelligence	3 SWS	Lecture / Practice (/ 🗣	Neumann, Friederich

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

T 7.34 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 2022	2311616	Communication Systems and Protocols	2 SWS	Lecture / 🗣	Becker, Becker
ST 2022	2311618	Tutorial for 2311616 Communication Systems and Protocols	1 SWS	Practice / 🗣	Stammler

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

Prerequisites
none

T 7.35 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					
ST 2022	2310511	Communications Engineering II	2 SWS	Lecture /	Jäkel
ST 2022	2310513	Tutorial for 2310511 Communications Engineering II	1 SWS	Practice /	Sturm
WT 22/23	2310509	Communications Engineering II	2 SWS	Lecture /	Jäkel
WT 22/23	2310510	Übung zu 2310509 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.

7.36 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					
ST 2022	2310517	Communication Engineering Laboratory	4 SWS	Practical course /	Schmalen, Jäkel, Bansbach, Sturm
WT 22/23	2310517	Communication Engineering Laboratory	4 SWS	Practical course /	Schmalen, Jäkel, Sturm, Bansbach

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

Prerequisites
none

T 7.37 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

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 2022	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.

T 7.38 Course: Computational Intelligence [T-MACH-105314]

Responsible: apl. Prof. Dr. Ralf Mikut
Dr. Ines Reinartz
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

Competence Certificate
Written exam (Duration: 1h)

Prerequisites
none

T 7.39 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	2

Events					
WT 22/23	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
passing the corresponding "Tutorial Continuum Mechanics of Solids and Fluids" (T-MACH-110333)

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 7.40 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 22/23	2303177	Control of Linear Multivariable Systems	3 SWS	Lecture /	Kluwe
WT 22/23	2303179	Control of Linear Multivariable Systems (Tutorial to 2303177)	1 SWS	Practice /	N.N.

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 7.41 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 2022	2306337	Control of Power-Electronic Systems	3 SWS	Lecture / ❂	Liske, Schmitz-Rode
ST 2022	2306338	Tutorial for 2306337 Control of Power-Electronic Systems	1 SWS	Practice / ❂	Liske, Schmitz-Rode

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 2022	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 22/23	2303169	Control Theory Laboratory	4 SWS	Block / 🗣	Hohmann

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

Prerequisites
none

T 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					
ST 2022	2143873	Actual topics of BioMEMS	2 SWS	Seminar / 🗘	Guber, Ahrens

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

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

Prerequisites
none

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

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	3

Events					
ST 2022	2117084	Decentrally controlled intralogistic systems	2 SWS	Practical course / 🗣	Furmans, Sperling, Ries
WT 22/23	2117084	Decentrally controlled intralogistic systems	2 SWS	Practical course / 🗣	Furmans, Sperling, Arndt

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

Competence Certificate
Certificate by colloquium with presentation

Prerequisites
None

T 7.47 Course: Deep Learning and Neural Networks [T-INFO-109124]

Responsible: Prof. Dr. Alexander Waibel
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 2022	2400024	Deep Learning and Neural Networks	4 SWS	Lecture / 🗣	Waibel

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

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
Oral examination	3	Grade to a third	Each summer term	1

Events					
ST 2022	2400007	Deep Learning for Computer Vision I: Basics	2 SWS	Lecture / 🗣	Stiefelhagen, Roitberg

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

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 22/23	2400258	Deep Learning for Computer Vision II: Advanced Topics	2 SWS	Lecture / 🗣	Stiefelhagen, Roitberg, Sarfraz

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

T 7.50 Course: Design of Electrical Machines [T-ETIT-100785]

Responsible: Dr.-Ing. Klaus-Peter Becker
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 22/23	2306324	Design of Electrical Machines	2 SWS	Lecture /	Doppelbauer
WT 22/23	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

7.51 Course: Design Principles for Interactive Real-Time Systems [T-INFO-101290]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: M-INFO-100753 - Design Principles for Interactive Real-Time Systems

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

Events					
ST 2022	24648	Design Principles for Interactive Real-Time Systems	2 SWS	Lecture / 🗣	Peinsipp-Byma, Sauer

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

T 7.52 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 2022	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 7.53 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 22/23	2308450	Digital Beam-Forming for Imaging Radar	2 SWS	Lecture / 🗣	Younis
WT 22/23	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 7.54 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 2022	2312683	Digital Circuit Design	2 SWS	Lecture / 🧩	Peric
ST 2022	2312685	Übungen zu 2312683 Design digitaler Schaltkreise	1 SWS	Practice / 🧩	Peric

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

T 7.55 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 2022	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 7.56 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 2022	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 7.57 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 22/23	232301486	Digital Twin Engineering	2 SWS	Lecture / 🗣	

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 7.58 Course: Digitalization of Products, Services & Production [T-MACH-108491]

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

Part of: M-MACH-101283 - Virtual Engineering A
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	1

Events					
WT 22/23	2122310	Digitalization of Products, Services & Production	2 SWS	Seminar / 🗣	Pätzold

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

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

T 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 2022	2302106	Verteilte ereignisdiskrete Systeme	2 SWS	Lecture / 🧩	Heizmann
ST 2022	2302108	Übungen zu 2302106 Verteilte ereignisdiskrete Systeme	1 SWS	Practice / 🗣	Weinreuter

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

Prerequisites
none

T 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 22/23	2113077	Drive Train of Mobile Machines	2 SWS	Lecture / 🗣	Geimer
WT 22/23	2113078	Übung zu 'Antriebsstrang mobiler Arbeitsmaschinen'	1 SWS	Practice / 🗣	Geimer, Herr

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 2022	2162210	Dynamics of electro-mechanical systems	2 SWS	Lecture /	Fidlin, Römer
ST 2022	2162211	Dynamics of electro-mechanical systems (Tutorial)	2 SWS	Practice /	Altoé, Fidlin, Römer

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

Competence Certificate
Written exam, 180 minutes

Prerequisites
None

T 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	1

Events					
WT 22/23	2163111	Dynamics of the Automotive Drive Train	2 SWS	Lecture / 🗣	Fidlin
WT 22/23	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: Electric Rail Vehicles [T-MACH-102121]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Prof. Dr.-Ing. Peter Gratzfeld

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102692 - Electric Rail Vehicles

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

Events					
ST 2022	2114346	Electric Rail Vehicles	2 SWS	Lecture / 🗣	Tesar, Gratzfeld

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

Competence Certificate

Oral examination

Duration: ca. 20 minutes

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

Prerequisites

none

T 7.65 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 22/23	2312700	Electrical Engineering Components	3 SWS	Lecture / 🗣	Kempf
WT 22/23	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 7.66 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 7.67 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.

T 7.68 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

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 7.69 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 7.70 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 2022	2400017	Energy Informatics 2	4 SWS	Lecture / Practice (/ 🗣	Hagenmeyer, Förderer, Stucky, Bao, Elbez, Kühnapfel, Schäfer, Mikut, Cakmak, Heidrich, Zahn, An, Phipps, Meisenbacher

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 7.71 Course: Energy Systems Analysis [T-WIWI-102830]

Responsible: Dr. Armin Ardone
Prof. Dr. Wolf Fichtner

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-100499 - Energy Systems Analysis

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

Events					
WT 22/23	2581002	Energy Systems Analysis	2 SWS	Lecture / 🗣	Fichtner, Ardone, Dengiz, Yilmaz

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

Competence Certificate
The assessment consists of a written exam (60 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

Prerequisites
None

Recommendation
None

Annotation
Since 2011 the lecture is offered in winter term. Exams can still be taken in summer term.

T 7.72 Course: Engineering Mechanics IV [T-MACH-105274]

Responsible: Prof. Dr.-Ing. Wolfgang Seemann
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 2022	2162231	Engineering Mechanics IV	2 SWS	Lecture /	Proppe
ST 2022	2162232	Engineering Mechanics IV (Tutorial)	2 SWS	Practice /	Proppe, Keller

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".

T 7.73 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 2022	2114917	Engineer's Field of Work	2 SWS	Lecture / 🗣	Doppelbauer, Geimer, Gratzfeld

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

7.74 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					
ST 2022	2545001	Entrepreneurship	2 SWS	Lecture /	Terzidis, Kuschel
WT 22/23	2545001	Entrepreneurship	2 SWS	Lecture /	Terzidis

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 7.75 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					
ST 2022	9003053	ARS REFLECTIONIS. Thinking and Acting Responsibly in Engineering, Science, and Innovation		Block / 🖥	Kühler, Does
WT 22/23	9003053	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 7.76 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					
ST 2022	2143882	Fabrication Processes in Microsystem Technology	2 SWS	Lecture / 🗣	Bade

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

Competence Certificate
Oral examination, 20 minutes

Prerequisites
none

T 7.77 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 22/23	2309466	Field Propagation and Coherence	2 SWS	Lecture / 🧩	Freude
WT 22/23	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 7.78 Course: Fundamentals in the Development of Commercial Vehicles [T-MACH-111389]

Responsible: Dr. 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					
ST 2022	2114844	Fundamentals in the Development of Commercial Vehicles II	1 SWS	Lecture / 🖥	Weber
WT 22/23	2113812	Fundamentals in the Development of Commercial Vehicles I	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

7.79 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 22/23	2113810	Fundamentals of Automobile Development I	1 SWS	Lecture / 🗣	Frech
WT 22/23	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 7.80 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 2022	2114842	Fundamentals of Automobile Development II	1 SWS	Block / 🗣	Frech
ST 2022	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 7.81 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 22/23	2165515	Fundamentals of Combustion I	2 SWS	Lecture / 🗣	Maas
WT 22/23	2165517	Fundamentals of Combustion I (Tutorial)	1 SWS	Practice / 🗣	Bykov
WT 22/23	3165016	Fundamentals of Combustion I	2 SWS	Lecture / 🗣	Maas
WT 22/23	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 7.82 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 2022	2130927	Fundamentals of Energy Technology	3 SWS	Lecture /	Cheng, Badea
ST 2022	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 7.83 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

Events					
ST 2022	24611	Fuzzy Sets	3 SWS	Lecture / 🗣	Pfaff

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

T 7.84 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 22/23	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 7.85 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	1

Events					
WT 22/23	2311608	Hardware Modeling and Simulation	2 SWS	Lecture / 🧩	Becker, Becker
WT 22/23	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

Recommendation
Lecture „Systems and Software Engineering“ (23605)

Annotation
During semester written, otherwise oral examination.

From WS 19/20 the module will be managed by Prof. Jürgen Becker and Dr. Jens Becker.

From WS 19/20 the module is offered in WS.

T 7.86 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 2022	2311619	Hardware Synthesis and Optimisation	3 SWS	Lecture / 🗣	Becker
ST 2022	2311621	Tutorial for 2311619 Hardware Synthesis and Optimisation	1 SWS	Practice / 🗣	Dörr

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 7.87 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 22/23	2311620	Hardware/Software Co-Design	2 SWS	Lecture /	Sander, Becker
WT 22/23	2311623	Tutorial for 2311620 Hardware/ Software Co-Design	1 SWS	Practice /	Lesniak

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 7.88 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					
ST 2022	3122512	Heat and Mass Transfer	2 SWS	Lecture / 🧩	Maas
WT 22/23	2165512	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 7.89 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 22/23	2307360	High-Voltage Technology	2 SWS	Lecture / 🗣	Badent
WT 22/23	2307362	Tutorial for 2307362High-Voltage Technology	1 SWS	Practice / 🗣	Badent, Zajadatz

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

T 7.90 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 22/23	2307392	High-Voltage Test Technique	2 SWS	Lecture / 🗣	Badent
WT 22/23	2307394	Tutorial for 2307392 High-Voltage Test Technique	2 SWS	Practice / 🗣	Gielnik

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

Prerequisites
none

7.91 Course: Human-Machine-Interaction [T-INFO-101266]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-100729 - Human Computer Interaction

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

Events					
ST 2022	24659	Human-Computer-Interaction	2 SWS	Lecture / 🖥	Beigl

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

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-106257 - Human-Machine-Interaction Pass must have been passed.

T 7.92 Course: Human-Machine-Interaction in Anthropomatics: Basics [T-INFO-101361]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Dr. Jürgen Geisler

Organisation: KIT Department of Informatics

Part of: M-INFO-100824 - Human-Machine-Interaction in Anthropomatics: Basics

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

Events					
WT 22/23	24100	Human-Machine-Interaction in Anthropomatics: Basics	2 SWS	Lecture /	van de Camp

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

T 7.93 Course: Human-Machine-Interaction Pass [T-INFO-106257]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-100729 - Human Computer Interaction

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

Events					
ST 2022	2400095	Human-Computer-Interaction	1 SWS	Practice / 🖥	Beigl, Pescara
ST 2022	24659	Human-Computer-Interaction	2 SWS	Lecture / 🖥	Beigl

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 22/23	24890	Humanoid Robotics Laboratory	4 SWS	Practical course / 🗣	Asfour

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

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-105142 - Humanoid Robots - Practical Course must not have been started.

Recommendation

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

Annotation

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

T 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 22/23	2400048	Seminar Humanoid Robots	2 SWS	Seminar / 🗣	Asfour

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

T 7.96 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 22/23	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

7.97 Course: Industrial Circuitry [T-ETIT-100716]

Responsible: Dr.-Ing. Klaus-Peter Becker
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 22/23	2306327	Industrial Circuitry	2 SWS	Lecture /	Liske

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

Prerequisites
none

T 7.98 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 2022	2122014	Information Engineering	2 SWS	Seminar / 🧩	Ovtcharova, Mitarbeiter

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

Competence Certificate
Alternative exam assessment (written composition and speech)

Prerequisites
None

T 7.99 Course: Information Fusion [T-ETIT-106499]

Responsible: Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-103264 - Information Fusion

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

Events					
WT 22/23	2302139	Information Fusion	2 SWS	Lecture / Blended	Heizmann
WT 22/23	2302141	Erxercize for 2302139 Information Fusion	1 SWS	Practice / On-Site	Heizmann, Bihler

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

Prerequisites
none

T 7.100 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 summer term	1

Events					
WT 22/23	24102	Information Processing in Sensor Networks	3 SWS	Lecture / 🗣	Li

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

T 7.101 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

Events					
ST 2022	2118094	Information Systems in Logistics and Supply Chain Management	2 SWS	Lecture / 🖥	Kilger

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

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 7.102 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 2022	2302144	Informationstechnik in der industriellen Automation	2 SWS	Lecture / 🗣	Bort

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

Prerequisites
none

T 7.103 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					
ST 2022	2303192	Innovation Lab	2 SWS	Project (P / 🗣	Hohmann, Zwick, Sax, Stork, Nahm
WT 22/23	2303192	Innovation Lab	2 SWS	Project (P / 🗣	Hohmann, Zwick, Sax, Stork, Nahm

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

Competence Certificate
see module description

T 7.104 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 winter term	1

T 7.105 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 2022	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

7.106 Course: Integrated Product Development [T-MACH-105401]

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

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 22/23	2145156	Integrated Product Development	4 SWS	Lecture / 🗣	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.

T 7.107 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 2022	2312688	Integrated Systems and Circuits	2 SWS	Lecture / 🗣	Ilin
ST 2022	2312690	Tutorial for 2312688 Integrated Systems and Circuits	1 SWS	Practice / 🧩	Wünsch, Ilin

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

Prerequisites
none

T 7.108 Course: Intellectual Property Rights and Strategies in Industrial Companies [T-MACH-105442]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Sven Matthiesen
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					
ST 2022	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 7.109 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	3

Events					
ST 2022	2150600	International Production Engineering A	2 SWS	Lecture / Blended	Fleischer

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

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

Prerequisites
One of the following courses must be started:

- T-MACH-108844 - Automated Manufacturing Systems
- T-MACH-109055 - Machine Tools and Industrial Handling
- T-MACH-110962 - Machine Tools and High-Precision Manufacturing Systems

Modeled Conditions
You have to fulfill one of 3 conditions:

1. The course T-MACH-108844 - Automated Manufacturing Systems must have been started.
2. The course T-MACH-109055 - Machine Tools and Industrial Handling must have been started.
3. 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 7.110 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	3

Events					
WT 22/23	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-109055 - Machine Tools and Industrial Handling
- 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 3 conditions:
   1. The course T-MACH-108844 - Automated Manufacturing Systems must have been passed.
   2. The course T-MACH-109055 - Machine Tools and Industrial Handling must have been passed.
   3. 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 7.111 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	4

Events					
ST 2022	2581010	Introduction to Energy Economics	2 SWS	Lecture / 🗣	Fichtner
ST 2022	2581011	Übungen zu Einführung in die Energiewirtschaft	2 SWS	Practice / 🗣	Lehmann, Sandmeier, Ardone, Fichtner

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

Competence Certificate
The assessment consists of a written exam (90 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

Prerequisites
None.

T 7.112 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

Competence Certificate
written examination (60 min)

Prerequisites
none

T 7.113 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 2022	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 7.114 Course: Introduction to Multi-Body Dynamics [T-MACH-105209]

Responsible: Prof. Dr.-Ing. Wolfgang Seemann
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 2022	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 7.115 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					
ST 2022	2305744	Einführung in die wissenschaftliche Methode	1 SWS	Seminar / 🗣	Nahm
WT 22/23	2305504	Einführung in die wissenschaftliche Methode	1 SWS	Seminar / 🗣	Nahm

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

Prerequisites
none

T 7.116 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	1

Events					
ST 2022	2123352	IoT platform for engineering	3 SWS	Project (P / 🗣	Ovtcharova, Maier
WT 22/23	2123352	IoT platform for engineering	3 SWS	Project (P / 🗣	Ovtcharova, Maier

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

Competence Certificate
Assessment of another type (graded), procedure see webpage. Number of participants limited to 20 people. There is a participant selection process.

T 7.117 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	3

Events					
ST 2022	2118184	IT-Fundamentals of Logistics: Opportunities for Digital Transformation	2 SWS	Lecture / 🧩	Thomas

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

Competence Certificate
The success control takes place in form of a written examination 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

Annotation
1) Detailed script can be downloaded online (www.tup.com), updated and enhanced annually.

2) CD-ROM with chapters and exercises at the end of the semester available from the lecturer, also updated and enhanced annually.

T 7.118 Course: Lab Computer-Aided Methods for Measurement and Control [T-MACH-105341]

Responsible: 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 22/23	2137306	Lab Computer-aided methods for measurement and control	3 SWS	Practical course / 🗣	Stiller, Müßigmann

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

Competence Certificate
Colloquia

Prerequisites
none

T 7.119 Course: Lab Course Electrical Drives and Power Electronics [T-ETIT-100718]

Responsible: Dr.-Ing. Klaus-Peter Becker
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 2022	2306331	Lab Course Electrical Drives and Power Electronics	4 SWS	Practical course / 🗣	Becker

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

Prerequisites
none

T 7.120 Course: Lab Course Electrical Power Engineering [T-ETIT-100728]

Responsible: Dr.-Ing. Rainer Badent
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
Oral examination	6	Grade to a third	Each winter term	1

Events					
WT 22/23	2307398	Lab Course Electrical Power Engineering	4 SWS	Practical course / 🗣	Badent, N.N.

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

Competence Certificate
Success is checked in the form of an oral examination. The overall grade results from the 8 attempts.

Prerequisites
none

T 7.121 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					
ST 2022	2312669	Laboratory Nanoelectronic Technology	4 SWS	Practical course / 🗣	Ilin
WT 22/23	2312669	Laboratory Nanoelectronics	4 SWS	Practical course / 🗣	Kempf, weitere Mitarbeitende

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

Prerequisites
none

T 7.122 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 2022	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.

T 7.123 Course: Laboratory Digital Signal Processing [T-ETIT-101935]

Responsible: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100364 - Laboratory Digital Signal Processing

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

Events					
ST 2022	2302134	Praktikum Digitale Signalverarbeitung	4 SWS	Practical course / 🧩	Schwabe, Tabuchi Barczak, Heizmann

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

Prerequisites
none

T 7.124 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					
ST 2022	2312674	Laboratory FPGA Based Circuit Design	4 SWS	Practical course / 🗣	Wünsch
WT 22/23	2312674	Laboratory FPGA Based Circuit Design	4 SWS	Practical course / 🗣	Kempf, Wünsch

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

Prerequisites
none

7.125 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 2022	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

7.126 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 22/23	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 7.127 Course: Laboratory Mechatronics [T-MACH-105370]

Responsible: Prof. Dr. Veit Hagenmeyer
Prof. Dr.-Ing. Wolfgang Seemann
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 22/23	2105014	Laboratory mechatronics	3 SWS	Practical course / 🗣	Stiller, Hagenmeyer, Böhland, Chen, Müßigmann, Orth

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

Competence Certificate

The laboratory course is offered exclusively as ungraded course work. The assessment consists of a group colloquium at the beginning of the individual specialization phases (Part 1). In addition, a robot control system for a pick-and-place task must be successfully implemented in the group phase (Part 2).

Prerequisites

None

T 7.128 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					
ST 2022	2313714	Laboratory Nanotechnology	4 SWS	Practical course / 🗣	Trampert, Lemmer
WT 22/23	2313714	Laboratory Nanotechnology	4 SWS	Practical course / 🗣	Lemmer, Trampert

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

Prerequisites
none

T 7.129 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					
ST 2022	2313712	Laboratory Optoelectronics	4 SWS	Practical course / 🗣	Trampert, Kling
WT 22/23	2313712	Laboratory Optoelectronics	4 SWS	Practical course / 🗣	Kling, Trampert

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

Prerequisites
none

T 7.130 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					
ST 2022	2313708	Laboratory Solar Energy	4 SWS	Practical course / 🗣	Trampert, Paetzold, Richards
WT 22/23	2313716	Laboratory Solar Energy	4 SWS	Practical course / 🗣	Richards, Trampert, Paetzold

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

Prerequisites
none

T 7.131 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

Competence Certificate
oral colloquium, ungraded

Prerequisites
none

Annotation
NwT students attend only part of the lecture

T 7.132 Course: Lighting Engineering [T-ETIT-100772]

Responsible: Prof. Dr. Cornelius Neumann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100485 - Lighting Engineering

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

Events					
WT 22/23	2313739	Lighting Engineering	2 SWS	Lecture / 🗣	Neumann
WT 22/23	2313741	Lighting Engineering (Tutorial to 2313739)	1 SWS	Practice	Neumann

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

Prerequisites
none

T 7.133 Course: Lightweight Engineering Design [T-MACH-105221]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Norbert Burkardt

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 2022	2146190	Lightweight Engineering Design	2 SWS	Lecture / 🗣	Albers, Burkardt

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

Competence Certificate
Written examination (90 min)

Prerequisites
None

T 7.134 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 2022	24613	Localization of Mobile Agents	3 SWS	Lecture / 🗣	Zea Cobo, Li

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

T 7.135 Course: Logistics - Organisation, Design and Control of Logistic Systems [T-MACH-102089]

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

Part of: M-MACH-104985 - Logistics - Organisation, Design and Control of Logistic Systems

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

Competence Certificate
The assessment consists of a 90 minutes written examination (according to §4(2), 1 of the examination regulation).

Prerequisites
None

Recommendation
Requied are lectures on “Linear Algebra” and “Stochastic”.

T 7.136 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
Written examination	9	Grade to a third	Each summer term	2

Events					
ST 2022	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 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

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 7.137 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					
ST 2022	2161224	Machine Dynamics	2 SWS	Lecture / 🖥	Proppe
ST 2022	2161225	Machine Dynamics (Tutorial)	1 SWS	Practice / 🧩	Proppe, Fischer
WT 22/23	2161224	Machine Dynamics	2 SWS	Lecture / 🖥	Proppe

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

Competence Certificate
written exam, 180 min.

Prerequisites
none

T 7.138 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	5	Grade to a third	Each winter term	1

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.

T 7.139 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	3

Events					
WT 22/23	2511500	Machine Learning 1 - Fundamental Methods	2 SWS	Lecture / 🗣	Zöllner
WT 22/23	2511501	Exercises to Machine Learning 1 - Fundamental Methods	1 SWS	Practice / 🗣	Zöllner, Daaboul, 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.

T 7.140 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	3

Events					
ST 2022	2511502	Machine Learning 2 - Advanced methods	2 SWS	Lecture / 🗣	Zöllner
ST 2022	2511503	Exercises for Machine Learning 2 - Advanced Methods	1 SWS	Practice / 🗣	Zöllner

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.

T 7.141 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 22/23	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 7.142 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 22/23	2137308	Machine Vision	4 SWS	Lecture / Practice (/ 🗣	Lauer, Kinzig

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

Competence Certificate

Type of Examination: written exam

Duration of Examination: 60 minutes

Prerequisites

None

T 7.143 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 2022	2302116	Fertigungsmesstechnik	2 SWS	Lecture /	Heizmann

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

T 7.144 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.

7.145 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

Events					
WT 22/23	2117051	Material flow in logistic systems	15 SWS	Others (sons / 🗣	Furmans, Fleischmann, Köhler

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

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 7.146 Course: Materials of Lightweight Construction [T-MACH-105211]

Responsible: Prof. Dr.-Ing. Peter Elsner
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 2022	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 7.147 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 22/23	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.

7.148 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 22/23	2302117	Measurement Technology	2 SWS	Lecture / 🧩	Heizmann
WT 22/23	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 7.149 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 22/23	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 7.150 Course: Mechano-Informatics and Robotics [T-INFO-101294]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-100757 - Mechano-Informatics and Robotics

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

Events					
WT 22/23	2400077	Mechano-Informatics and Robotics	2 SWS	Lecture / 🗣	Asfour

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

T 7.151 Course: Medical Imaging Techniques I [T-ETIT-101930]

Responsible: Prof. Dr. Olaf Dössel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100384 - Medical Imaging Techniques I

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

Events					
WT 22/23	2305261	Medical Imaging Techniques I	2 SWS	Lecture	N.N.

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

Prerequisites
none

T 7.152 Course: Medical Imaging Techniques II [T-ETIT-101931]

Responsible: Prof. Dr. Olaf Dössel
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100385 - Medical Imaging Techniques II

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

Events					
ST 2022	2305262	Medical Imaging Techniques II	2 SWS	Lecture / 🗣	Potyagaylo, Nahm

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

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

Prerequisites
none

Recommendation
The contents of the M-ETIT-100384 module are required.

T 7.153 Course: Medical Robotics [T-INFO-101357]

Responsible: Prof. Dr.-Ing. Torsten Kröger
Jun.-Prof. Dr. Franziska Mathis-Ullrich

Organisation: KIT Department of Informatics

Part of: M-INFO-100820 - Medical Robotics

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

Events					
ST 2022	24681	Medical Robotics	2 SWS	Lecture / 🗣	Mathis-Ullrich

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

T 7.154 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 2022	2146176	Methods and processes of PGE - Product Generation Engineering	4 SWS	Lecture / 🗣	Albers

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 7.155 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 22/23	2302113	Methods of Signal Processing	2 SWS	Lecture /	Heizmann
WT 22/23	2302115	Methods of Signal Processing (Tutorial to 2302113)	1+1 SWS	Practice /	Heizmann, Diaz Ocampo

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

Prerequisites
none

T 7.156 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 2022	2142881	Microactuators	2 SWS	Lecture /	Kohl

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

Competence Certificate
written exam, 60 min.

Prerequisites
none

T 7.157 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 2022	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 7.158 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 7.159 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 22/23	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 7.160 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					
ST 2022	2308407	Microwave Engineering	2 SWS	Lecture / 🗣	Pauli
ST 2022	2308409	Tutorial for 2308407 Microwave Engineering	1 SWS	Practice / 🗣	Nuß
WT 22/23	2308407	Microwave Engineering	2 SWS	Lecture / 🧩	Pauli
WT 22/23	2308409	Tutorial for 2308407 Microwave Engineering	1 SWS	Practice / 🖥	Bhutani

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

Prerequisites
none

Annotation
WS: german

SS: english

The exam is in each semester and for every student bilingual.

T 7.161 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					
ST 2022	2308415	Microwave Engineering Lab	4 SWS	Practical course / 🗣	Pauli
WT 22/23	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 7.162 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 2022	2308420	Microwaves Measurement Techniques	2 SWS	Lecture / 🗣	Pauli, Ruess
ST 2022	2308422	Übungen zu 2308420 Mikrowellenmesstechnik	1 SWS	Practice / 🗣	Pauli, Ruess

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

Prerequisites
none

7.163 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 2022	2105024	Modern Control Concepts I	2 SWS	Lecture /	Matthes, Groell
ST 2022	2106020	Tutorial on Modern Control Concepts I	2 SWS	Practice /	Matthes

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

Competence Certificate
Written exam (Duration: 1 h)

Prerequisites
none

T 7.164 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

Competence Certificate
oral exam (Duration: 30min)

Prerequisites
none

T 7.165 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 2022	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 7.166 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 2022	2308430	Modern Radio Systems Engineering	2 SWS	Lecture / 🗣	Bhutani, Li
ST 2022	2308431	Tutorial 2308430 Modern Radio Systems Engineering	1 SWS	Practice / 🗣	Bhutani

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

Prerequisites
none

T 7.167 Course: Motion in Man and Machine - Seminar [T-INFO-105140]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-102555 - Motion in Man and Machine - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	2

Events					
ST 2022	2400063	Motion in Man and Machine	3 SWS	Seminar / 🗣	Asfour

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

T 7.168 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					
ST 2022	2115808	Motor Vehicle Laboratory	2 SWS	Practical course / 🗣	Frey
WT 22/23	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

T 7.169 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 2022	2312668	Nano- and Quantum Electronics	3 SWS	Lecture / 🗣	Kempf
ST 2022	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.

7.170 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 2022	2303173	Nichtlineare Regelungssysteme	2 SWS	Lecture / 🗣	Kluwe

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

Prerequisites
none

T 7.171 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 2022	2309468	Nonlinear Optics	2 SWS	Lecture / 🗣	Koos
ST 2022	2309469	Nonlinear Optics (Tutorial)	2 SWS	Practice / 🗣	Koos

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

Prerequisites
none

T 7.172 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

Competence Certificate
written exam, 60 minutes

Prerequisites
none

T 7.173 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

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

Prerequisites
none

7.174 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 2022	2309490	Photonics and Communications Lab	4 SWS	Practical course / 🗣	Koos, Freude, Randel

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

Prerequisites
none

T 7.175 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 2022	2311647	Optical Design Lab	4 SWS	Practical course / 🗣	Stork

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

Prerequisites
none

T 7.176 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 22/23	2309460	Optical Transmitters and Receivers	2 SWS	Lecture /	Freude
WT 22/23	2309461	Tutorial for 2309460 Optical Transmitters and Receivers	2 SWS	Practice /	Freude, N.N.

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

Prerequisites
none

7.177 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 22/23	2309464	Optical Waveguides and Fibers	2 SWS	Lecture / 🗣	Koos, Bao, Drayß
WT 22/23	2309465	Tutorial for 2309464 Optical Waveguides and Fibers	1 SWS	Practice / 🗣	Koos, Bao, Drayß

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

Prerequisites
none

7.178 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 2022	2303162	Optimale Regelung und Schätzung	2 SWS	Lecture / 🗣	Kluwe

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

Prerequisites
none

T 7.179 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 22/23	2303183	Optimization of Dynamic Systems	2 SWS	Lecture /	Hohmann
WT 22/23	2303185	Optimization of Dynamic Systems (Tutorial to 2303183)	1 SWS	Practice /	Bohn
WT 22/23	2303851	Accompanying group tutorial for 2303183 Optimization of Dynamic Systems	1 SWS	Tutorial (/	Bohn

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

7.180 Course: Optoelectronic Measurement Engineering [T-ETIT-100771]

Responsible: Dr.-Ing. Klaus Trampert
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100484 - Optoelectronic Measurement Engineering

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

Events					
ST 2022	2313736	Optoelectronic Measurement Engineering	2 SWS	Lecture / 🗣	Trampert

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

Prerequisites
none

T 7.181 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 22/23	2313726	Optoelectronics	2 SWS	Lecture /	Lemmer
WT 22/23	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 7.182 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 2022	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

T 7.183 Course: Pattern Recognition [T-INFO-101362]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Tim Zander

Organisation: KIT Department of Informatics

Part of: M-INFO-100825 - Pattern Recognition

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

Events					
ST 2022	24675	Pattern Recognition	4 SWS	Lecture / Practice (/ 🗣	Beyerer

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

T 7.184 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 2022	2313737	Photovoltaics	3 SWS	Lecture / 🗣	Powalla, Lemmer
ST 2022	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.

7.185 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 2022	2303166	Physical and Data-Based Modelling	3 SWS	Lecture / 🗣	Hohmann
ST 2022	2303168	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 7.186 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					
ST 2022	2305282	Physiology and Anatomy for Engineers II	2 SWS	Lecture / 🗣	Nahm
WT 22/23	2305281	Physiology and Anatomy for Engineers I	2 SWS	Lecture / ⚙	Nahm, Weiß

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 7.187 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 22/23	2313729	Plasma Sources	3 SWS	Lecture / 🗣	Kling

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

Prerequisites
none

T 7.188 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 22/23	2313709	Polymerelectronics/ Plastic Electronics	2 SWS	Lecture /	Lemmer

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

Competence Certificate
oral exam (approx. 20 minutes)

Prerequisites
none

T 7.189 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	1

Events					
ST 2022	2122376	PLM for product development in mechatronics	2 SWS	Lecture / 🗣	Eigner
WT 22/23	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 7.190 Course: Plug-and-Play Material Handling [T-MACH-106693]

Responsible: Jonathan Auberle
Prof. Dr.-Ing. Kai Furmans

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-104983 - Plug-and-Play Material Handling

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each winter term	2

Events					
WT 22/23	2117070	Plug-and-play material handling	2 SWS	Practical course / 🧩	Furmans, Müller, Enke

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

Competence Certificate
Presentation of the four steps of the course content (design, implementation, test concept and evaluation)

Prerequisites
None

T 7.191 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 22/23	2306357	Leistungselektronische Systeme in der Energietechnik	3 SWS	Lecture / ⚙	Hiller
WT 22/23	2306358	Übung zu 2306357 Leistungselektronische Systeme in der Energietechnik	1 SWS	Practice / ⚙	Hiller

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

Prerequisites
none

T 7.192 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	4

Events					
ST 2022	2306323	Power Electronics	2 SWS	Lecture /	Hiller
ST 2022	2306324	Tutorial for 2306385 Power Electronics	1 SWS	Practice /	Hiller, Frank

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 7.193 Course: Power Electronics for Photovoltaics and Wind Energy [T-ETIT-104569]

Responsible: Dr.-Ing. Klaus-Peter Becker
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 winter term	1

Events					
WT 22/23	2306347	Power Electronics for Photovoltaics and Wind Energy	2 SWS	Lecture	Burger

Prerequisites
none

T 7.194 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	6	Grade to a third	Each winter term	1

Events					
WT 22/23	2307371	Power Network	2 SWS	Lecture / 🗣	Leibfried
WT 22/23	2307373	Tutorial for 2307371 Power Network	2 SWS	Practice / 🗣	Leibfried, Geis-Schroer

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

T 7.195 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 22/23	2307383	Power Systems and Economy	2 SWS	Lecture / 🗣	Weissmüller

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

Prerequisites
none

T 7.196 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 2022	2307372	Power Transmission and Power Network Control	2 SWS	Lecture / 🗣	Leibfried
ST 2022	2307374	Übungen zu 2307372 Energieübertragung und Netzregelung	1 SWS	Practice / 🗣	Bisseling

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

Prerequisites
none

T 7.197 Course: Practical Aspects of Electrical Drives [T-ETIT-100711]

Responsible: Dr.-Ing. Klaus-Peter Becker
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 2022	2306311	Practical Aspects of Electrical Drives	2 SWS	Lecture / 🧩	Doppelbauer
ST 2022	2306313	Übungen zu 2306311 Praxis elektrischer Antriebe	1 SWS	Practice / 🧩	Doppelbauer

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

Prerequisites
none

T 7.198 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 2022	24871	Practical Course Machine Learning and Intelligent Systems	4 SWS	Practical course / 🗣	Hanebeck, Fennel

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 7.199 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					
ST 2022	2400082	Laboratory: Smart Energy System Lab	2 SWS	Practical course / 🗣	Hagenmeyer, Waczowicz, Süß, Turowski
WT 22/23	2400159	Laboratory: Smart Energy System Lab	2 SWS	Practical course / 🗣	Hagenmeyer, Waczowicz, Süß, Turowski

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

7.200 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 22/23	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 7.201 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 22/23	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.

T 7.202 Course: Practical Training in Basics of Microsystem Technology [T-MACH-102164]

Responsible: Dr. Arndt Last
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105479 - Practical Training in Basics of Microsystem Technology

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	1

Events					
ST 2022	2143875	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last
ST 2022	2143877	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last
WT 22/23	2143875	Introduction to Microsystem Technology - Practical Course	2 SWS	Practical course / 🗣	Last
WT 22/23	2143877	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 7.203 Course: Predictive Driver Assistance Systems [T-ETIT-100692]

Responsible: Dr. Rüdiger Walter Henn
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100360 - Predictive Driver Assistance Systems

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

Events					
WT 22/23	2308097	Predictive Driver Assistance Systems	2 SWS	Lecture / 🧩	Henn, Weber

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

Prerequisites
none

T 7.204 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

Competence Certificate
Written examination (Duration: 45min)

Prerequisites
none

T 7.205 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 2022	2110678	Production Techniques Laboratory	4 SWS	Practical course /	Deml, Fleischer, Furmans, Ovtcharova

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

None

T 7.206 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
Oral examination	4	Grade to a third	Each term	2

Events					
WT 22/23	2311641	Project Management in the Development of Products for Safety-Critical Applications	2 SWS	/	Nolle
WT 22/23	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 7.207 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 2022	2146210	ProVIL - Product Development in a Virtual Idea Laboratory	3 SWS	Lecture / 🖥	Albers, Albers Assistenten

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

Competence Certificate
colloquia and presentations.

Prerequisites
none

7.208 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	2

Events					
WT 22/23	2149667	Quality Management	2 SWS	Lecture /	Lanza

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

Competence Certificate
Written Exam (60 min)

Prerequisites
none

7.209 Course: Rail System Technology [T-MACH-106424]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Prof. Dr.-Ing. Peter Gratzfeld

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-103232 - Rail System Technology

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

Events					
ST 2022	2115919	Rail System Technology	2 SWS	Lecture / 🗣	Heckele, Gratzfeld
WT 22/23	2115919	Rail System Technology	2 SWS	Lecture / 🗣	Heckele, Gratzfeld

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

Competence Certificate
Oral examination

Duration: ca. 20 minutes

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

Prerequisites
none

T 7.210 Course: Rail Vehicle Technology [T-MACH-105353]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Prof. Dr.-Ing. Peter Gratzfeld

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102683 - Rail Vehicle Technology

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

Events					
ST 2022	2115996	Rail Vehicle Technology	2 SWS	Lecture / 🗣	Reimann, Gratzfeld
WT 22/23	2115996	Rail Vehicle Technology	2 SWS	Lecture / 🗣	Reimann, Gratzfeld

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

Competence Certificate
Oral examination

Duration: ca. 20 minutes

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

Prerequisites
none

T 7.211 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 22/23	2306353	Real Time Control of Electrical Drives	3 SWS	Lecture / 🧩	Liske
WT 22/23	2306354	Tutorial for 2306353 Real Time Control of Electrical Drives	1 SWS	Practice / 🧩	Liske

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

T 7.212 Course: Real-Time Systems [T-INFO-101340]

Responsible: Prof. Dr.-Ing. Thomas Längle
Organisation: KIT Department of Informatics
Part of: M-INFO-100803 - Real-Time Systems

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

Events					
ST 2022	24576	Real-Time Systems	4 SWS	Lecture / Practice (/ 🗣	Längle, Ledermann

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

T 7.213 Course: Reinforcement Learning [T-INFO-111255]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-105623 - Reinforcement Learning

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Irregular	1

Events					
WT 22/23	2400163	Reinforcement Learning	SWS: 3 / ECTS: 5 SWS	Lecture / Practice (/ 🗣	Neumann

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

T 7.214 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 22/23	2145350	Reliability and Test Engineering (Lecture)	2 SWS	Lecture /	Gwosch
WT 22/23	2145351	Workshop Reliability and Test Engineering	2 SWS	Practical course /	Gwosch

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

Competence Certificate
The grade is composed of the evaluation of a final report following the practical part. The assessment criteria are as follows:

- Structure of the report
- Comprehensibility and comprehensibility
- Preparation of the tests
- Use of test and reliability methods
- Formulation and answering of test hypotheses
- Test evaluation, comprehensible results

Attendance and active participation in the lab is mandatory.

Prerequisites
none

Recommendation
We strongly recommend the attendance of the MSuP lectures. Students who have not (yet) attended are recommended to learn the contents in advance.

T 7.215 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	3	Grade to a third	Each winter term	4

Events					
WT 22/23	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 7.216 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 2022	24870	Robotics - Practical Course	4 SWS	Practical course / 🗣	Asfour

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

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
Should have attended the lectures Robotics I - III, and Mechano-Informatics and Robotics.

T 7.217 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 22/23	2424152	Robotics I - Introduction to Robotics	3/1 SWS	Lecture / 🗣	Asfour

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

T 7.218 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 2022	2400074	Robotics II: Humanoid Robotics	2 SWS	Lecture / 🗣	Asfour

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

T 7.219 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 2022	2400067	Robotics III - Sensors and Perception in Robotics	2 SWS	Lecture / 🗣	Asfour

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

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.

T 7.220 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 22/23	2117072	Seamless Engineering - Logistics Robotics Workshop	2 SWS	Lecture / Practice (/	Furmans, Sax

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

Competence Certificate

The assessment of success takes place in the form of a written examination as well as an examination performance of another kind.

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

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 7.221 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 7.222 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 7.223 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 7.224 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 7.225 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 7.226 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 7.227 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 7.228 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	2

Competence Certificate
Alternative test achievement (graded):

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

Prerequisites
none

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-112115 - Artificial Intelligence in Production must have been started.

T 7.229 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 2022	2311633	Seminar Creating a Patent Specification	2 SWS	Seminar / 🗣	Stork

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

Prerequisites
none

T 7.230 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					
ST 2022	2151643	Seminar Data Mining in Production	2 SWS	Seminar /	Lanza
WT 22/23	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 7.231 Course: Seminar Embedded Systems [T-ETIT-100753]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Prof. Dr.-Ing. Eric Sax
Prof. Dr. Wilhelm Stork

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-100455 - Seminar Embedded Systems

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

Events					
ST 2022	2311627	Seminar Embedded Systems	2 SWS	Seminar / 🗘	Becker, Sax, Stork
WT 22/23	2311627	Seminar Embedded Systems	2 SWS	Seminar / 🗘	Becker, Sax, Stork

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

Prerequisites
none

T 7.232 Course: Seminar for Rail System Technology [T-MACH-108692]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Prof. Dr.-Ing. Peter Gratzfeld

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					
ST 2022	2115009	Seminar for Rail System Technology	1 SWS	Seminar / 🗣	Tesar, Geimer, Gratzfeld
WT 22/23	2115009	Seminar for Rail System Technology	1 SWS	Seminar / 🗣	Gratzfeld, Tesar, Geimer

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

Competence Certificate
Examination: Writing a Seminararbeit, final presentation

Prerequisites
none

T 7.233 Course: Seminar Intelligent Industrial Robots [T-INFO-104526]

Responsible: Prof. Dr.-Ing. Heinz Wörn
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 22/23	24785	Intelligent Industrial Robots	2 SWS	Seminar	Hein

T 7.234 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 2022	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 7.235 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					
ST 2022	2312679	Seminar on Quantum Detectors and Sensors	2 SWS	Seminar / 🧩	Kempf, und Mitarbeiter
WT 22/23	2312716	Seminar on Quantum Detectors and Sensors	2 SWS	Seminar / 🗣	Kempf, Ilin, Wünsch

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

Prerequisites
none

T 7.236 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

T 7.237 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 2022	2312684	Project Management for Engineers	2 SWS	Seminar / ✕	Noe

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

Prerequisites
none

T 7.238 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

Events					
ST 2022	2308432	Seminar Radar- and Communication Systems	3 SWS	Seminar / 🗣	Zwick, Ulusoy, Mitarbeiter*innen
WT 22/23	2308432	Seminar Radar- and Communication Systems	3 SWS	Seminar / 🧩	Zwick

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

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 7.239 Course: Seminar Robotics and Medicine [T-INFO-104525]

Responsible: Jun.-Prof. Dr. Franziska Mathis-Ullrich
Organisation: KIT Department of Informatics
Part of: M-INFO-102211 - Seminar Robotics and Medicine

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

Events					
ST 2022	24336	Robotics and Medicine	2 SWS	Seminar / 🗣	Mathis-Ullrich
WT 22/23	24336	Robotics and Medicine	2 SWS	Seminar / 🗣	Mathis-Ullrich

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

T 7.240 Course: Seminar: Energy Informatics [T-INFO-106270]

Responsible: Prof. Dr. Dorothea Wagner
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 22/23	2400013	Seminar: Energy Informatics	2 SWS	Seminar / 🗣	Wagner, Hagenmeyer, Fichtner, Gritzbach, Wolf, Heidrich, Phipps, Ueckerdt, Bläsius, Göttlicher

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

T 7.241 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 2022	2304231	Sensors	2 SWS	Lecture / 🗣	Menesklou

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

7.242 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

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

T 7.243 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 winter term	2

Events					
WT 22/23	2311611	Software Engineering	2 SWS	Lecture / 🗣	Reichmann

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

Prerequisites
none

T 7.244 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 22/23	2313745	Solar Energy	3 SWS	Lecture / 🗣	Richards, Paetzold
WT 22/23	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 7.245 Course: Spaceborne Radar Remote Sensing [T-ETIT-106056]

Responsible: Prof. Dr.-Ing. Thomas Zwick
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	6	Grade to a third	Each summer term	1

Events					
ST 2022	2308427	Spaceborne Radar Remote Sensing	1 SWS	/ 🗣	Younis, Prats
ST 2022	2308428	Spaceborne Radar Remote Sensing	2 SWS	Lecture / 🗣	Prats, Moreira
ST 2022	2308429	Tutorial Spaceborne Radar Remote Sensing	1 SWS	Tutorial (/ 🗣	Younis

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

Competence Certificate
Written

Prerequisites
"T-ETIT-101949 - Spaceborne SAR Remote Sensing" is not allowed to be started or to be completed.

Recommendation
Signal processing and radar fundamentals.

Annotation
Actual information can be found at the internet page of the IHE (www.ihe.kit.edu).

T 7.246 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 22/23	24113	Stochastic Information Processing	3 SWS	Lecture / 🗣	Hanebeck, Frisch

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

T 7.247 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 22/23	2314010	Strategy Derivation for Engineer	2 SWS	Seminar /	Arndt

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

Prerequisites
none

T 7.248 Course: System Integration in Micro- and Nanotechnology [T-MACH-105555]

Responsible: 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 2022	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 7.249 Course: System Integration in Micro- and Nanotechnology 2 [T-MACH-110272]

Responsible: 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

Competence Certificate
Oral exam, approx. 15 min.

Prerequisites
None

Annotation
Attention: The lecture and exam will be offered for the first time in WS20/21!

T 7.250 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	4

Events					
ST 2022	2174576	Systematic Materials Selection	3 SWS	Lecture /	Dietrich
ST 2022	2174577	Excercises in Systematic Materials Selection	1 SWS	Practice /	Dietrich, Mitarbeiter

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 7.251 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 22/23	2311612	Laboratory System-on-Chip	4 SWS	Practical course / 🗣	Becker, Peric

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

Prerequisites
none

T 7.252 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 22/23	2311605	Systems and Software Engineering	2 SWS	Lecture /	Sax
WT 22/23	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

7.253 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 2022	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 7.254 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 22/23	2313720	Technical Optics	2 SWS	Lecture / 🗣	Neumann
WT 22/23	2313722	Technical Optics (Tutorial to 2313720)	1 SWS	Practice / 🗣	Neumann

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

Prerequisites
none

T 7.255 Course: Thermal Solar Energy [T-MACH-105225]

Responsible: Prof. Dr. Robert Stieglitz
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 22/23	2169472	Thermal Solar Energy	2 SWS	Lecture / 🗣	Stieglitz

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

Competence Certificate
Oral examination of about 30 minutes

Prerequisites
none

T 7.256 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 22/23	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.

7.257 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 22/23	2161255	Tutorial Mathematical Methods in Continuum Mechanics	2 SWS	Practice / 🧩	Gajek, 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 7.258 Course: Vehicle Lightweight Design - Strategies, Concepts, Materials [T-MACH-105237]

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

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 22/23	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 7.259 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	2

Events					
WT 22/23	2121352	Virtual Engineering I	2 SWS	Lecture / 🗣	Ovtcharova
WT 22/23	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

T 7.260 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					
ST 2022	2123350	Virtual Engineering Lab	3 SWS	Project (P / 🗣	Ovtcharova, Häfner
WT 22/23	2123350	Virtual Engineering Lab	3 SWS	Project (P / 🗣	Ovtcharova, Häfner

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

Competence Certificate
Assessment of another type (graded), procedure see webpage.

T 7.261 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					
ST 2022	2121003	Virtual Solution Methods and Processes	4 SWS	Project (P /	Ovtcharova, Maier
WT 22/23	2121003	Virtual Solution Methods and Processes	4 SWS	Project (P /	Ovtcharova, Maier

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

T 7.262 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	1

Events					
ST 2022	2123351	Virtual training factory 4.X	3 SWS	Project (P / 🧩	Ovtcharova
WT 22/23	2123351	Virtual training factory 4.X		/ 🗣	Ovtcharova, Mitarbeiter

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

Competence Certificate
Assessment of another type (graded), procedure see webpage.

T 7.263 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	3

Events					
ST 2022	2400062	Wearable Robotic Technologies	2 SWS	Lecture / 🗣	Asfour, Beigl
ST 2022	5016643	BUT - Attractive Robot Technologies		Lecture / ⚙	Asfour

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