Karlsruher Institut für Technologie

Module Handbook
Computer Science Master 2025 (Master of Science (M.Sc.))

SPO 2025

Summer term 2025

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KIT DEPARTMENT OF INFORMATICS

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1 Introduction

The module handbook is the official guide for students regarding their academic progress and program of study. It describes the modules and the corrsponding exams. It also explains their interdependencies, for example the need to pass one module before taking another. For each module its content and the qualification goals are provided. Furthermore, the module handbook explains the means of measuring academic success, such as the type of exam or course work (in German: "Studienleistung") the students must pass. The scope of each module is indicated by credit points (CP), which are credited after the successful completion of the module. CP = ECTS (European Credit Transfer System) = Leistungspunkte in German (LP).

The course catalog (in German: "Vorlesungsverzeichnis", https://campus.studium.kit.edu/events/catalog.php) complements the module handbook and provides up-to-date information on various event data (e.g. time and place of the course) for each semester.

Every semester the module handbook is updated. The new module handbook is available about a month before the semester begins. Prior to that students can refer to the current module handbook but should expect changes, especially with elective modules.

The most important information regarding modules is:

- Are there prerequisites or other requirements for this module?
- How many credits are you awarded for the module?
- What term is the module held in? E.g. summer / winter term
- Which language is the module held in?
- Who is responsible for the module? E.g. which professor

The purpose of this introduction is to give an overview of the study program in computer science at KIT and provide additional regulations, not specified in the Study and Examination Regulations (in German Prüfungsordnung). It provides students with a more well-rounded idea of the requirements of the modules and their field of study. It also gives information on elective modules, study minors and interdisciplinary qualifications (= soft skills), helping the students to make a more personal plan of study, taking into consideration factors like the turns of the modules.

1.1 Program and Qualification Profile

The Master of Science in Computer Science continues the education and development of the scientific competences that the students have acquired during their Bachelor program of study. The Master Program of Study provides students with the knowledge and skills necessary for scientific work and research. The program stands out due to the variety and broad range of the courses. This Master Program of Study is structured to provide well-grounded and a broad based education at the same time. Students are required to take two graduate specializations. The program offers a wide variety of specializations in computer science areas including Theoretical Foundations, Algorithm Engineering, Cryptography and Security, Parallel Computing, Software Engineering and Compiler Construction, Design of Embedded Systems and Computer Architectures, Telematics, Anthropomatics and Cognitive Systems and Robotics and Automation.

The core focus of the program is the two graduate specializations. For each specialization, students have to select courses of at least 15 ECTS. For a comprehensive education the program offers a broad variety of compulsory courses. Students must also select a minor in a related interdisciplinary field (minor studies). Key competences such as social and teamwork skills are also mandatory (key competences).

Graduates of the Master of Science in Computer Science are equipped with essential skills:

- *Computer Science Competences (Core Competences)*
  Graduates are able to independently apply and enhance their scientific knowledge and methods in computer science. They can assess the relevance and consequences of different computer science methods in solving complex scientific and social problems. Graduates have the necessary skills needed to successfully solve applied as well as scientifically complex problems in the field of computer science and related interdisciplinary fields.
- *Communication Skills*
  Graduates can present and explain computer science ideas clearly and convincingly, both orally and in writing. They are able to communicate effectively to and with technical and non-technical audiences.
- *Team-work and Project Work*
  Graduates are able to work in multidisciplinary teams. They have project planning and organizing skills.
- *Commitment to Society (Commitment to the Civil Society)*
  Graduates recognize the impact of computer science in a societal context. They have the understanding of professional and ethical responsibilities and are able to act accordingly.
- *Personal and Professional Development*
  Graduates are able to adapt to the newest technologies and use their knowledge for further development.

1.2 Additional certficates within the Master's program

The KIT Department of Informatics offers eight different certificates within the Master's program. The Master Computer Science can be completed with or without a certificate. The regulations for completing a certificate are ment as guidelines for structuring the study plans, no additional effort should be necessary. The study and examination regulations for the Master's degree program apply unchanged, when students aim to achieve a certificate. Certificates are awarded at the end of the studies in addition to the Master's certificate in computer science, e.g. “Master of Computer Science with an IT Security profile”. An overview of the certificates and the associated guidelines and regulations can be found at: https://www.informatik.kit.edu/english/9378.php

1.3 Modularization of computer science studies

The Computer Science program has a structure based on modules. A module may consist of several courses or only one course. Modules themselves are classified into ten areas of specialization. The module hand book only contains those areas of specialization, that can be studied completly in english. For further areas of specialization, you may refer to the german module hand book of "Master of Science in Informatik". The structure of the Master Program of Study is:

- 2 Areas of specialization
- Elective Studies in Computer Science
- Minor Studies
- Interdisciplinary Qualifications

Further constraints students must fulfill are:

- to choose four advanced mandatory modules (in German Stammmodule, see 2.1) in their areas of specialization or their elective studies
- to choose 12 – 18 CP of practical courses and seminars (see 2.2) in their areas of specialization or their elective studies.

1.3.1 Credit points

To keep track of the students' performance, study and examination achievements are evaluated with credit points (CP = ECTS European Credit Transfer System, in German Leistunspunkte = LP). One credit point corresponds to approximately 30 hours of workload for an average student.

1.3.2 Modules and partial achievements

Modules contain one or more partial achievements and their description. Partial achievements are abstract descriptions of the examinations or of the type of course work required for passing the module. Prerequisites and recommendations are also specified for each partial achievement.

Modules and partial achievements are assigned credit points. On the one hand the credits indicate the amount of work necessary in order to pass the examinations and fullfill all requirements in a module. On the other hand, the credits usually also indicate the weight of a partial achievement in a specific module. Exceptions from this rule are specified accordingly.Details on the calculation of the module grades or of the Bachelor final grade are published on the department website: https://www.informatik.kit.edu/faq-wiki/doku.php?id=notenberechnung.

The section field of study (see section 3) in the handbook contains the structure of the master program of study and the specific modules to be chosen in each area. From there you can navigate to each module and their partial achievements. The courses are also linked to the partial achievements, making it easier to understand modules.

Modules are dynamic constructs, in which updates and changes can occur on a regular basis. Some modules are no longer offered, some partial achievements and associated courses or prerequisites change (e.g. if the type of the exam changes). The module handbook of the current semester is therefore always binding for students. If the requirements of a module change, students usually may still complete the module in the version they started with (e.g. if they already took an exam). This means, that the exams in the modules can be taken, even if the course is not being offered anymore, provided that students have already begun the module. Changes and associated rules for changing between module versions are usually announced in advance. In case of problems with the online registration for examinations, the Informatics Study Program Service (ISS) (e-mail: beratung-informatik@informatik.kit.edu) can assist. ISS should also be contacted, if a module has been started, but can no longer be completed.

The completed module will appear in the individual study plan (in German Studienablaufplan).

1.3.3 Academic levels

The Master Program of Study in Computer Science is structured for a period of two years with two semesters each. All modules have level four, i.e. master level.

1.4 Exams

Exams can be written, oral or they can be in form of an examination of another type (in German: Prüfungsleistung anderer Art). These exams are graded. Partial achievements can also be in form of ungraded course work (in German: Studienleistung). For further information, please refer to the Study and Examination Regulations (in German: Studien- und Prüfungsordnung) §4. Each partial achievement is linked to the corresponding courses (exercise, lecture, seminar, practical course etc.) and the exam event (in German Prüfungsveranstaltung, see next section).

1.4.1 Registration for / withdraw from exams and repetition of exams

Registration and withdraw (or sometimes de-registration, in German: Abmeldung) from exams or course works take place in the Campus-Management Portal (CMS https://campus.studium.kit.edu). Deadlines on registration and withdraw are provided on the website of the course and in CMS. Most courses use the ILIAS E-Learning-Platform at KIT for posting and exchanging information (https://www.zml.kit.edu/lms-ilias.php).

In order to register for an exam (or course work) students have to access the exam event (in German Prüfungsveranstaltung). Students must ensure that they first select the module and the partial achievement in their individual study plan in CMS. An exam event specifies not only the time and place when and where an exam takes place, but also provides students with further information regarding the exam or course work as well as deadlines.

Students are encouraged to verify that they are actually registered for the exam or course work and that the status is registered (in German: angemeldet). If there are concerns regarding the registration, students should contact the ISS (e-mail: beratung-informatik@informatik.kit.edu). Participating in exams without registration is not permitted! Further information regarding registration and withdrwal can be found in https://www.informatik.kit.edu/faq-wiki/doku.php?id=start

Each exam (oral, written or of another type) can usually be repeated once. In the case of a written exam, after failing twice, an oral re-examination takes place promptly (usually in the same examination period). This exam can only be “passed” (4.0) or “not passed” (5.0). If an exam is not passed after the re-examination, students lose their right to study computer science. Participation in further exams is not permitted. There is the possibility to request a second re-examination, which has to be approved by the examination board. If the request is approved, further exams can be taken. However, students will not receive the credits for these exams, until the failed exam has been passed in the second re-examination. The second re-examination consists in the participation in a written exam and if this exam is not passed either, in the participation in a further oral re-examination. If the second re-examination is failed, the credits passed in between are discarded.

Course work can be repeated until they are being passed, if no further regulations are provided in the module handbook.

1.5 Student advising

The Department of Informatics at KIT offers help with questions regarding studies, applications or student organization through the Informatics Study Program Services (ISS) (e-mail: beratung-informatik@informatik.kit.edu). ISS is an official service and provides official information.

The student representative body for informatics (Fachschaft Mathe-Info, FSMI) also gives helpful and in some cases more tailored advice. They offer assistance with queries and give advice regarding your studies.

2 Structure of the Master Program of Study

To complete the masters' degree in computer science students need to complete 120 CP. The credits are mostly achieved through taking different modules but also through the master thesis (30 CP). Students are allowed to exceed the maximum of 120 CP by one single module. Credits should be spread out evenly over all semesters.

The table in Figure 1 contains an overview of the Master Program of Study.

Sem. / Area	Area of Specialization I min. 15 CP	Area of Specialization II min. 15 CP	Elective Studies max. 49 CP	Minor Studies 9 – 18 CP	Key Competences 2 – 6 CP
1	Advanced Mandatory Module I	Advanced Mandatory Module II Advanced Mandatory Module IV	Advanced Mandatory Module III	Electrical Engineering/ Mathematics/ Mechanical Engineering/ Economics	General Studies / Language Courses / Soft Skills
2	Seminars (min. 3 CP) + Practical Courses (min. 6 CP) = in total min. 12 CP / max. 18 CP				
3	min. 10 CP Lecture modules	min. 10 CP Lecture modules	Elective modules		
4	Master Thesis 30 CP				

Figure 1: Structure of the Master Program of Study

During the studies at least four advanced mandatory modules (with 6 CP each) must be completed. They can be chosen in one of the specialization areas or in the elective studies area.

There are ten areas of specializations in English. This module handbook only features ten areas of specialization that can be studied completely in English. Further two specialization: Cryptography and System Architecture can be chosen by students with sufficient German language skills.

Students must choose two specilization areas. In each area of specialization students must choose modules of at least 15 CP. 10 CP must be of modules containing lectures. The advanced mandatory modules cannot be chosen to achieve 10 CP on lectures. In the specialization areas Telematics and System Architecture only 8 CP of module containing lectures are required.

A total of overall 73 CP in both specialization areas can not be exceeded.

Once exams have been taken in a specialization area, this specialization area is set. A change of the specialization area is possible with the permission of the examination board. For that students have to fill in a form (for details see https://www.informatik.kit.edu/faq-wiki/doku.php?id=start) and submit it to ISS via E-mail (berating-informatik@informatik.kit.edu). In the section 3 the list of modules for each specialization is listed.

This module handbook contains only modules in Englisch. **Students may choose a maximum of 30 CP of the 120 CP in German, if they have the necessary language skills.** The geman module handbook should be consulted, in order to know which german modules can be chosen in which areas (spcialization, elective studies etc.) and their specific regulations regarding the exams.

2.1 Advanced mandatory modules (in German Stammmodule)

Advanced mandatory modules cover important basic themes in computer science. They assure, that students have a broad education and prepare them for the area of specialization. They are offered once each year. This cannot be guaranteed for other elective modules. Students may also choose advanced mandatory modules in German as part of the four advanced mandatory modules.

Students must take four advanced mandatory modules in their master studies. Advanced mandatory modules, that have been completed during the bachelor studies, cannot be repeated during master studies. The table in Figure 2 provides the list of advanced mandatory modules.

The advanced mandatory modules can be taken either in one of the specialization areas or in the elective studies area.

	Advanced mandatory modules	CP	Winter / Summer term
M-INFO-106299	Advanced Artificial Intelligence	6	Summer term
M-INFO-101173	Algorithms II	6	Winter term
M-INFO-100818	Computer Architecture	6	Summer term
M-INFO-100856	Computer Graphics	6	Winter term
M-INFO-100799	Formal Systems	6	Winter term
M-INFO-100729	Human Computer Interaction	6	Summer term
M-INFO-106315	IT Security	6	Winter term
M-INFO-100893	Robotics I- Introduction to Robotics	6	Winter term
M-INFO-100833	Software Engineering II	6	Summer term
M-INFO-100801	Telematics	6	Winter term

Figure 2: List of advanced mandatory modules

2.2 Seminars and practical courses in computer science

Students have to take at least 3 CP in seminars. They also have to take at least 6 CP in practical courses. A minimum of 12 CP of seminars and practical courses must be achieved in total. A maximum of 18 CP of seminars and practical courses is permitted.

Seminars and practical courses in minor studies are not subject to these constraints. These constraints regard only seminars and practical courses to be chosen in the areas of specialization and elective studies.

2.3 Elective Studies in computer science

Elective modules are not necessarily offered regularly. The current ones can be found in section 3. All modules of all specialization areas can be chosen in the elective studies area. A maximum of 49 CP is permitted (120 CP minus the minimum of credit points to be achieved in the specialization areas, the minor studies, interdisciplinary qualifications and the master thesis).

2.4 Minor Studies

To give the students a broader education, minor studies provide knowledge of an adjacent field of study. Students must choose at least 9 CP and a maximum of 18 CP. Additional credits will be discarded. Minor Studies have a significant importance for the future career, to have learned of other fields outside of the computer science core. The minor modules are listed in section 3. Some minor studies have only one module, others consist of several. Students can only choose one minor subject.

Students may also choose an individual compiled list of modules for their minor. The constraints can be read in the FAQ: https://www.informatik.kit.edu/faq-wiki/doku.php?id=ergaenzungsfach.

2.5 Interdisciplinary Qualifications

Another part of the studies are the interdisciplinary qualifications (2 – 6 CP). This area includes key competences and soft skills on social topics, interdisciplinary academic topics as well as foreign languages.

All courses from the House of Competence (HoC), FORUM Science and Society (except computer science or minor studies courses) and from the Language Center (SpZ), but also special courses of the informatics department, can be validated in this area. The courses are not listed in the module handbook, but can be found on the webpages of these institutions.

These qualifications are not graded. Although some exams are graded and the partial achievement may also be listed in the individual study plan with a grade, the interdisciplinary qualifications can only be passed/failed, so these grades does no contribute to the overall grade of the Master program.

Participation certificats (in German: Teilnahmebescheinigungen) cannot not be validated as interdisciplinary qualifications. An exam or coursework must be done.

2.6 Additional modules (in German: Zusatzleistungen)

During the master studies, students may take additional courses (max. 30 CP). These achievements are not included in the overall grade. If the corresponding partial achievements cannot be selected in the individual study plan, students should contact ISS.

3 Field of study structure

Election notes
Please note that two specialization subjects and one minor subject must be taken in the Master's program. You can select these in your study plan when clicking on the elective button "Select areas" next to the study program identifier Informatics / Computer Science Master 2025.

Mandatory	
Master‘s Thesis	30 CR
Areas of Specialization (Election: 2 items)	
Area of Specialization: Algorithm Engineering	15-73 CR
Area of Specialization: Cryptography and Security	15-73 CR
Area of Specialization: Data Science	15-73 CR
Area of Specialization: Design of Embedded Systems and Computer Architectures	15-73 CR
Area of Specialization: Human-centred Machine Intelligence	15-73 CR
Area of Specialization: Robotics and Automation	15-73 CR
Area of Specialization: Software Engineering and Compiler Construction	15-73 CR
Area of Specialization: Telematics	15-73 CR
Area of Specialization: Theoretical Foundations	15-73 CR
Mandatory	
Elective Studies in Informatics	6-49 CR
Minor Studies (Election: 1 item)	
Minor Studies: Electrical Engineering	9-18 CR
Minor Studies: Mathematics	9-18 CR
Minor Studies: Economics	9-18 CR
Minor Studies: Law	9-18 CR
Mandatory	
Interdisciplinary Qualifications	2-6 CR

3.1 Master‘s Thesis

Credits
30

Mandatory		
M-INFO-106828	Module Master's Thesis	30 CR

3.2 Area of Specialization: Algorithm Engineering

Credits
15-73

Specialization Coordinator: Prof. P. Sanders

Election notes
Students must choose at least 10 CP of lectures (no practical courses, no seminars, no advanced mandatory courses). In total students must choose at least 15 CP in each specialization.

Elective Modules: Algorithm Engineering (Election: between 15 and 73 credits)		
M-INFO-107200	Advanced Data Structures	5 CR
M-INFO-100795	Algorithm Engineering	5 CR
M-INFO-106960	Algorithmic Graph Theory	5 CR
M-INFO-106961	Algorithms for Visualization of Graphs	5 CR
M-INFO-107201	Algorithms II	6 CR
M-INFO-104447	Automated Planning and Scheduling	5 CR
M-INFO-107228	Computational Geometry	6 CR
M-INFO-106644	Fine-Grained Complexity Theory & Algorithms	6 CR
M-INFO-107211	Graph Partitioning and Graph Clustering in Theory and Practice	5 CR
M-INFO-101573	Hands-on Bioinformatics Practical	3 CR
M-INFO-100749	Introduction to Bioinformatics for Computer Scientists	3 CR
M-INFO-107203	Practical Course: Efficient Parallel C++	6 CR
M-INFO-107199	Parallel Algorithms	5 CR
M-INFO-107167	Parameterized Algorithms	6 CR
M-INFO-106784	Practical Course: Fine-grained Algorithm Design and Engineering	6 CR
M-INFO-107168	Probability and Computing	5 CR
M-INFO-107209	Seminar: Advanced Topics on SAT Solving	3 CR
M-INFO-106086	Seminar: Algorithm Engineering	4 CR
M-INFO-107027	Seminar: Current Trends in Theoretical Computer Science	4 CR
M-INFO-106645	Seminar: Fine-Grained Complexity Theory & Algorithms	4 CR
M-INFO-100750	Seminar: Hot Topics in Bioinformatics	3 CR
M-INFO-107172	Seminar: Recent Highlights in Algorithms	4 CR
M-INFO-107202	Text Indexing	5 CR
M-INFO-107264	Seminar: Practical Graph Algorithms	4 CR

3.3 Area of Specialization: Cryptography and Security

Credits
15-73

Specialization Coordinator: Prof. J. Müller-Quade

Election notes
Students must choose at least 10 CP of lectures (no practical courses, no seminars, no advanced mandatory courses). In total students must choose at least 15 CP in each specialization.

Elective Modules: Cryptography and Security (Election: between 15 and 73 credits)		
M-INFO-106303	Access Control Systems: Models and Technology	5 CR
M-INFO-106810	Artificial Intelligence & IT-Security	6 CR
M-INFO-105334	Decentralized Systems: Fundamentals, Modeling, and Applications	6 CR
M-INFO-106998	IT Security	6 CR
M-INFO-106996	Practical Course: Application Security	4 CR
M-INFO-106867	Practical Course: Artificial Intelligence & Security Lab (AISEC-Lab)	4 CR
M-INFO-106627	Practical Course: Real-world Vulnerability Discovery and Exploits	4 CR
M-INFO-105453	Practical Course: Security, Usability and Society	4 CR
M-INFO-107241	Practical Introduction to Hardware Security	6 CR
M-INFO-105452	Privacy Enhancing Technologies	6 CR
M-INFO-106654	Research Focus Class: Blockchain & Cryptocurrencies	6 CR
M-INFO-106866	Research Practical Course: Artificial Intelligence & Security	6 CR
M-INFO-105591	Resilient Networking	6 CR
M-INFO-105780	Scientific Methods to Design and Analyze Secure Decentralized Systems	5 CR
M-INFO-107242	Seminar in Privacy	4 CR
M-INFO-106868	Seminar: Hot Topics in Artificial Intelligence & Security 1	4 CR
M-INFO-106869	Seminar: Hot Topics in Artificial Intelligence & Security 2	4 CR
M-INFO-104891	Seminar: Hot Topics in Decentralized Systems	3 CR
M-INFO-106392	Seminar: Hot Topics in Explainable Artificial Intelligence (XAI)	4 CR
M-INFO-105585	Seminar: Post-Quantum Cryptography	3 CR
M-INFO-107216	Seminar: Privacy and Security	4 CR
M-INFO-105408	Seminar: Quantum Information Theory	3 CR
M-INFO-105761	Seminar: Secure Multiparty Computation	3 CR
M-INFO-106344	Software Security Engineering	3 CR

3.4 Area of Specialization: Data Science

Credits
15-73

Specialization Coordinators: Prof. K. Böhm, Prof. G. Neumann

Election notes
Students must choose at least 10 CP of lectures (no practical courses, no seminars, no advanced mandatory courses). In total students must choose at least 15 CP in each specialization.

Elective Modules: Data Science (Election: between 15 and 73 credits)		
M-INFO-106812	Advanced Bayesian Data Analysis	5 CR
M-INFO-106655	Data Science and Artificial Intelligence for Energy Systems	6 CR
M-INFO-106959	Machine Learning for Natural Sciences	6 CR
M-INFO-106470	Machine Learning in Climate and Environmental Sciences	6 CR

3.5 Area of Specialization: Design of Embedded Systems and Computer Architectures

Credits
15-73

Specialization Coordinators: Prof. J. Henkel, Prof. W. Karl

Election notes
Students must choose at least 10 CP of lectures (no practical courses, no seminars, no advanced mandatory courses). In total students must choose at least 15 CP in each specialization.

Elective Modules: Design of Embedded Systems and Computer Architectures (Election: between 15 and 73 credits)		
M-INFO-107230	Design and Architectures of Embedded Systems (ESII)	3 CR
M-INFO-105775	Embedded Machine Learning Lab	4 CR
M-INFO-100807	Low Power Design	3 CR
M-INFO-107229	Optimization and Synthesis of Embedded Systems (ESI)	3 CR
M-INFO-103706	Practical Course: Internet of Things (IoT)	4 CR
M-INFO-107265	Practical Course: Chip Design I	3 CR
M-INFO-107266	Practical Course: Chip Design II	3 CR
M-INFO-102570	Practical Course: Digital Design & Test Automation Flow	3 CR
M-INFO-102661	Practical Course: FPGA Programming	3 CR
M-INFO-104031	Practical Course: Low Power Design and Embedded Systems	4 CR
M-INFO-107241	Practical Introduction to Hardware Security	6 CR
M-INFO-100850	Reliable Computing I	3 CR
M-INFO-102662	Seminar Dependable Computing	3 CR
M-INFO-102663	Seminar Near Threshold Computing	3 CR
M-INFO-102961	Seminar Non-volatile Memory Technologies	3 CR
M-INFO-107231	Seminar: Embedded Systems I	3 CR
M-INFO-107232	Seminar: Embedded Systems II	3 CR
M-INFO-100851	Testing Digital Systems I	3 CR
M-INFO-102962	Testing Digital Systems II	3 CR

3.6 Area of Specialization: Human-centred Machine Intelligence

Credits
15-73

Specialization Coordinator: Prof. R. Stiefelhagen

Election notes
Students must choose at least 10 CP of lectures (no practical courses, no seminars, no advanced mandatory courses). In total students must choose at least 15 CP in each specialization.

Elective Modules: Human-centred Machine Intelligence (Election: between 15 and 73 credits)		
M-INFO-107198	Advanced Artificial Intelligence	6 CR
M-INFO-106810	Artificial Intelligence & IT-Security	6 CR
M-INFO-106655	Data Science and Artificial Intelligence for Energy Systems	6 CR
M-INFO-107197	Deep Learning and Neural Networks	6 CR
M-INFO-105775	Embedded Machine Learning Lab	4 CR
M-INFO-106302	Explainable Artificial Intelligence	3 CR
M-INFO-106237	Geometric Deep Learning	3 CR
M-INFO-106650	HRI and Social Robotics	6 CR
M-INFO-107166	Human Computer Interaction	6 CR
M-INFO-106649	Humanoid Robots - Locomotion and Whole-Body Control	6 CR
M-INFO-107152	Humanoid Robots - Seminar	3 CR
M-INFO-107176	Lab Project: Speech Translation	6 CR
M-INFO-107169	Machine Learning - Foundations and Algorithms	6 CR
M-INFO-106959	Machine Learning for Natural Sciences	6 CR
M-INFO-106470	Machine Learning in Climate and Environmental Sciences	6 CR
M-INFO-102555	Motion in Human and Machine - Seminar	3 CR
M-INFO-107177	Practical Course: Natural Language Dialog Systems	6 CR
M-INFO-107178	Natural Language Processing	6 CR
M-INFO-105329	Optimization Methods for Machine Learning and Engineering	5 CR
M-INFO-107170	Participatory Technology Design	6 CR
M-INFO-106867	Practical Course: Artificial Intelligence & Security Lab (AISEC-Lab)	4 CR
M-INFO-106648	Practical Course: Movement and Technology	6 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-INFO-106866	Research Practical Course: Artificial Intelligence & Security	6 CR
M-INFO-106300	Research Practical Course: Interactive Learning	6 CR
M-INFO-107174	Research Project Deep Learning for Robotics	6 CR
M-INFO-107163	Research Project: Generative AI for Autonomous Agents	6 CR
M-INFO-107155	Robotics - Practical Course	6 CR
M-INFO-107123	Robotics II - Humanoid Robotics	3 CR
M-INFO-107090	Sampling Methods for Machine Learning	6 CR
M-INFO-102725	Seminar Advanced Topics in Machine Translation	3 CR
M-INFO-106490	Seminar: Artificial Intelligence for Energy Systems	4 CR
M-INFO-106958	Seminar: Critical Topics in AI	3 CR
M-INFO-107175	Seminar: Deep Learning for Robotics	3 CR
M-INFO-106651	Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society	3 CR
M-INFO-106868	Seminar: Hot Topics in Artificial Intelligence & Security 1	4 CR
M-INFO-106869	Seminar: Hot Topics in Artificial Intelligence & Security 2	4 CR
M-INFO-106392	Seminar: Hot Topics in Explainable Artificial Intelligence (XAI)	4 CR
M-INFO-106498	Seminar: Human-Robot Interaction	3 CR
M-INFO-106301	Seminar: Interactive Learning	3 CR
M-INFO-107217	Seminar: Interpretability and Causality in Machine Learning	3 CR
M-INFO-106719	Seminar: Machine Learning in Climate and Environmental Sciences	3 CR
M-INFO-106284	Seminar: Recent Topics of Machine Learning in Materials Science and Chemistry	3 CR
M-INFO-107179	Seminar: Speech-to-Speech Translation	3 CR
M-INFO-107113	Wearable Robotic Technologies	4 CR

3.7 Area of Specialization: Robotics and Automation

Credits 15-73

Specialization Coordinator: Prof. T. Asfour

Election notes
Students must choose at least 10 CP of lectures (no practical courses, no seminars, no advanced mandatory courses). In total students must choose at least 15 CP in each specialization.

Elective Modules: Robotics and Automation (Election: between 15 and 73 credits)		
M-INFO-106608	Autonomous Learning for Intelligent Robot Perception	4 CR
M-INFO-106190	Computational Imaging	5 CR
M-INFO-106650	HRI and Social Robotics	6 CR
M-INFO-106649	Humanoid Robots - Locomotion and Whole-Body Control	6 CR
M-INFO-107152	Humanoid Robots - Seminar	3 CR
M-INFO-106959	Machine Learning for Natural Sciences	6 CR
M-INFO-106648	Practical Course: Movement and Technology	6 CR
M-INFO-107174	Research Project Deep Learning for Robotics	6 CR
M-INFO-107155	Robotics - Practical Course	6 CR
M-INFO-107162	Robotics I - Introduction to Robotics	6 CR
M-INFO-107123	Robotics II - Humanoid Robotics	3 CR
M-INFO-107130	Robotics III - Sensors and Perception in Robotics	3 CR
M-INFO-107090	Sampling Methods for Machine Learning	6 CR
M-INFO-107175	Seminar: Deep Learning for Robotics	3 CR
M-INFO-106651	Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society	3 CR
M-INFO-106498	Seminar: Human-Robot Interaction	3 CR
M-INFO-106284	Seminar: Recent Topics of Machine Learning in Materials Science and Chemistry	3 CR
M-INFO-107113	Wearable Robotic Technologies	4 CR

3.8 Area of Specialization: Software Engineering and Compiler Construction

Credits 15-73

Specialization Coordinators: Prof. A. Koziolek, Prof. R. Reussner

Election notes
Students must choose at least 10 CP of lectures (no practical courses, no seminars, no advanced mandatory courses). In total students must choose at least 15 CP in each specialization.

Elective Modules: Software Engineering and Compiler Construction (Election: between 15 and 73 credits)		
M-INFO-106966	Compiler Design	9 CR
M-INFO-106626	Engineering Self-Adaptive Systems	3 CR
M-INFO-107203	Practical Course: Efficient Parallel C++	6 CR
M-INFO-106102	Logical Foundations of Cyber-Physical Systems	6 CR
M-INFO-106931	Model-Driven Software Development	3 CR
M-INFO-106932	Practical Course: Model-Driven Software Development	6 CR
M-INFO-106512	Seminar: Applications and Extensions of Timed Systems	4 CR
M-INFO-105309	Seminar: Continuous Software Engineering	4 CR
M-INFO-107236	Seminar: Software Architecture, Security and Privacy	4 CR
M-INFO-107237	Software Architecture and Quality	3 CR
M-INFO-107235	Software Engineering II	6 CR
M-INFO-107212	Software Product Line Engineering	3 CR
M-INFO-106344	Software Security Engineering	3 CR
M-INFO-107239	Software Test and Quality Management (SQM)	5 CR
M-INFO-106293	Timed Systems	6 CR

3.9 Area of Specialization: Telematics

Credits
15-73

Specialization Coordinators: Prof. S. Abeck, Prof. H. Hartenstein, Prof. M. Ziterbart

Election notes
Students must choose at least 8 CP of lectures (no practical courses, no seminars, no advanced mandatory courses). In total students must choose at least 15 CP in each specialization.

Elective Modules: Telematics (Election: between 15 and 73 credits)		
M-INFO-106303	Access Control Systems: Models and Technology	5 CR
M-INFO-106655	Data Science and Artificial Intelligence for Energy Systems	6 CR
M-INFO-105334	Decentralized Systems: Fundamentals, Modeling, and Applications	6 CR
M-INFO-107215	Distributed Computing	4 CR
M-INFO-107244	Practical Course on Network Security Research	3 CR
M-INFO-107166	Human Computer Interaction	6 CR
M-INFO-100800	Internet of Everything	4 CR
M-INFO-107245	Mobile Communication	4 CR
M-INFO-107218	Network Security: Architectures and Protocols	4 CR
M-INFO-100784	Next Generation Internet	4 CR
M-INFO-107220	Practical Course on Telematics Research	3 CR
M-INFO-105870	Practical Course: Advanced Topics in High Performance Computing, Data Management and Analytics	6 CR
M-INFO-105453	Practical Course: Security, Usability and Society	4 CR
M-INFO-105955	Practical Course: Smart Energy System	6 CR
M-INFO-107221	Practical Course: Software Defined Networking	6 CR
M-INFO-105452	Privacy Enhancing Technologies	6 CR
M-INFO-106654	Research Focus Class: Blockchain & Cryptocurrencies	6 CR
M-INFO-105591	Resilient Networking	6 CR
M-INFO-105780	Scientific Methods to Design and Analyze Secure Decentralized Systems	5 CR
M-INFO-106490	Seminar: Artificial Intelligence for Energy Systems	4 CR
M-INFO-104891	Seminar: Hot Topics in Decentralized Systems	3 CR
M-INFO-107243	Telematics	6 CR
M-INFO-107161	Ubiquitous Computing	5 CR

3.10 Area of Specialization: Theoretical Foundations

Credits
15-73

Specialization Coordinators: Prof. B. Beckert, Prof. P. Sanders

Election notes
Students must choose at least 10 CP of lectures (no practical courses, no seminars, no advanced mandatory courses). In total students must choose at least 15 CP in each specialization.

Elective Modules: Theoretical Foundations (Election: between 15 and 73 credits)		
M-INFO-107200	Advanced Data Structures	5 CR
M-INFO-106960	Algorithmic Graph Theory	5 CR
M-INFO-106961	Algorithms for Visualization of Graphs	5 CR
M-INFO-107201	Algorithms II	6 CR
M-INFO-104447	Automated Planning and Scheduling	5 CR
M-INFO-107228	Computational Geometry	6 CR
M-INFO-106256	Constructive Logic	5 CR
M-INFO-106644	Fine-Grained Complexity Theory & Algorithms	6 CR
M-INFO-107211	Graph Partitioning and Graph Clustering in Theory and Practice	5 CR
M-INFO-106102	Logical Foundations of Cyber-Physical Systems	6 CR
M-INFO-107167	Parameterized Algorithms	6 CR
M-INFO-106784	Practical Course: Fine-grained Algorithm Design and Engineering	6 CR
M-INFO-107238	Practical SAT Solving	5 CR
M-INFO-107168	Probability and Computing	5 CR
M-INFO-107209	Seminar: Advanced Topics on SAT Solving	3 CR
M-INFO-106086	Seminar: Algorithm Engineering	4 CR
M-INFO-106512	Seminar: Applications and Extensions of Timed Systems	4 CR
M-INFO-107027	Seminar: Current Trends in Theoretical Computer Science	4 CR
M-INFO-106645	Seminar: Fine-Grained Complexity Theory & Algorithms	4 CR
M-INFO-103306	Seminar: Proofs from THE BOOK	3 CR
M-INFO-107172	Seminar: Recent Highlights in Algorithms	4 CR
M-INFO-105330	Seminar: Scalable Parallel Graph Algorithms	4 CR
M-INFO-106293	Timed Systems	6 CR

3.11 Elective Studies in Informatics

Credits
6-49

Elective Studies (Election: between 6 and 49 credits)		
M-INFO-106303	Access Control Systems: Models and Technology	5 CR
M-INFO-107198	Advanced Artificial Intelligence	6 CR
M-INFO-107200	Advanced Data Structures	5 CR
M-INFO-100795	Algorithm Engineering	5 CR
M-INFO-106960	Algorithmic Graph Theory	5 CR
M-INFO-106961	Algorithms for Visualization of Graphs	5 CR
M-INFO-107201	Algorithms II	6 CR
M-INFO-106810	Artificial Intelligence & IT-Security	6 CR
M-INFO-104447	Automated Planning and Scheduling	5 CR
M-INFO-106608	Autonomous Learning for Intelligent Robot Perception	4 CR
M-INFO-106966	Compiler Design	9 CR
M-INFO-107228	Computational Geometry	6 CR
M-INFO-106190	Computational Imaging	5 CR
M-INFO-106256	Constructive Logic	5 CR
M-INFO-106655	Data Science and Artificial Intelligence for Energy Systems	6 CR
M-INFO-105334	Decentralized Systems: Fundamentals, Modeling, and Applications	6 CR
M-INFO-107197	Deep Learning and Neural Networks	6 CR
M-INFO-107230	Design and Architectures of Embedded Systems (ESII)	3 CR
M-INFO-107215	Distributed Computing	4 CR
M-INFO-107234	Edge-AI in Software and Sensor Applications	3 CR
M-INFO-105775	Embedded Machine Learning Lab	4 CR
M-INFO-106626	Engineering Self-Adaptive Systems	3 CR
M-INFO-106302	Explainable Artificial Intelligence	3 CR
M-INFO-106644	Fine-Grained Complexity Theory & Algorithms	6 CR
M-INFO-106237	Geometric Deep Learning	3 CR
M-INFO-107211	Graph Partitioning and Graph Clustering in Theory and Practice	5 CR
M-INFO-106650	HRI and Social Robotics	6 CR
M-INFO-107166	Human Computer Interaction	6 CR
M-INFO-106649	Humanoid Robots - Locomotion and Whole-Body Control	6 CR
M-INFO-107152	Humanoid Robots - Seminar	3 CR
M-INFO-100800	Internet of Everything	4 CR
M-INFO-100749	Introduction to Bioinformatics for Computer Scientists	3 CR
M-INFO-106998	IT Security	6 CR
M-INFO-107176	Lab Project: Speech Translation	6 CR
M-INFO-106102	Logical Foundations of Cyber-Physical Systems	6 CR
M-INFO-100807	Low Power Design	3 CR
M-INFO-107169	Machine Learning - Foundations and Algorithms	6 CR
M-INFO-106959	Machine Learning for Natural Sciences	6 CR
M-INFO-106470	Machine Learning in Climate and Environmental Sciences	6 CR
M-INFO-107245	Mobile Communication	4 CR
M-INFO-106931	Model-Driven Software Development	3 CR
M-INFO-107178	Natural Language Processing	6 CR
M-INFO-107233	Natural Language Processing and Software Engineering	3 CR
M-INFO-107218	Network Security: Architectures and Protocols	4 CR
M-INFO-100784	Next Generation Internet	4 CR
M-INFO-107229	Optimization and Synthesis of Embedded Systems (ESI)	3 CR
M-INFO-105329	Optimization Methods for Machine Learning and Engineering	5 CR
M-INFO-107199	Parallel Algorithms	5 CR
M-INFO-107167	Parameterized Algorithms	6 CR
M-INFO-107170	Participatory Technology Design	6 CR
M-INFO-107244	Practical Course on Network Security Research	3 CR

M-INFO-107220	Practical Course on Telematics Research	3 CR
M-INFO-103706	Practical Course: Internet of Things (IoT)	4 CR
M-INFO-105870	Practical Course: Advanced Topics in High Performance Computing, Data Management and Analytics	6 CR
M-INFO-106800	Practical Course: AI for Climate and Weather Predictions	6 CR
M-INFO-106996	Practical Course: Application Security	4 CR
M-INFO-106867	Practical Course: Artificial Intelligence & Security Lab (AISEC-Lab)	4 CR
M-INFO-107265	Practical Course: Chip Design I	3 CR
M-INFO-107266	Practical Course: Chip Design II	3 CR
M-INFO-102570	Practical Course: Digital Design & Test Automation Flow	3 CR
M-INFO-107203	Practical Course: Efficient Parallel C++	6 CR
M-INFO-106784	Practical Course: Fine-grained Algorithm Design and Engineering	6 CR
M-INFO-102661	Practical Course: FPGA Programming	3 CR
M-INFO-100724	Practical Course: General-Purpose Computation on Graphics Processing Units	3 CR
M-INFO-104031	Practical Course: Low Power Design and Embedded Systems	4 CR
M-INFO-106932	Practical Course: Model-Driven Software Development	6 CR
M-INFO-106648	Practical Course: Movement and Technology	6 CR
M-INFO-107177	Practical Course: Natural Language Dialog Systems	6 CR
M-INFO-106627	Practical Course: Real-world Vulnerability Discovery and Exploits	4 CR
M-INFO-105453	Practical Course: Security, Usability and Society	4 CR
M-INFO-105955	Practical Course: Smart Energy System	6 CR
M-INFO-107221	Practical Course: Software Defined Networking	6 CR
M-INFO-101567	Practical Course: Visual Computing	6 CR
M-INFO-107241	Practical Introduction to Hardware Security	6 CR
M-INFO-107238	Practical SAT Solving	5 CR
M-INFO-105452	Privacy Enhancing Technologies	6 CR
M-INFO-107168	Probability and Computing	5 CR
M-INFO-105623	Reinforcement Learning	6 CR
M-INFO-100850	Reliable Computing I	3 CR
M-INFO-106654	Research Focus Class: Blockchain & Cryptocurrencies	6 CR
M-INFO-106866	Research Practical Course: Artificial Intelligence & Security	6 CR
M-INFO-106300	Research Practical Course: Interactive Learning	6 CR
M-INFO-107174	Research Project Deep Learning for Robotics	6 CR
M-INFO-107163	Research Project: Generative AI for Autonomous Agents	6 CR
M-INFO-105591	Resilient Networking	6 CR
M-INFO-107155	Robotics - Practical Course	6 CR
M-INFO-107162	Robotics I - Introduction to Robotics	6 CR
M-INFO-107123	Robotics II - Humanoid Robotics	3 CR
M-INFO-107130	Robotics III - Sensors and Perception in Robotics	3 CR
M-INFO-107090	Sampling Methods for Machine Learning	6 CR
M-INFO-105780	Scientific Methods to Design and Analyze Secure Decentralized Systems	5 CR
M-INFO-102725	Seminar Advanced Topics in Machine Translation	3 CR
M-INFO-102662	Seminar Dependable Computing	3 CR
M-INFO-107242	Seminar in Privacy	4 CR
M-INFO-102663	Seminar Near Threshold Computing	3 CR
M-INFO-102961	Seminar Non-volatile Memory Technologies	3 CR
M-INFO-107209	Seminar: Advanced Topics on SAT Solving	3 CR
M-INFO-106086	Seminar: Algorithm Engineering	4 CR
M-INFO-106512	Seminar: Applications and Extensions of Timed Systems	4 CR
M-INFO-106490	Seminar: Artificial Intelligence for Energy Systems	4 CR
M-INFO-105309	Seminar: Continuous Software Engineering	4 CR
M-INFO-106958	Seminar: Critical Topics in AI	3 CR

M-INFO-107027	Seminar: Current Trends in Theoretical Computer Science	4 CR
M-INFO-107175	Seminar: Deep Learning for Robotics	3 CR
M-INFO-107231	Seminar: Embedded Systems I	3 CR
M-INFO-107232	Seminar: Embedded Systems II	3 CR
M-INFO-106651	Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society	3 CR
M-INFO-106645	Seminar: Fine-Grained Complexity Theory & Algorithms	4 CR
M-INFO-106868	Seminar: Hot Topics in Artificial Intelligence & Security 1	4 CR
M-INFO-106869	Seminar: Hot Topics in Artificial Intelligence & Security 2	4 CR
M-INFO-100750	Seminar: Hot Topics in Bioinformatics	3 CR
M-INFO-104891	Seminar: Hot Topics in Decentralized Systems	3 CR
M-INFO-106392	Seminar: Hot Topics in Explainable Artificial Intelligence (XAI)	4 CR
M-INFO-106498	Seminar: Human-Robot Interaction	3 CR
M-INFO-106301	Seminar: Interactive Learning	3 CR
M-INFO-107217	Seminar: Interpretability and Causality in Machine Learning	3 CR
M-INFO-106719	Seminar: Machine Learning in Climate and Environmental Sciences	3 CR
M-INFO-107205	Seminar: Operating Systems	3 CR
M-INFO-105585	Seminar: Post-Quantum Cryptography	3 CR
M-INFO-107264	Seminar: Practical Graph Algorithms	4 CR
M-INFO-107216	Seminar: Privacy and Security	4 CR
M-INFO-103306	Seminar: Proofs from THE BOOK	3 CR
M-INFO-105408	Seminar: Quantum Information Theory	3 CR
M-INFO-107172	Seminar: Recent Highlights in Algorithms	4 CR
M-INFO-105330	Seminar: Scalable Parallel Graph Algorithms	4 CR
M-INFO-105761	Seminar: Secure Multiparty Computation	3 CR
M-INFO-107236	Seminar: Software Architecture, Security and Privacy	4 CR
M-INFO-107179	Seminar: Speech-to-Speech Translation	3 CR
M-INFO-107237	Software Architecture and Quality	3 CR
M-INFO-107235	Software Engineering II	6 CR
M-INFO-107212	Software Product Line Engineering	3 CR
M-INFO-106344	Software Security Engineering	3 CR
M-INFO-100719	Software-Evolution	3 CR
M-INFO-107239	Software Test and Quality Management (SQM)	5 CR
M-INFO-107243	Telematics	6 CR
M-INFO-100851	Testing Digital Systems I	3 CR
M-INFO-102962	Testing Digital Systems II	3 CR
M-INFO-107202	Text Indexing	5 CR
M-INFO-106293	Timed Systems	6 CR
M-INFO-107161	Ubiquitous Computing	5 CR
M-INFO-107113	Wearable Robotic Technologies	4 CR

3.12 Minor Studies: Electrical Engineering

Credits
9-18

Elective Modules (Election: between 9 and 18 credits)		
M-ETIT-105616	Channel Coding: Algebraic Methods for Communications and Storage	3 CR
M-ETIT-105617	Channel Coding: Graph-Based Codes	6 CR
M-ETIT-100449	Hardware Modeling and Simulation	4 CR
M-ETIT-106963	Hardware Synthesis and Optimization	6 CR
M-ETIT-105971	Mobile Communications	4 CR
M-ETIT-105604	Nano- and Quantum Electronics	6 CR
M-ETIT-100456	Optical Engineering	4 CR
M-ETIT-105073	Student Innovation Lab	15 CR
M-ETIT-100537	Systems and Software Engineering	5 CR
M-ETIT-100462	Systems Engineering for Automotive Electronics	4 CR

3.13 Minor Studies: Mathematics

Credits
9-18

Elective Modules (Election: between 9 and 18 credits)		
M-MATH-101336	Graph Theory	9 CR
M-MATH-102950	Combinatorics	9 CR
M-MATH-106957	Modern Methods in Combinatorics	6 CR

3.14 Minor Studies: Economics

Credits
9-18

Elective Modules (Election: between 9 and 18 credits)		
M-WIWI-105659	Advanced Machine Learning and Data Science	9 CR
M-WIWI-105032	Data Science for Finance	9 CR
M-WIWI-106258	Digital Marketing	9 CR
M-WIWI-101503	Service Design Thinking	9 CR

3.15 Minor Studies: Law

Credits
9-18

Elective Modules (Election: between 9 and 18 credits)		
M-INFO-107030	EU Data Protection Law	3 CR
M-INFO-107029	Public International Law with an Economic Law Focus	3 CR
M-INFO-107028	Seminar: Law and Legal Studies	3 CR

3.16 Interdisciplinary Qualifications

Credits
2-6

Interdisciplinary Qualifications (Election: between 2 and 6 credits)		
M-INFO-107254	Interdisciplinary Qualifications	6 CR

4 Modules

M 4.1 Module: Access Control Systems: Models and Technology [M-INFO-106303]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-112775	Access Control Systems: Models and Technology	5 CR	Hartenstein

Competence Certificate
See Partial Achievements (Teilleistung).

Prerequisites
See Partial Achievements (Teilleistung).

Competence Goal
- The student understands the challenges of access control in the era of hyperconnectivity.
- The student understands that an information security model defines access rights that express for a given system which subjects are allowed to perform which actions on which objects. The student understands that a system is said to be secure with respect to a given information security model, if it enforces the corresponding access rights.
- The student is able to derive suitable access control models from scenario requirements and is able to specify concrete access control systems. The student is able to decide which concrete architectures and protocols are technically suited for realizing a given access control model.
- The student knows access control protocols using cryptographic methods and is able to compare protocol realizations based on different cryptographic building blocks.
- The student is aware of the limits of access control models and systems with respect to their analyzability and performance and security characteristics. The student is able to identify the resulting tradeoffs.
- The student knows the state of the art with respect to current research endeavors, e.g., access control in the context of decentralized and distributed systems, Trusted Execution Environments, AI, robotics, or hash-chain based systems.

Content
Access control systems are everywhere and the backbone of secure services as they incorporate who is and who is not authorized: think of operating systems, information systems, banking, vehicles, robotics, cryptocurrencies, or decentralized applications as examples. The course starts with current challenges of access control in the era of hyperconnectivity, i.e., in cyber-physical or decentralized systems. Based on the derived needs for next generation access control, we first study how to specify access control and analyze strengths and weaknesses of various approaches. We then focus on up-to-date proposals, like IoT and AI access control. We look at current cryptographic access control aspects, blockchains and cryptocurrencies, and trusted execution environments. We also discuss the ethical dimension of access management. Students prepare for lecture and exercise sessions by studying previously announced literature and by preparation of exercises that are jointly discussed in the sessions.

Workload
Lecture workload:

1. Attendance time
   Lecture: 2 SWS: 2,0h x 15 = 30h
   Exercises: 1 SWS: 1,0h x 15 = 15h
2. Self-study (e.g., independent review of course material, work on homework assignments)
   Weekly preparation and follow-up of the lecture: 15 x 1h x 3 = 45h
   Weekly preparation and follow-up of the exercise: 15 x 2h = 30h
3. Preparation for the exam: 30h

Σ = 150h = 5 ECTS

Recommendation
Basics according to the lectures "Information Security" and "IT Security Management for Networked Systems" are recommended.

M 4.2 Module: Advanced Artificial Intelligence [M-INFO-107198]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

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

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

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

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

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

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

M 4.3 Module: Advanced Bayesian Data Analysis [M-INFO-106812]

Responsible: Prof. Dr. Nadja Klein
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Data Science

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

Mandatory			
T-INFO-113673	Advanced Bayesian Data Analysis	5 CR	Klein

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- Develop a deep understanding of Bayesian statistical principles and computational techniques.
- Master the application of Bayesian regression models to real-world data.
- Gain proficiency in Markov Chain Monte Carlo (MCMC) methods, including Metropolis-Hastings and Gibbs sampling.
- Acquire skills in implementing Bayesian models using relevant software tools such Stan.

Content
This course deepens students' understanding of Bayesian methods and introduces the latest advancements in Bayesian computation. It is designed for Master students in Computer Science, Mathematics, Economathematics, Techno-Mathematics, Business Informatics, or similar programs seeking to enhance their expertise.

Examples of topics covered are the review of key Bayesian concepts including Bayes' Theorem, conjugate prior distributions, and posterior inference. For instance, students may explore the Beta-Binomial conjugacy, where a Beta prior pairs with a Binomial likelihood, and the Normal-Normal conjugacy, where a Normal prior pairs with a normal likelihood with known variance. These examples demonstrate how conjugate priors simplify posterior calculations and enhance analytical tractability.

Next, students delve into Bayesian supervised learning, covering linear, logistic, and nonparametric approaches, with an emphasis on applying Bayesian methods to real-world data and interpreting results.

The course also covers ways to perform posterior estimation, such as, Markov Chain Monte Carlo (MCMC) inference, including the Metropolis-Hastings algorithm and Gibbs sampling. We explore Bayesian high-dimensional regression techniques, such as the horseshoe prior, for handling models with many predictors. Additionally, students will learn about mixture models and Dirichlet processes, which are powerful tools for modelling heterogeneous data and uncovering latent structures.

We conclude with approximate inference methods, including variational inference and Approximate Bayesian Computation (ABC), essential for dealing with complex models and large datasets.

Workload
150h

Recommendation
- Knowledge in R or Python
- Mathematics-heavy lecture. The basics will be reviewed, but mathematical proficiency is helpful

4.4 Module: Advanced Data Structures [M-INFO-107200]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114223	Advanced Data Structures	4 CR	Sanders
T-INFO-114224	Advanced Data Structures Project/Experiment	1 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students acquire a systematic understanding of algorithmic issues and solution approaches in the area of advanced data structures, building on existing knowledge in the subject area of algorithms. They will also be able to apply learned techniques to related problems and interpret and comprehend current research topics in this area.

Upon successful completion of the course, students will be able to:
• explain terms, structures, basic problem definitions, and algorithms from the lecture;
• select which algorithms and data structures are suitable for solving a problem and, if necessary, adapt them to the requirements of a specific problem;
• use algorithms and data structures, analyze them mathematically, and prove the algorithmic properties.

Content
In this lecture we deal with modern data structures for fundamental objects such as trees, graphs, integers, and strings. These data structures are the basis for many applications and an important part of efficient algorithms. We look at highlights from different research areas and learn techniques for solving a wide variety of problems.

In addition to the theoretical analysis of data structures, we also look at the practical performance of the various data structures and their applications.

Workload
The lectures including the project/experiment with 5 CP corresponds to 150 working hours, which are divided approximately as follows:
• ca. 30 hours attending lectures
• ca. 60 hours preparing and following-up lectures
• ca. 30 hours working on the project/experiment
• ca. 30 hours preparing for the examination

4.5 Module: Advanced Machine Learning and Data Science [M-WIWI-105659]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: Minor Studies: Economics

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

Mandatory			
T-WIWI-111305	Advanced Machine Learning and Data Science	9 CR	Ulrich

Competence Certificate
The assessment is carried out in an alternative form.The final grade is evaluated based on the intermediate presentations during the project, the quality of the implementation, the final written thesis and a final presentation.

Prerequisites
None

Competence Goal
After a successful project, the students can:

- select and apply modern machine learning methods to solve a data science problem;
- organize themselves in a team in a goal-oriented manner and bring an extensive software project in the field of data science and machine learning to success;
- deepen their data science and machine learning skills
- solve a finance problem with the help of data science and machine learning algorithm.

Content
The course is targeted at students with a major in Data Science and/or Machine Learning and/or Quantitative Finance. It offers students the opportunity to develop hands-on knowledge on new developments in the intersection of quantitative financial markets, data science and machine learning. The result of the project should not only be a final thesis, but the implementation of methods or development of an algorithm in machine learning and data science. Typically, problems and data are taken from current research and innovations in the field of quantitative asset and risk management.

Workload
Total effort for 9 credit points: approx. 270 hours are divided into the following parts: Communication:Exchange during the project: 30 h, Final presentation: 10 h; Implementation and thesis: Preparation before development (Problem analysis and solution design): 70 h, Solution implementation: 110 h, Tests and quality assurance: 50 h.

Recommendation
None

M 4.6 Module: Algorithm Engineering (2400051) [M-INFO-100795]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-101332	Algorithm Engineering	4 CR	Sanders
T-INFO-111856	Algorithm Engineering Pass	1 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

There are two partial achievements Algorithm Engineering and Algorithm Engineering Exercises. The partial achievement Algorithm Engineering Exercises must be started to be allowed to take the oral examination for Algorithm Engineering.

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students acquire a systematic understanding of algorithmic problems and solution approaches in the field of Algorithm Engineering, building on existing knowledge in the subject area of algorithms. In addition, they will be able to apply learned techniques to related problems and interpret and comprehend current research topics in the field of Algorithm
Engineering.

Upon successful completion of the course, the student will be able to
• Explain terms, structures, basic problem definitions, and algorithms from the lecture;
• select which algorithms and data structures are suitable for solving an algorithmic problem and, if necessary, adapt them to the requirements of a specific problem;
• Execute algorithms and data structures, analyze them mathematically precise and prove the algorithmic properties;
• Explain machine models from the lecture and analyze algorithms and data structures according to these models
• Analyze new problems from applications, reduce them to their algorithmic core and create a suitable abstract model; based on the concepts and techniques learned in the lecture, design and analyze own solutions in this model, and prove algorithmic properties in this model.

Content
• What is Algorithm Engineering, Motivation etc.
• Realistic modeling of machines and applications
• practice-oriented algorithm design
• implementation techniques
• experimental techniques
• evaluation of measurements

The above skills are taught primarily using concrete examples. In the past these were for example the following topics from the area of basic algorithms and data structures:

• linked lists without special cases
• sorting: parallel, external, superscalar,...
• priority queues (cache efficient,...)
• search trees for integer keys
• Full text indexes
• graph algorithms: minimal spanning trees (external,...), route planning

In each of these cases, the focus is on the best known practical and theoretical methods. These usually differ considerably from
from the methods taught in beginners' lectures.

Workload
Lecture and exercise with a combined 3 semester hours, 5 ECTS

5 ECTS correspond to about 150h of work, split into

about 45h visiting lectures and exercise or block seminar

about 25h preparation and follow-up on lectures

about 40h solving exercise tasks (programming, preparing presentation for mini seminar, etc)

about 40h exam preparation

M 4.7 Module: Algorithmic Graph Theory (2400043) [M-INFO-106960]

Responsible: Dr. rer. nat. Torsten Ueckerdt
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-113918	Algorithmic Graph Theory	5 CR	Ueckerdt

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know the basic concepts of algorithmic graph theory and the most important graph classes and their characterizations in this context, namely perfect graphs, chordal graphs, comparability graphs, as well as interval, split and permutation graphs. They will also be able to execute and analyze algorithms for recognizing these graphs and for solving basic algorithmic problems on these graphs. They are also able to identify subproblems in applied problems that can be expressed using these graph classes and to develop algorithms for new problems on these graph classes that are related to problems from the lectures.

Content
Many basic problems that arise in many contexts, such as coloring problems or finding independent sets and maximal cliques, are NP-hard in general graphs. However, instances of these difficult problems that occur in applications are often much more structured and can therefore be solved efficiently. The lecture first introduces perfect graphs and their most important subclass, chordal graphs, and presents algorithms for various generally NP-hard problems on chordal graphs. Subsequently, in-depth concepts such as comparability graphs are discussed, with the help of which various other graph classes (interval, split and permutation graphs) can be characterized and recognized, and tools for the design of specialized algorithms for these are presented.

Workload
Lecture with 3SWS, 5LP

5 CP corresponds to approx. 150 working hours, of which

approx. 45h lecture attendance

approx. 60 hours of follow-up work and completion of exercises

approx. 45h exam preparation

Recommendation
See partial achievements (Teilleistung)

M 4.8 Module: Algorithms for Visualization of Graphs [M-INFO-106961]

Responsible: Dr. rer. nat. Torsten Ueckerdt
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-113919	Algorithms for Visualization of Graphs	5 CR	Ueckerdt

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students acquire a systematic understanding of algorithmic problems and solution approaches in the field of graph visualization, which builds on existing knowledge in the areas of graph theory and algorithmics.
After successfully completing the course, students will be able to
- explain concepts, structures and basic problem definitions from the lecture;
- execute layout algorithms for different graph classes, analyze them mathematically precisely and prove the algorithmic properties;
- explain complexity results from the lecture and independently perform similar reduction proofs for new layout problems;
- select which algorithms are suitable for solving a given layout problem and, if necessary, adapt them to the requirements of a concrete problem; - select which algorithms are suitable for solving a given layout problem and, if necessary, adapt them to the requirements of a concrete problem. adapt them to the requirements of a specific problem;
- analyze unknown visualization problems from graph drawing applications, reduce them to their algorithmic core and create an abstract model from this; design and analyze their own solutions in this model based on the concepts and techniques learned in the lecture and prove the algorithmic properties.

Content
Networks are relationally structured data that are increasingly appearing in a wide variety of application areas. Examples range from physical networks, such as transportation and supply networks, to abstract networks, such as social networks. Network visualization is a fundamental tool for the investigation and understanding of networks.

Mathematically, networks can be modelled as graphs and the visualization problem can be reduced to the algorithmic core problem of determining a layout of the graph, i.e. suitable node and edge positions in the plane. Depending on the application and graph class, different requirements are placed on the type of drawing and the quality criteria to be optimized. The research field of graph drawing draws on approaches from classical algorithmics, graph theory and algorithmic geometry.

During the course, a representative selection of visualization algorithms will be presented and discussed in depth.

Workload
Lecture and exercise with 3 SWS, 5 LP
5 LP corresponds to approx. 150 working hours, of which
approx. 45 hours attendance of the lecture and exercise,
approx. 25 hours preparation and follow-up,
approx. 40 hours working on the exercise sheets
approx. 40 hours exam preparation

M 4.9 Module: Algorithms II [M-INFO-107201]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114225	Algorithms II	6 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student has an in-depth insight into the theoretical and practical aspects of algorithms and is able to identify and formally formulate algorithmic problems in various application areas. Furthermore, they know advanced algorithms and data structures from the areas of graph algorithms, algorithmic geometry, string matching, algebraic algorithms, combinatorial optimization, and external memory algorithms. They are able to independently understand algorithms they are unfamiliar with, associate them with the above areas, apply them, determine their running time, evaluate them, and select appropriate algorithms for given applications. Furthermore, the student is able to adapt existing algorithms to related problems. In addition to algorithms for concrete problems, the student knows advanced techniques of algorithmic design. This includes parameterized algorithms, approximation algorithms, online algorithms, randomized algorithms, parallel algorithms, linear programming, and algorithm engineering techniques. For given algorithms, the student is able to identify techniques used to better understand these algorithms. In addition, they are able to select appropriate techniques for a given problem and use them to design their own algorithms.

Content
This module is designed to provide students with the basic theoretical and practical aspects of algorithm design, analysis, and engineering. It teaches general methods for designing and analyzing algorithms for basic algorithmic problems, as well as the basic principles of general algorithmic methods such as approximation algorithms, linear programming, randomized algorithms, parallel algorithms, and parameterized algorithms.

Workload
Lecture with 3 semester hours + 1 semester hour exercise
6 ECTS correspond to about 180 hours

about 45h visiting the lectures
about 15h visiting the exercises
about 90h follow-up of lectures and solving the exercise sheets
about 30h preparation for the exam

M 4.10 Module: Artificial Intelligence & IT-Security [M-INFO-106810]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113668	Artificial Intelligence & IT-Security	6 CR	Wressnegger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know basic concepts of applying artificial intelligence and machine learning in computer security, and are able to evaluate the performance, quality, and security of such systems.

- Students know and understand basic concepts of features and feature engineering in computer security as well as basic attacks against learning-based systems.
- Students know how to apply AI in computer security.
- Students are able differentiate attack vectors against AI.
- Students understand limits of learning-based security solutions.

Content
The lecture is about combining the fields of artificial intelligence, machine learning and computer security in practice. Many tasks in the computer security landscape are based on manual labor, such as searching for vulnerabilities or analyzing malware. Here, machine learning can be used to establish a higher degree of automation, providing more “intelligent” security solutions (AI for Security). However, also these learning-based systems can be attacked and need to be secured (Security of AI). As an example, viciously crafted inputs can be exploited by an adversary to cause devastating damage in the application area. It thus is of utmost importance to investigate, research, and know about the security properties of AI methods.

The module introduces students to theoretic and practical aspects of AI in computer security as well as security of AI. We cover basics on features and feature engineering in the security domain, discuss fundamental learning settings in security and point out “Dos and Don’ts” of using AI/ML in computer security. Moreover, we put particular focus on “Explainable AI” (XAI) and it’s use in computer security, before we introduce attacks and defense against learning-based systems as discussed in the first half of the course. We cover input-manipulation attacks (e.g., adversarial examples), model-manipulation attacks (e.g., backdooring attacks), privacy attacks (e.g., model stealing and membership inference) and attacks against XAI.

Workload
- 58h attendance time
- 56h preparation and follow-up time
- 66h exam preparation

Recommendation
The basics of IT security and artificial intelligence are a prerequisite.

M 4.11 Module: Automated Planning and Scheduling [M-INFO-104447]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-109085	Automated Planning and Scheduling	5 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- The students will be able to model various planning tasks in the PDDL language and solve them using off-the-shelf planners.
- The students will understand the approaches used in automated planning and scheduling algorithms, which will allow them to efficiently model and solve real world planning and scheduling problems by selecting the proper algorithms for the given task.

Content
The course offers an introduction to the methods and techniques used in automated planning and scheduling. The course is focused on classical deterministic planning, i.e., planning in a fully observable deterministic environment. The students will learn how to use automated planners and schedulers and also how they work. The topics covered in the lecture include:

- applications of automated planning in artificial intelligence
- formalization of planning problems and the PDDL language
- computational complexity of planning and scheduling
- basic state space search algorithms (forwards/backwards search)
- heuristic search algorithms and planning heuristics
- plan space planning
- planning graph and the graph plan algorithm
- satisfiability based planning
- hierarchical task network planning
- classical scheduling approaches
- constraint-based scheduling
- planning for virtual agents in computer games

Workload
2 SWS lecture + 1 SWS exercises
(Preparation and follow-up time: 4h/week for lecture plus 2h/week for exercises; exam preparation: 15h)
Total workload: (2 SWS + 1 SWS + 4 SWS + 2 SWS) x 15h + 15h exam preparation = 9x15h + 15h = 150h = 5 ECTS

4.12 Module: Autonomous Learning for Intelligent Robot Perception [M-INFO-106608]

Responsible: Prof. Dr. Rudolph Triebel
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Elective Studies in Informatics

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

Mandatory			
T-INFO-113327	Autonomous Learning for Intelligent Robot Perception	4 CR	Triebel

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are capable of describing the details of different methods for autonomous learning, and they can place them in the context of intelligent robot perception. They are able to derive mathematical principles of these algorithms and they can name and describe relevant applications.

Content
This lecture conveys the main principles of Intelligent Robot Perception, where the major focus is on machine learning techniques that are particularly useful for robot vision applications. The most important design criteria for these methods are run-time and data efficiency, safety, and autonomy, where the latter refers to independence of human interactions and the ability to take decisions during learning (aka. active learning). In the lecture, we will analyse modern learning techniques that meet these criteria, and we will show concrete applications of these in robotic perception tasks such as object detection and pose estimation, grasp detection and semantic mapping.

Workload
120h

Recommendation
A basic understanding of probability theory and linear algebra is required

4.13 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: Minor Studies: Electrical Engineering

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

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

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

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

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

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

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

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

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

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

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Minor Studies: Electrical Engineering

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

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

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

Prerequisites
none

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

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

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

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

Total workload: approx. 180 h = 6 LP

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

4.15 Module: Combinatorics (MATHAG37) [M-MATH-102950]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: Minor Studies: Mathematics

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

Mandatory			
T-MATH-105916	Combinatorics	8 CR	Aksenovich

Competence Certificate
The final grade is given based on the written final exam (2h).

By successfully working on the problem sets, a bonus can be obtained. To obtain the bonus, one has to achieve 50% of the points on the solutions of the exercise sheets 1-6 and also of the exercise sheets 7-12. If the grade in the final written exam is between 4,0 and 1,3, then the bonus improves the grade by one step (0,3 or 0,4).

Prerequisites
none

Competence Goal
The students understand, describe, and use fundamental notions and techniques in combinatorics. They can analyze, structure, and formally describe typical combinatorial questions. The students can use the results and methods such as inclusion-exclusion, generating functions, Young tableaux, as well as the developed proof ideas, in solving combinatorial problems. In particular, they can analyze the existence and the number of ordered and unordered arrangements of a given size. The students understand and critically use the combinatorial methods. Moreover, the students can communicate using English technical terminology.

Content
The course is an introduction into combinatorics. Starting with counting problems and bijections, classical methods such as inclusion-exclusion principle and generating functions are discussed. Further topics include Catalan families, permutations, Young tableaux, partial orders, and combinatorial designs.

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

Annotation
- Course is held in English
- This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

Workload
Total workload: 240 hours

Attendance time: 90 hours

- Course including module examination during the course of study

Self-study: 150 hours

- Deepening the study content by working on the lecture content at home
- Completion of exercises
- In-depth study of the course content using suitable literature and internet research
- Preparation for the module examination during the course of study

Recommendation
Knowledge of the modules Linear Algebra 1 and 2 and Analysis 1 and 2 is recommended.

4.16 Module: Compiler Design [M-INFO-106966]

Responsible: Prof. Dr. André Platzer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-113925	Compiler Design	9 CR	Platzer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- Distinguish the main phases of a state-of-the-art compiler
- Understand static and dynamic semantics of an imperative language
- Develop parsers and lexers e.g. with parser generators, combinators
- Perform semantic analysis
- Translate abstract syntax trees to intermediate representations and static single assignment form
- Analyze the dataflow in an imperative language
- Perform standard compiler optimizations
- Generate assembly code
- Allocate registers using a graph-coloring algorithm
- Understand opportunities and limitations of compiler optimizations
- Appreciate design tradeoffs how representation affects optimizations
- Automatically manage memory using garbage collection
- Develop complex software following high-level specifications

Content
This course covers the design and implementation of compiler and runtime systems for high-level programming languages, and examines the interaction between language design, compiler design, and runtime organization. Topics covered include lexical and syntactic analysis, semantic analysis, type-checking, program analysis, code generation and optimization, memory management, and runtime organization.

Compilers and principles of compiling are one fundamental core aspect of computer science. Compilers and several other parts of compiler technology (especially parsing, transformation, analysis, and optimization) play important roles in many systems built every day. The knowledge gained in this course should be broad enough that if you are confronted with the task of contributing to the implementation of a real compiler in the field or similar technology, you should be able to do so confidently and quickly.

Workload
9 ECTS from 270h of coursework consisting of

- 60h=15*4h from 4SWS lectures
- 90h preparation, reading lecture notes, studying
- 100h developing a compiler
- 20h exam preparation

Recommendation
Students are expected to have significant experience in a high-level programming language. Students are also expected to follow the lecture notes.

M 4.17 Module: Computational Geometry [M-INFO-107228]

Responsible: TT-Prof. Dr. Thomas Bläsius
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114251	Computational Geometry	6 CR	Bläsius
T-INFO-114252	Computational Geometry - Pass	0 CR	Bläsius

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students develop a systematic understanding of questions and solution approaches in the field of computational geometry, building on their existing knowledge of theoretical computer science and algorithms. Upon successful completion of the course, students will be able to:

* explain concepts, structures, and fundamental problem definitions presented in the lectures

* execute geometric algorithms, analyze them mathematically, and prove their properties

* select appropriate algorithms and data structures for solving a given geometric problem and adapt them to specific problem scenarios if necessary

* analyze unfamiliar geometric problems, reduce them to their algorithmic core, and create an abstract model; based on the concepts and techniques learned in the lecture, design their own solutions within this model, analyze them, and prove their properties

Content
Spatial data is processed in a wide variety of areas in computer science, such as computer graphics and visualization, geographic information systems, robotics, and more. Computational geometry focuses on the design and analysis of geometric algorithms and data structures. This module introduces frequently used techniques and concepts in computational geometry, which are explored in depth using selected and application-related questions.

Workload
Lecture with exercises, 4 hours per week (SWS), 6 ECTS 6 ECTS corresponds to approximately 180 hours of work, including: ~60 hours attending lectures and exercises ~30 hours preparation and review ~60 hours working on exercise sheets ~30 hours exam preparation

Recommendation
Basic knowledge of algorithms and data structures (e.g., from the courses Algorithms 1 + 2) is expected.

M 4.18 Module: Computational Imaging [M-INFO-106190]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Elective Studies in Informatics

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

Mandatory			
T-INFO-112573	Computational Imaging	5 CR	Meyer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

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

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

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

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

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

4.19 Module: Constructive Logic [M-INFO-106256]

Responsible: Prof. Dr. André Platzer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Elective Studies in Informatics

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

Mandatory			
T-INFO-112704	Constructive Logic	5 CR	Platzer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- Understand the working principles of logic
- Understand how the meaning of a proposition comes from its verifications
- Distinguish propositions from judgments
- Use proof rules to conduct formal proofs
- Formalize informal problems into precise logical language
- Justify how proof rules fit to one another in sound and complete ways
- Assess the validity of a formal proof
- Understand propositions as types, proofs as programs, formulas as programs
- Relate constructive logic to computation and constructive proofs to functional programs
- Relate deductive proof search to computation in logic programming
- Relate induction to recursion and use induction to prove properties in and about logical systems
- Understand the principles and applications of logic programming

Content
This course provides a thorough introduction to modern constructive logic, its roots in philosophy, its numerous applications in computer science, and its mathematical properties. The core topics of this course are intuitionistic logic, natural deduction, Curry-Howard isomorphism, propositions as types, proofs as programs, formulas as programs, functional programming, logic programming, Heyting arithmetic and primitive recursion, cut elimination, connections between classical and constructive logic, inductive definitions, sequent calculus, and decidable classes. Advanced topics may include type theory, proof search, linear logic, temporal logic, modal logic.

Annotation
Course web page: https://lfcps.org/course/constlog.html

Workload
5 ECTS from 150h of coursework consisting of
45h = 15 * 3h from 3 SWS lectures
15h = 15 * 1h from 1 SWS exercises
90h preparation, reading lecture notes, studying
22h exam preparation

Recommendation
You will be expected to follow the lecture notes.

4.20 Module: Data Science and Artificial Intelligence for Energy Systems [M-INFO-106655]

Responsible: TT-Prof. Dr. Benjamin Schäfer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Area of Specialization: Human-centred Machine Intelligence
Area of Specialization: Data Science
Elective Studies in Informatics

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

Mandatory			
T-INFO-113402	Data Science and Artificial Intelligence for Energy Systems	6 CR	Schäfer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- Students obtained a foundational knowledge of data-driven methods in energy systems as an active research field. They can name some ongoing challenges.
- They can explain different data science methods and their applications in energy systems (including Langevin processes, superstatistics, (probabilistic) forecasts and explainable AI).
- Students can employ AI methods to solve problems in energy systems, including optimizing systems and forecasting time series.
- Students can exploit key properties of trained machine learning models and interpretability tools.
- Students can select suitable analysis tools, justify their choice and carry out data-driven analysis on power systems .

Content
Artificial Intelligence (AI) is a key technology in many areas of society and research. Energy systems with the ongoing energy transition (“Energiewende”) make it a fascinating field for deploying AI methods. AI and machine learning algorithms can play a crucial role in improving energy efficiency, optimizing power generation and distribution or enhancing system stability while facilitating additional renewable energy integration. In this lecture, we review some mechanics of energy systems, their design and optimization questions and how to solve these using data-driven approaches. We will discuss deterministic dynamics, as well as stochastic aspects of energy systems and will explore fundamental AI algorithms and their applications in energy systems. We will cover both classical time series methods as well as state-of-the-art AI techniques, e.g. for optimization or forecasting.

Workload
Course workload:
1. Attendance time: 4 SWS x 15=60 (Course, exercise, etc.)
2. Self-study: 6 h x 15 = 90 (independent review of course material, work on homework assignments)
3. Preparation for the exam: 30h

60+90+30=180h= 6ECTS

Recommendation
Knowledge of AI basics is very helpful.
Previous participation in “Energieinformatik 1” and/or “Energieinformatik 2” is beneficiary but not mandatory.
Knowledge of Python is highly recommended.

M 4.21 Module: Data Science for Finance [M-WIWI-105032]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: Minor Studies: Economics

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

Mandatory			
T-WIWI-102878	Computational Risk and Asset Management	4,5 CR	Ulrich
T-WIWI-110213	Python for Computational Risk and Asset Management	4,5 CR	Ulrich

Competence Certificate
The module examination takes the form of an alternative exam assessment.
The alternative exam assessment consists of a Python-based "Takehome Exam". At the end of the third week of January, the student is given a "Takehome Exam" which he processes and sends back independently within 4 hours using Python. Precise instructions will be announced at the beginning of the course. The alternative exam assessment can be repeated a maximum of once. A timely repeat option takes place at the end of the third week in March of the same year. More detailed instructions will be given at the beginning of the course.

Competence Goal
The aim of the module is to use data science, machine learning and financial market theories to generate better investment, risk and asset management decisions. The student gets to know the characteristics of different asset classes in an application-oriented manner using real financial market data. We use Python and web scraping techniques to extract, visualize and examine patterns of publicly available financial market data. Interesting and non-public financial market data such as (option and futures data on shares and interest) are provided. Financial market theories are also discussed to improve data analysis through theoretical knowledge. Students get to know stock, interest rate, futures and options markets through the "data science glasses". Through "finance theory glasses" students understand how patterns can be communicated and interpreted using finance theory. Python is the link through which we bring data science and modern financial market modeling together.

Content
The course covers several topics, among them:

- Pattern detection in price and return data in equity, interest rate, futures and option markets
- Quantitative Portfolio Strategies
- Modeling Return Densities using tools from financial econometrics, data science and machine learning
- Valuation of equity, fixed-income, futures and options in a coherent framework to possibly exploit arbitrage opportunities
- Neural networks and Natural Language Processing

Workload
The total workload for this module is 270 hours (9 credit points).The total number of hours resulting from income from studying online video, answering quizzes, studying Ipython notebooks, active and interactive "Python Data Sessions" and reading literature you have heard.

Recommendation
Basic knowledge of capital markt theory.

M 4.22 Module: Decentralized Systems: Fundamentals, Modeling, and Applications [M-INFO-105334]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-110820	Decentralized Systems: Fundamentals, Modeling, and Applications	6 CR	Hartenstein

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
1. Fundamentals & Modeling

1. The student is able to recognize and distinguish distributed, federated, and decentralized systems.
2. The student understands consensus, consistency and coordination within the context of networked and decentralized systems.
3. The student understands the concept of Sybil attacks.
4. The student is familiar with decentralized algorithms for leader election and mutual exclusion for execution contexts with various guarantees.
5. The student understands the formally proven limits of fault tolerance and their underlying assumptions. This includes an understanding of synchronous and asynchronous network models which underpin the respective proofs. The student also understands several models for fault tolerance, notably silent and noisy crash as well as byzantine fault tolerance within the context of decentralized and distributed systems.
6. The student has a basic understanding of state machine replication.
7. The student knows various models for and levels of consistency.

2. Applications

1. The student understands conflict-free replicated data types and their use in decentralized systems like Matrix.
2. The student has a fundamental understanding of blockchain-based cryptocurrencies (e.g. Bitcoin/Ethereum), Payment Channels, and decentralized communication systems like Matrix.
3. The student understands trust relations in distributed and decentralized systems and applications.
4. The student is able to understand how the previously introduced theoretical foundations relate to networked and decentralized systems in practice.
5. The student understands concepts of decentralized storage systems.

Content
Decentralized Systems (like blockchain-based systems) represent distributed systems that are controlled by multiple parties who make their own independent decisions. In this course, we cover fundamental theoretical aspects as well as up-to-date decentralized systems and connect theory with current practice. We thereby address fault tolerance, security and trust, as well as performance aspects at the example of applications like Bitcoin, Ethereum, IPFS, and Matrix. As a research-oriented lecture, we may cover additional current topics like verifiable computing and/or identity and access management in decentralized settings.
The lecture covers at least the following topics:

- Fundamentals
    - Peer-to-Peer Overlay Networks, Sybil and Eclipse Attacks
    - Formalization of decentralized systems, including models for their computation, communication, faults, and timing.
    - Leader election and mutual exclusion in decentralized systems based on different models for node identities and timing.
    - Byzantine consensus in synchronous and asynchronous settings, including Bracha’s fundamental algorithm for reliable broadcast, Practical Byzantine Fault Tolerant consensus, and fundamental limits.
    - Consistency models and protocols including Conflict-Free Replicated Data Types.
- Applications
    - The Matrix decentralized messaging platform
    - Distributed Ledgers and Blockchains at the examples of Bitcoin and Ethereum, in particular Proof-of-Work and Proof-of-Stake consensus
    - Payment Channel Networks and Rollups
    - Decentralized storage systems, at the example of IPFS

Workload
1. Attendance time (Course, exercise, etc.)
Lecture: 3 SWS: 3,0h x 15 = 45h
Exercise: 1 SWS: 1,0h x 15 = 15h
2. Self-study (e.g. independent review of course material, work on homework assignments)
Weekly preparation and follow-up of the lecture: 15 x 1h x 3 = 45h
Weekly preparation and follow-up of the exercise: 15 x 2h = 30h
3. Preparation for the exam: 45 h
Σ = 180h = 6 ECTS

Recommendation
Basics according to the lectures "Information Security" and "Introduction to Computer Networks" are recommended.

M 4.23 Module: Deep Learning and Neural Networks [M-INFO-107197]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

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

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

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

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

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

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

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

Workload
180h.

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

M 4.24 Module: Design and Architectures of Embedded Systems (ESII) [M-INFO-107230]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-114254	Design and Architectures of Embedded Systems (ESII)	3 CR	Henkel

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student learns methods for mastering complexity and applies these methods to the design of embedded systems. He/she evaluates and selects specific architectures for embedded systems. Furthermore, the student receives an introduction to current research topics.

Content
Nowadays, it is possible to integrate several billion transistors on a single chip and thus realize complete SoCs (systems-on-chip). The trend towards being able to use more and more transistors continues unabated, meaning that the complexity of such systems will also continue to increase. Computers will increasingly be ubiquitous, i.e. they will be integrated into the environment and will no longer be perceived as computers by humans. Examples include sensor networks, electronic textiles and many more. However, the physically possible complexity will not be readily achievable in practice, as there is currently a lack of powerful design processes capable of handling this high level of complexity. Powerful ESL tools ("Electronic System Level Design Tools") and novel architectures will be required. The focus of this lecture is therefore on high-level design methods and architectures for embedded systems. Since the power consumption of (mostly mobile) embedded systems is of crucial importance, one focus of the design methods will be on the design with regard to low power consumption.

Workload
90h

4.25 Module: Digital Marketing [M-WIWI-106258]

Responsible: Prof. Dr. Ann-Kristin Kupfer
Organisation: KIT Department of Economics and Management
Part of: Minor Studies: Economics

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

Mandatory			
T-WIWI-112693	Digital Marketing	4,5 CR	Kupfer
Supplementary Courses (Election: 4,5 credits)			
T-WIWI-106981	Digital Marketing and Sales in B2B	1,5 CR	Klarmann, Konhäuser
T-WIWI-114174	Economic Decision Making	4,5 CR	Scheibehenne
T-WIWI-107720	Market Research	4,5 CR	Klarmann
T-WIWI-112711	Media Management	4,5 CR	Kupfer
T-WIWI-111848	Online Concepts for Karlsruhe City Retailers	3 CR	Klarmann

Competence Certificate
The assessment is carried out as partial exams 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
Students

- have an advanced knowledge about central marketing contents
- have a fundamental understanding of the marketing instruments
- know current fundamental principles and latest trends in the field of digital marketing
- know and understand several strategic concepts and how to implement them
- are able to implement their extensive marketing knowledge in a practical context
- are able to critically discuss and question theoretical concepts and current practices in marketing
- have theoretical knowledge that is fundamental for writing a master thesis in the field of marketing
- have gained insight into scientific research that prepares them to independently write a master's thesis
- have the theoretical knowledge and skills necessary to work in or collaborate with the marketing department of a company

Content
The aim of this module is to deepen central marketing contents in different areas.

Workload
Total effort for 9 credit points: approx. 270 hours.
The exact distribution is done according to the credit points of the courses of the module.

4.26 Module: Distributed Computing [M-INFO-107215]

Responsible: Prof. Dr. Achim Streit
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-114235	Distributed Computing	4 CR	Streit

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Competence Goal
Students understand the basic concepts of distributed systems, in particular Grid and Cloud Computing as well as the management and analysis of big and distributed data. They apply underlying paradigms and services to given examples. Students analyze methods and technologies of Grid and Cloud Computing as well as distributed data management, which are suitable for use in everyday and industrial application areas or which are used today by Google, Facebook, Amazon, etc. For this purpose, students will compare web/grid services, elementary grid functionalities, data lifecycles, metadata, archiving, cloud service types (IaaS, SaaS, PaaS) and public/private clouds
using real-world examples.

Content
The lecture introduces the world of distributed computing with a focus on fundamentals and technologies from Grid and Cloud Computing as well as the handling of Big Data. The lecture combines theory and
application with the help of relevant examples from science and industry.

First, an introduction to the main characteristics of distributed systems is given. Then the topic of Grid Computing is discussed in more detail and the close relationship between Grid computing and distributed data management is illustrated using the example of the WLCG, the infrastructure for distributing, storing and analyzing data from the particle accelerator at CERN.

Subsequently, the topic of cloud computing is discussed and compared with the preceding. After the definition of basic terms and concepts, virtualization is introduced as one of the key technologies of Cloud Computing; finally, common architectures, services and components in the Cloud context are discussed using examples and in general.

Next, common methods for authorization and authentication in distributed environments will be discussed. The lecture includes the description of the basics of Authentication and Authorization Infrastructures (AAI) as well as different technologies, for example certificate- or token-based procedures.

In a further block of topics, concepts for the management and analysis of large or distributed data are presented. In this context tools and frameworks, as well as the lifecycle of data, its metadata and data storage are explained.

Workload
2 SWS = 120 h per semester
• 30 h in the weekly lecture during the semester
• 90 h post-processing of lectures and self-learning of the content due to its complexity

M 4.27 Module: Edge-AI in Software and Sensor Applications [M-INFO-107234]

Responsible: Dr. Victor Pankratius
Organisation: KIT Department of Informatics
Part of: Elective Studies in Informatics

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

Mandatory			
T-INFO-114258	Edge-AI in Software and Sensor Applications	3 CR	Pankratius

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Qualification goals

After completing the module, students have the following skills. They...

- can name and explain the theoretical and practical aspects of software and sensor technology in the context of edge and fog computing
- can name and use techniques of software engineering and algorithm development for sensor applications
- can name and use methods of artificial intelligence in the context of resource constraints and fault tolerance
- can weigh the characteristic properties of the methods and tools presented, their advantages and disadvantages against each other and can select a suitable tool for a given application scenario.

Learning objectives

Students can name the relevant elements of a technical system and their tasks in edge/fog computing. Students are able to name resource constraints of different types (CPU, memory, communication, energy) and describe their effects on software and algorithm design. Students can describe functional principles of sensors of different types (e.g. microelectromechanical systems - MEMS), describe their functional principles in accelerators, gyroscopes, pressure/ humidity sensors, particle detection, etc., explain applications and their context (e.g. gesture recognition in mobile phones/"wearables"/"hearables", localization & navigation, environmental measurements). Students are able to design software systems for edge and fog applications and to develop complex edge and fog software projects in an engineering manner. The problems and requirements of different application areas can be recognized, processed and transferred to a new context. Problems in recognizing patterns in sensor data, classification and prediction can be solved using model-based algorithms or machine learning approaches. Problems in deriving instructions for action can be solved using inference techniques.

Content
Edge computing comprises applications, data and services that are relocated to the outer edges of networks. Such systems typically require local data processing with limited resources such as energy consumption, CPUs, memory or connectivity. Fog computing also combines these aspects with cloud architectures. The importance of these approaches is growing today for modern sensor applications and ranges from industrial applications to Internet-of-Things, ubiquitous computing, consumer applications in cell phones, wearables & hearables (e.g. health & fitness applications), drones or applications in augmented reality. At the same time, the proportion of hardware-related software is also growing in all sensor applications, which opens up new possibilities. In this context, artificial intelligence methods are becoming increasingly important in order to realize learning systems with improved autonomy and immediate feedback. This module presents the current status as well as research work and open problems.

Workload
2 SWS: (2 SWS + 1.5 x 2 SWS) x 15 + 15 h exam preparation = 90 h = 3 ECTS

Recommendation
Knowledge of e.g. cognitive systems, software engineering, algorithms, computer networks & structures, low-power design is helpful.

4.28 Module: Embedded Machine Learning Lab [M-INFO-105775]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-111549	Embedded Machine Learning Lab	4 CR	Henkel

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student will understand the main concept of machine learning (ML) on embedded systems, the constraints present on such platforms, and the design objectives for ML algorithms on such platforms. The student will be able to understand various concepts of compression of neural networks. The student will gain hands-on experience with current state-of-the-art ML frameworks, parameter tuning of algorithms, and will develop software programs for implementing the concepts. The student will be able to compare and analyze the current state-of-the-art algorithms regarding their flexibility and performance on embedded devices.

Content
IoT devices more and more rely on ML models to perform their operations. They thereby also generate lots of data that should be used to improve these ML models through on-device learning. Devices need to perform the training with this data locally due to privacy constraints or communication limitations. However, the inference of neural networks, and especially the training, requires too many resources (computations, memory, energy, etc.) — unless the available resources are considered in the design.

This lab provides insights into deploying machine learning algorithms to embedded devices.

Since embedded devices operate with significantly lower resources than the commonly-employed high-end GPUs, making neural networks run fast without sacrificing much accuracy on embedded devices is a challenging task. The lab covers training and inference on resource-constrained devices, introducing state-of-the-art methodologies like pruning and quantization.

The students will learn about neural networks beyond theory, working with popular frameworks like TensorFlow, the effects of hyperparameters, and how they influence the network. Furthermore, the student will learn about resource and accuracy trade-offs in neural networks and design custom networks to achieve given resource or accuracy requirements.

This lab requires basic (theoretic) knowledge about neural networks and training. Further knowledge of Linux environments and Python is strongly advised since they will be intensively used in the lab and are the de-facto industry standard for machine learning research.

The students will meet every week. Exact dates and times will be fixed in the first kick-off meeting. Depending on the number of participants, students will work together in groups of 2-3 students.

Workload
(2 SWS +1.5*2 SWS)*10

+55 h final project

+15 h presentation & report

= 120 h = 4 ECTS

Recommendation
This lab requires a basic (theoretic) knowledge about neural networks and training. Further knowledge of Linux environments and Python is strongly advised since they will be intensively used in the lab and are the de-facto industry standard for machine learning research.

M 4.29 Module: Engineering Self-Adaptive Systems [M-INFO-106626]

Responsible: Prof. Dr. Raffaela Mirandola
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-113349	Engineering Self-Adaptive Systems	3 CR	Mirandola

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- Understand the motivation for self-adaptation
- Get familiar with the basic principles and conceptual model of self-adaptation
- Understand how to engineer self-adaptive software systems from a software engineering perspective
- Understand the decision-making process using formal analysis at runtime for quality assurance
- Understand the notion of uncertainty in self-adaptive systems and how to tame it with formal verification at runtime
- Understand the level of adoption of self-adaptive systems in industry.

Content
Self-adaptation is an important field of research and engineering that aims to address the challenging problem of how to engineer software systems that have to deal with uncertainties that can only be resolved at run time.

The course presents the basic principles of self-adaptation and introduces a conceptual feedback loop model of a self-adaptive system. It introduces quality models which can be used to estimate quality properties at runtime by a self-adaptive system to provide guarantees for the quality goals. The role played by the different types of uncertainties is then explored analyzing different possible approaches.

Workload
Course workload:

30h in Class (lectures)
45h self-study during the semester
15h preparation for the exam

4.30 Module: EU Data Protection Law [M-INFO-107030]

Responsible: Gustavo Gil Gasiola
Organisation: KIT Department of Informatics
Part of: Minor Studies: Law

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

Mandatory			
T-INFO-113887	EU Data Protection Law	3 CR	Gil Gasiola

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are able to comprehend the EU data protection regulation, including the General Data Protection Regulation and related EU data regulations.

They know the foundations of data protection rules, including fundamental concepts (e.g., “personal data”, “processing”, “data subject”). They are also familiar with the principles of personal data processing (lawfulness, limited purpose, transparency, accountability) as well as the rights of the data subject.

They can identify the main obligations of the controller and the processor.

Students understand the conditions for the transfer of personal data to third countries.

They can identify the other regulations that govern data in the European Union.

Students are able to read and understand legal text related to data regulation.

They can understand and solve simple data protection cases.

Content
The General Data Protection Regulation (GDPR) of the European Union is a milestone in protecting individuals from the unlawful use of their data. In a data-driven society, economy, and government, this protection has become essential to guarantee fundamental rights. In addition to its direct impact on the legal systems of all Member States, the GDPR has a major influence on third countries that have adopted similar regulations (e.g. Switzerland, Argentina, Brazil, South Africa, and many others). In this way, the EU Data Protection Regulation has established itself as the “gold standard” of data protection, providing guidance to address the challenges posed by new technologies and new ways of creating, using and sharing personal data. Understanding the structure of data protection in the EU is therefore essential to grasp its impact on individual rights, public administration, business models, and even technological development.
This lecture aims to provide a structured overview of the EU Data Protection Regulation, and to offer tools to understand the regulatory structure of the EU Data Regulation. The lecture will cover the following topics:
- Introduction to EU law
- Development of the EU data protection regulation
- Legal structure of data protection in the EU
- Role of national and sectoral laws
- Data protection as fundamental right
- Principles of data protection
- Lawfulness of personal data processing
- Anonymization and pseudonymization of personal data
- Special categories of personal data
- Rights of the data subject
- Transfer of personal data to third countries
- Responsibility of the controller and the processor
- Security of personal data and personal data breach
- Open Data Directive
- Data Governance Act
- Data Act

Workload
- Attendance time to the lectures = 15 x 90 min = 22 h 30 min
- Self-study during the semester = 47 h 30 min
- Preparation for the exam = 20 h
- Total = 90 h

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

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

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

Competence Certificate
See Partial Achievements (Teilleistung).

Prerequisites
See Partial Achievements (Teilleistung).

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

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

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

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

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

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

• Interactive Learning
◦ Integrating Human Feedback
◦ Explanatory Interactive Learning

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

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

4.32 Module: Fine-Grained Complexity Theory & Algorithms [M-INFO-106644]

Responsible: Prof. Dr.-Ing. Marvin Künnemann
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-113391	Fine-Grained Complexity Theory & Algorithms	6 CR	Künnemann

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know the foundations of fundamental algorithmic barriers in the polynomial-time and exponential-time regimes. They are able to use fine-grained reductions to relate the time complexity of different problems. They can derive conditional lower bounds from such reductions, based on established hardness assumptions.
Furthermore, they know about the techniques underlying the fastest known algorithms for central problems in the field.

Content
- fine-grained reductions:
  -- conditional lower bounds
  -- main techniques for obtaining such reductions
- central hardness assumptions and their applications:
  -- (Strong) Exponential Time Hypothesis
  -- Orthogonal Vectors Hypothesis
  -- 3SUM Hypothesis
  -- APSP Hypothesis
- conditional lower bounds for string problems, algorithmic graph theory, geometry
- algorithmic techniques:
  -- fastest known algorithms for central problems (SAT, Orthogonal Vectors, 3SUM, APSP)
  -- polynomial method
  -- applications of fast matrix multiplication
  -- Fast Fourier Transform/polynomial multiplication

Workload
Lecture with exercises, 4 SWS, 6 CP
6 CP amounts to 180 h, distributed as follows:
- about 60 h attendance of lectures and exercise sessions
- about 30 h of preparation and reviewing course material
- about 60 h solving exercise sheets
- about 30 h exam preparation

Recommendation
Basic knowledge of theoretical computer science and algorithm design is recommended.

M 4.33 Module: Geometric Deep Learning [M-INFO-106237]

Responsible: Jun.-Prof. Dr. Jan Stühmer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-112662	Geometric Deep Learning	3 CR	Stühmer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students gain a theoretical and methodical approach to modern Deep Learning as well as knowledge and experience about the application of Deep Learning methods on networks and graphs

Students are able to apply this knowledge for understanding existing state-of-the-art Deep Learning architectures and for deriving novel architectures from first principles

Content
- This module provides students with both theoretical and practical insights into modern Deep Learning
- In particular, we focus on a novel approach for understanding deep neural networks with mathematical tools from geometry and group theory
- This enables a methodical approach to Deep Learning: starting from first principles of symmetry and invariance, we derive different network architectures for analyzing unstructured sets, grids, graphs, and manifolds
- Topics of the course include: group theory, graph neural networks, convolutional neural networks, applications of geometric deep learning in diverse fields such as geometry processing, molecular dynamics, social networks, game playing (computer Go), processing of text and speech, as well as applications in medicine

Workload
90h

Recommendation
Knowledge about the foundations of machine learning, group theory and linear algebra useful but not required.

M 4.34 Module: Graph Partitioning and Graph Clustering in Theory and Practice [M-INFO-107211]

Responsible: Prof. Dr. Peter Sanders
Dr. rer. nat. Torsten Ueckerdt

Organisation: KIT Department of Informatics

Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114232	Graph Partitioning and Graph Clustering in Theory and Practice	4 CR	Sanders, Ueckerdt
T-INFO-114233	Graph Partitioning and Graph Clustering in Theory and Practice - Practical	1 CR	Sanders, Ueckerdt

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The aim of the lecture is to provide students with an initial insight into the problems of graph partitioning and graph clustering and to apply knowledge from graph theory and algorithmics.

On the one hand, the problems that arise are reduced to their algorithmic core and then solved efficiently. On the other hand, various modelling methods and their interpretations are discussed. After successfully completing the course, students will be able to apply the methods and techniques presented autonomously to related problems.

Content
Many applications in computer science involve the clustering and partitioning of graphs, e.g. the finite element method in scientific simulations, digital circuit design, route planning, web graph analysis or the analysis of social networks.

A well-known example where good partitioning of unstructured graphs is needed is parallel processing, where graphs must be partitioned to distribute computations evenly over a given number of processors and minimise communication between them. k processors, the graph must be divided into k blocks of approximately equal size so that the number of edges between the blocks is minimal.
Since many partitioning and clustering problems occur in practice, the problems discussed are introduced and motivated, and both the theoretical and practical aspects of graph partitioning and graph clustering are taught, including heuristics, meta-heuristics, evolutionary and genetic algorithms as well as approximation and streaming algorithms.

Workload
Lecture with project/experiment with 3 SWS, 5 CP correspond to approx. 150 working hours, of which
approx. 30 hours attending the lecture
approx. 60 hours of preparation and follow-up work
approx. 30 hours working on the project/experiment
approx. 30 hours exam preparation

M 4.35 Module: Graph Theory (MATHAG26) [M-MATH-101336]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: Minor Studies: Mathematics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	see Annotations	1 term	English	4	3

Mandatory			
T-MATH-102273	Graph Theory	8 CR	Aksenovich

Competence Certificate
The final grade is given based on the written final exam (3h).

By successfully working on the problem sets, a bonus can be obtained. To obtain the bonus, one has to achieve 50% of the points on the solutions of the exercise sheets 1-6 and also of the exercise sheets 7-12. If the grade in the final written exam is between 4,0 and 1,3, then the bonus improves the grade by one step (0,3 or 0,4).

Prerequisites
None

Competence Goal
The students understand, describe and use fundamental notions and techniques in graph theory. They can represent the appropriate mathematical questions in terms of graphs and use the results such as Menger's theorem, Kuratowski's theorem, Turan's theorem, as well as the developed proof ideas, to solve these problems. The students can analyze graphs in terms of their characteristics such as connectivity, planarity, and chromatic number. They are well positioned to understand graph theoretic methods and use them critically. Moreover, the students can communicate using English technical terminology.

Content
The course Graph Theory treats the fundamental properties of graphs, starting with basic ones introduced by Euler and including the modern results obtained in the last decade. The following topics are covered: structure of trees, paths, cycles and walks in graphs, minors, unavoidable subgraphs in dense graphs, planar graphs, graph coloring, Ramsey theory, and regularity in graphs.

Annotation
- Course is held in English
- This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

M 4.36 Module: Hands-on Bioinformatics Practical [M-INFO-101573]

Responsible: Prof. Dr. Alexandros Stamatakis
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Algorithm Engineering

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

Mandatory			
T-INFO-103009	Hands-on Bioinformatics Practical	3 CR	Stamatakis

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The participants develop and document an open-source tool or pipeline for sequence-based data analysis of biological data. The tool is likely to cover one or more of the main topics of the corresponding lecture and shall be useful to and usable for the biological user community. If possible, the tool should be published in a peer-reviewed scientific journal. Participants learn to work in teams of 2-3 programmers, to use version management tools such as github, to analyse and optimise the runtime behaviour of programs using appropriate tools, to test C/C++ programs for memory leaks (e.g., using valgrind), and to improve the quality of their code using SoftWipe (https://www.nature.com/articles/s41598-021-89495-8). Participants will be able to independently carry out and document larger software projects in the field of bioinformatics and evaluate as well as improve code quality. They are able to write a scientific paper in a team.

Content
In the practical course, we jointly develop an open-source tool (algorithms, analysis pipelines, parallelisation) with the aim of providing a new tool that is useful for biology and can be used by biologists at the end of the semester.

Workload
Weekly meetings with the supervisor 15 hours + internal team meetings 15 hours + programming time 45 hours + 15 hours writing paper or final report = 90 hours = 3 ECTS

4.37 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: Minor Studies: Electrical Engineering

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

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

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

Prerequisites
none

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

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

Topics covered in the course are:

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

Module grade calculation
The module grade results from the grade of the written examination.

Workload
The workload is covered by:

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

Sum: 120h = 4 LP

M 4.38 Module: Hardware Synthesis and Optimization [M-ETIT-106963]

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

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

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

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

Prerequisites
none

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

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

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

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

The following topics are covered:

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

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

Workload
The workload includes (4 SWS):

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

A total of 180 h = 6 CR

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

M 4.39 Module: HRI and Social Robotics [M-INFO-106650]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113396	HRI and Social Robotics	4 CR	Bruno
T-INFO-113397	HRI and Social Robotics - Pass	2 CR	Bruno

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know the foundations of Human-Robot Interaction (HRI) and Social Robotics, including: design principles and methodologies, human factors influencing HRI (anthropomorphization), sensors, actuators and software architecture for social robotics, challenges and solutions for key abilities of social robots (spatial interaction, engagement detection, non-verbal interaction, verbal interaction, emotion generation and detection), research methods (study design principles, statistical tools for analyses) and have seen state-of-the-art research topics in the field including social learning, theory of mind, trust and ethical considerations in HRI.
Thanks to the exercise sessions and assignments, students gain first-hand knowledge and can independently apply techniques related to the above theory items, including for collecting stakeholders' feedback for a robot design, programming the robot's social behaviour along multiple modalities, extracting relevant user information from available sensors, designing and analysing HRI experiments.

Content
The lectures cover all foundational topics in HRI (design principles and methodologies, human factors influencing HRI, sensors, actuators and software architecture for social robotics), challenges and solutions for key abilities of social robots (spatial interaction, engagement detection, non-verbal interaction, verbal interaction, emotion generation and detection), research methods (study design principles, statistical tools for analyses) and state-of-the-art topics including social learning, theory of mind and ethical considerations in HRI.
In the exercise sessions and related assignments students can experience first-hand how the theoretical concepts seen in the lectures can be applied in practice and learn how to collect stakeholders' feedback for a robot design, program the robot's social behaviour along multiple modalities, extract relevant user information from available sensors, design and analyse HRI experiments. At the end of the course, the students have a solid understanding of HRI, its principles, challenges and solutions and can autonomously apply such knowledge in practical contexts.

Workload
Course workload:
1) Attendance of the course: 22.5h (15x90min slots)
2) Attendance of the exercise sessions: 22.5h (15x90min slots)
3) Self-study of course material and work on homework assignments: 60h (4h/week)
4) Preparation for the exam: 80h

Recommendation
Knowledge of the content of modules Robotics I - Introduction to Robotics is helpful.

M 4.40 Module: Human Computer Interaction (24659) [M-INFO-107166]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114192	Human-Machine-Interaction	6 CR	Beigl
T-INFO-114193	Human-Machine-Interaction Pass	0 CR	Beigl

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
After completing the course, students will be able to
reproduce basic knowledge about the field of human-machine interaction
name and apply basic techniques for analysing user interfaces
apply basic rules and techniques for designing user interfaces
analyse and evaluate existing user interfaces and their function

Content
Topics are:
1. human information processing (models, physiological and psychological principles, human senses, action processes),
2. design principles and design methods, input and output units for computers, embedded systems and mobile devices,
3. principles, guidelines and standards for the design of user interfaces
4. technical basics and examples for the design of user interfaces (text dialogues and forms, menu systems, graphical interfaces, interfaces in the WWW, audio dialogue systems, haptic interaction, gestures),
5. methods for modelling user interfaces (abstract description of interaction, embedding in requirements analysis and the software design process),
6. evaluation of systems for human-machine interaction (tools, evaluation methods, performance measurement, checklists).
7. practising the above basics using practical examples and developing independent, new and alternative user interfaces.

Workload
The total workload for this course unit is approx. 180 hours (6.0 credits).

Attendance time: Attendance of the lecture 15 x 90 min = 22 h 30 min
Attendance time: Attendance of the exercise 8 x 90 min = 12 h 00 min
Preparation / follow-up of the lecture 15 x 150 min = 37 h 30 min
Preparation / follow-up of the exercise 8x 360min =48h 00min
Go through slides/script 2x 2 x 12 h =24 h 00 min
Prepare exam = 36 h 00 min

SUM = 180h 00 min

M 4.41 Module: Humanoid Robots - Locomotion and Whole-Body Control [M-INFO-106649]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

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

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

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

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

Annotation
Limitation to 30 participants

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

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

M 4.42 Module: Humanoid Robots - Seminar [M-INFO-107152]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114170	Humanoid Robots - Seminar	3 CR	Asfour

Competence Certificate
See partial Achievements (Teilleistung)

Prerequisites
See partial Achievements (Teilleistung)

Competence Goal
The students choose a topic from the field of humanoid robotics, e.g. robot design, motion generation, perception or learning. They conduct a literature research on this topic under the guidance of a scientific supervisor. At the end of the semester, they present the results and write a term paper in English in the form of a scientific publication.

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

Content
The student gained experience with literature research on a current research topic. He/she explored, understood and compared different approaches to a selected scientific problem. The student is able to write a summary of their literature research in the form of a scientific publication in English and to give a scientific talk on it.

Workload
Seminar with 2 SWS, 3 LP
3 LP corresponds to 90 hours, including
45 hours literature research
25 hours manuscript preparation
10 hours preparation of the presentation
10 hours attendance time

Recommendation
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III – Sensors and Perception in Robotics, Mechano-Informatics and Robotics and Wearable Robotic Technologies is recommended.

4.43 Module: Interdisciplinary Qualifications [M-INFO-107254]

Responsible: Prof. Dr. Bernhard Beckert
Organisation: KIT Department of Informatics
Part of: Interdisciplinary Qualifications

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

KC_Master (Election: between 1 and 6 credits)			
T-INFO-102051	Reading Group	1 CR	Reussner
T-INFO-111474	Self-Booking-HOC-SPZ-FORUM-Graded	1 CR	Coerdt
T-INFO-111475	Self-Booking-HOC-SPZ-FORUM-Graded	2 CR	Coerdt
T-INFO-111476	Self-Booking-HOC-SPZ-FORUM-Graded	3 CR	Coerdt
T-INFO-111477	Self-Booking-HOC-SPZ-FORUM-Ungraded	1 CR	Coerdt
T-INFO-111478	Self-Booking-HOC-SPZ-FORUM-Ungraded	2 CR	Coerdt
T-INFO-111479	Self-Booking-HOC-SPZ-FORUM-ungraded	3 CR	Coerdt
T-INFO-111839	Information, Science and Responsibility - Current Ethical Challenges of IT	1 CR	Kaplan
T-INFO-112148	Information, Wissenschaft und Verantwortung – aktuelle ethische Herausforderungen der IT	2 CR	Kaplan

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Learning objectives can be divided into three main categories, which complement each other:

1. Orientation knowledge
    - Students become aware of the cultural imprint of their position and are able to consider the views and interests of others (across disciplinary, cultural and linguistic boundaries).
    - They expand their ability to participate in academic or public discussions in an appropriate and relevant manner.
2. practical orientation
    - Students gain insight into the routines of professional action.
    - They further develop their learning skills.
    - They expand their ability to act by improving their foreign language skills.
    - They can link basic business and legal issues to their field of experience.
3. basic skills
    - Students can acquire new knowledge independently in a planned, targeted and methodologically sound manner and apply this knowledge to solve tasks and problems.
    - They can evaluate their own work.
    - They have efficient working techniques, can set priorities, make decisions and take responsibility.

Content
The House of Competence (HoC) is the central, research-based institution in the field of interdisciplinary competence development at KIT and offers students of all disciplines a broad learning portfolio. The HoC seminar program is divided into focus areas that aim to develop interdisciplinary skills for studies and careers. The three HoC laboratories are mainly responsible for the focus areas: the Methods LAB, Learning LAB and Writing LAB.

The courses in the HoC program can be credited in the areas of "Key Qualifications" (SQ), "Additional Professional Qualifications" (BOZ) and in the "Personal Competence Module" for student teachers (MPK). The requirements for the respective degree programs can be found in the applicable examination and study regulations. The current seminar program, which is published each semester, can be found on the HoC homepage at www.hoc.kit.edu.

Annotation
German courses and/or language courses in the native language are not recognized as key qualifications.

Only those examination and study achievements can be credited,
which cannot be taken in the computer science or supplementary subjects.
Certificates of attendance are not accepted.

Workload
Each credit point corresponds to approx. 25-30 hours of work (by the student). This is based on the average student who achieves an average performance. The workload includes (for a lecture)
1. Attendance time in lectures, exercises
2. Preparation and follow-up of the same
3. Exam preparation and attendance in the same.

M 4.44 Module: Internet of Everything (24104) [M-INFO-100800]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-101337	Internet of Everything	4 CR	Zitterbart

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students

- know the challenges of the Internet of Everything (IoE) from both a technical and legal perspective
- know and understand the risks to user privacy in the IoE as well as basic mechanisms and protocols to protect it
- are familiar with the basic architectures and protocols in the field of wireless sensor networks and the Internet of Things.

Students know the platforms and applications of the Internet of Everything. Students have an understanding the challenges of designing protocols and applications for the IoE.

Students know and understand the risks to the privacy of users of the future IoE. They know protocols and mechanisms to enable future applications, such as smart metering and smart traffic, while protecting the privacy of users.

Students know and understand classic sensor network protocols and applications, such as media access procedures, routing protocols, transport protocols and mechanisms for topology control. Students know and understand the interaction of individual communication layers and the influence on, for example, the energy requirements of the systems.

Students know protocols for the Internet of Things such as 6LoWPAN, RPL, CoAP and DICE. Students understand the challenges and assumptions that have led to the standardization of protocols.

Students have a basic understanding of security technologies in IoE. They know typical protection goals and attacks, as well as building blocks and protocols to implement the protection goals.

Content
The lecture deals with selected protocols, architectures, procedures and algorithms that are essential for IoE. In addition to classic topics from the field of wireless sensor-actuator networks, such as media access and routing, this also includes new challenges and solutions for the security and privacy of transmitted data in IoE. Socially and legally relevant aspects are also addressed.

Workload
Lecture with 2 SWS plus follow-up/exam preparation, 4 CP.

4 CP corresponds to approx. 120 working hours, of which

approx. 30 hours lecture attendance

approx. 60 hours preparation/follow-up work

approx. 30 hours exam preparation

Recommendation
See partial achievements (Teilleistung)

M 4.45 Module: Introduction to Bioinformatics for Computer Scientists (2400055) [M-INFO-100749]

Responsible: Prof. Dr. Alexandros Stamatakis
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-101286	Introduction to Bioinformatics for Computer Scientists	3 CR	Stamatakis

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students attain comprehensive knowledge of standard methods, algorithms, theoretical principles and open problems in the field of sequence-based bioinformatics (biological principles, sequence assembly, pairwise sequence alignment, multiple sequence alignment, phylogenetic tree reconstruction under parsimony, likelihood and Bayesian models, coalescent inference in population genetics). They develop the ability to categorise and evaluate algorithms and problems. They can select suitable models and methods for a given biological data analysis problem and can justify their choice. Students will be able to design analysis pipelines for biological data analysis.

Content
Initially, some basic concepts and mechanisms of biology are introduced. Subsequently, algorithms and models from the fields of sequence analysis (sequence alignment, dynamic programming, sequence assembly), population genetics, and discrete as well as numerical algorithms for inferring molecular phylogenetic trees (parsimony, likelihood, Bayesian inference) are discussed. Furthermore, discrete operations on trees are treated (e.g., topological distances between trees, consensus tree algorithms). A substantial part of the lectures will cover the practical implementation, the optimisation, and the parallelisation of the respective methods.

Workload
2 SWS lecture + 1.5 * 2 SWS follow-up) * 15 + 15 hours exam preparation = 90 hours = 3 ECTS

M 4.46 Module: IT Security [M-INFO-106998]

Responsible: Prof. Dr. Jörn Müller-Quade
TT-Prof. Dr. Christian Wressnegger

Organisation: KIT Department of Informatics

Part of: Area of Specialization: Cryptography and Security
Elective Studies in Informatics

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

Mandatory			
T-INFO-113960	IT Security	6 CR	Müller-Quade, Wressnegger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students
• have in-depth knowledge of cryptography and IT security
• know and understands sophisticated techniques and security primitives to achieve the protection goals
• know and understand scientific evaluation and analysis methods of IT security (game-based formalization of confidentiality and integrity, security and anonymity notions)
• have a good understanding of types of data, personal data, legal and technical fundamentals of privacy protection
• know and understand the fundamentals of system security (buffer overflow, return-oriented programming, ...)
• know different mechanisms for anonymous communication (TOR, Nym, ANON) and can assess their effectivity

Content
This advanced mandatory module deepens different topics of IT security. These include in particular:
• Elliptic curve cryptography
• Threshold cryptography
• Zero-knowledge proofs
• Secret sharing
• Secure multi-party computation and homomorphic encryption
• Methods of IT security (game-based analysis and the UC model)
• Crypto-currencies and consensus through proof-of-work/stake
• Anonymity on the Internet, anonymity with online payments
• Privacy-preserving machine learning
• Security of machine learning
• System security and exploits
• Threat modeling and quantification of IT security

Workload
Course workload:
1. Attendance time: 56 h
2. Self-study: 56 h
3. Preparation for the exam: 68 h

Recommendation
Attendance of the lecture Information Security is recommended.

Literature
Literature:
• Katz/Lindell: Introduction to Modern Cryptography (Chapman & Hall)
• Schäfer/Roßberg: Netzsicherheit (dpunkt)
• Anderson: Security Engineering (Wiley, and online)
• Stallings/Brown: Computer Security (Pearson)
• Pfleeger, Pfleeger, Margulies: Security in Computing (Prentice Hall)

M 4.47 Module: Lab Project: Speech Translation [M-INFO-107176]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114205	Lab Project: Speech Translation	6 CR	Niehues

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student
- is able to develop a language translation system using state-of-the-art methods.
- can evaluate language translation systems.
- can present his/her findings in a scientific lecture.

Content
The use of deep learning technologies has significantly improved the quality of machine translation of text and speech in recent years. In this internship, students will develop a language translation system for a new language pair using state-of-the-art methods.
In the first part of the internship, students are introduced step-by-step to the development of a translation system and its evaluation. To this end, the various subtasks must be solved. In the second part of the internship, the students are asked to independently analyse various improvements to the system.

Workload
180h
Approx. 15h presence
Approx. 15h pre/post processing
Approx. 140h self-study
Approx. 10h Preparation of scientific presentation

Recommendation
Students should have understood the theoretical principles as introduced in the lectures Deep Learning or Machine Translation.

M 4.48 Module: Logical Foundations of Cyber-Physical Systems [M-INFO-106102]

Responsible: Prof. Dr. André Platzer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-112360	Logical Foundations of Cyber-Physical Systems	6 CR	Platzer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
In modeling and control, successful students will
– understand core principles behind CPS. A solid understanding of these principles is important for anyone who wants to integrate cyber and physical components to solve problems that no part could solve alone.
– develop models and controls. In order to understand, design, and analyze CPS, it is important to be able to develop models for the relevant aspects of a CPS design and to design controllers for the intended functionalities based on appropriate specifications, including modeling with differential equations.
– identify relevant dynamical aspects. It is important to be able to identify which types of phenomena influence a property of a system. These allow us to judge, for example, where it is important to manage adversarial effects, or where a nondeterministic model is sufficient.

In computational thinking, successful students should be able to
– identify safety specifications and critical properties. In order to develop correct CPS designs, it is important to identify what “correctness” means, how a design may fail to be correct, and how to make it correct.
– understand abstraction in system designs. The power of abstraction is essential for the modular organization of CPS, and the ability to reason about separate parts of a system independently.
– express pre- and post-conditions and invariants for CPS models. Pre- and post-conditions allow us to capture under which circumstance it is safe to run a CPS or a part of a CPS design, and what safety entails. They allow us to achieve what abstraction and hierarchies achieve at the system level: decompose correctness of a full CPS into correctness of smaller pieces. Invariants achieve a similar decomposition by establishing which relations of variables remain true no matter how long and how often the CPS runs.
– reason rigorously about CPS models. Reasoning is required to ensure correctness and find flaws in CPS designs. Both informal and formal reasoning in a logic are important objectives for being able to establish correctness, which includes rigorous reasoning about differential equations.

In CPS skills, successful students will be able to
– understand the semantics of a CPS model. What may be easy in a classical isolated program becomes very demanding when that program interfaces with effects in the physical world.
– develop an intuition for operational effects. Intuition for the joint operational effect of a CPS is crucial, e.g., about what the effect of a particular discrete computer control algorithm on a continuous plant will be.
– understand opportunities and challenges in CPS and verification. While the beneficial prospects of CPS for society are substantial, it is crucial to also develop an understanding of their inherent challenges and of approaches for minimizing the impact of potential safety hazards. Likewise, it is important to understand the ways in which formal verification can best help improve the safety of system designs.

Content
Cyber-physical systems (CPSs) combine cyber capabilities (computation and/or communication) with physical capabilities (motion or other physical processes). Cars, aircraft, and robots are prime examples, because they move physically in space in a way that is determined by discrete computerized control algorithms. Designing these algorithms to control CPSs is challenging due to their tight coupling with physical behavior. At the same time, it is vital that these algorithms be correct, since we rely on CPSs for safety-critical tasks like keeping aircraft from colliding. In this course we will strive to answer the fundamental question posed by Jeannette Wing:

“How can we provide people with cyber-physical systems they can bet their lives on?”

The cornerstone of this course design are hybrid programs (HPs), which capture relevant dynamical aspects of CPSs in a simple programming language with a simple semantics. One important aspect of HPs is that they directly allow the programmer to refer to real-valued variables representing real quantities and specify their dynamics as part of the HP.

This course will give you the required skills to formally analyze the CPSs that are all around us—from power plants to pacemakers and everything in between—so that when you contribute to the design of a CPS, you are able to understand important safety-critical aspects and feel confident designing and analyzing system models. It will provide an excellent foundation for students who seek industry positions and for students interested in pursuing research.

Annotation
Course web page: https://lfcps.org/course/lfcps.html

Workload
6 ECTS from 180h of coursework consisting of
45h = 15 * 3 from 3 SWS lectures
15h = 15 * 1 from 1 SWS exercises
68h preparation, reading textbook, studying
40h solving exercises
12h exam preparation

Recommendation
The course assumes prior exposure to basic computer programming and mathematical reasoning. This course covers the basic required mathematical and logical background of cyber-physical systems. You will be expected to follow the textbook as needed: André Platzer. Logical Foundations of Cyber-Physical Systems. Springer 2018. DOI:10.1007/978-3-319-63588-0

M 4.49 Module: Low Power Design (24672) [M-INFO-100807]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-101344	Low Power Design	3 CR	Henkel

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are made aware of various low power design optimizations employed in state-of-the-art embedded devices. This involves optimization techniques that incorporate embedded machine learning algorithms to enhance system performance. At the end of the lecture, the students will be able to recognize the challenges involved in crafting efficient low power designs and how to tackle them.

Content
The lecture provides an overview of design methods, synthesis tools, estimation models, software techniques, operating system strategies, scheduling algorithms, embedded machine learning methods, etc., with the aim of minimizing the power consumption of embedded devices without compromising their performance. Both the research-relevant and industry-prevalent topics at different level of abstractions (from circuit to system) are discussed in this lecture.

Workload
Attendance time: 30 hours (2 SWS × 15 weeks)

Self-study: 45 hours (1.5 × 2 SWS × 15 weeks)

Exam preparation: 15 hours

Total: 90 hours (3 ECTS)

M 4.50 Module: Machine Learning - Foundations and Algorithms [M-INFO-107169]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

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

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

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

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

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

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

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

M 4.51 Module: Machine Learning for Natural Sciences [M-INFO-106959]

Responsible: TT-Prof. Dr. Pascal Friederich
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Area of Specialization: Data Science
Elective Studies in Informatics

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

Mandatory			
T-INFO-113916	Machine Learning for Natural Sciences	3 CR	Friederich
T-INFO-113917	Machine Learning for Natural Sciences - Pass	3 CR	Friederich

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Competence Goal
Qualification Objectives

• Students are able to name relevant machine learning methods, describe them, as well as develop independent proposals on how questions in the natural sciences and material sciences can be answered using machine learning methods.
Learning Objectives
• Necessary knowledge for the selection and, if necessary, the adaptation of suitable machine learning models.
• Knowledge about data availability and, if necessary, planning of training data generation
• Knowledge of practical implementation, training, and systematic evaluation of machine learning models in python using common libraries (sklearn, TensorFlow, Keras, PyTorch, etc.)
• Knowledge of ways and means to systematically analyze and interpret results.

Content
This module covers the theoretical and practical aspects of machine learning methods and their application to problems in natural sciences, especially in materials science and chemistry. Students gain insight into machine learning fundamentals as well as current research topics of this still young interdisciplinary field. Topics covered include the application of machine learning methods for medical image analysis, sequence analysis and generation, the prediction of material and molecular properties, generative models for materials design, Bayesian methods for decision making in autonomous experiments, as well as interpretation possibilities of all methods for gaining scientific understanding.
A practical exercise based on jupyter notebooks gives students insight into the practical aspects of machine learning for natural sciences and supports the learning process.

Workload
4 SWS: (2 SWS Lecture + 2 SWS Exercise + 1,5 x 4 SWS Preparation) x 15 + 30 h exam preparation
= 180 h

Recommendation
• Knowledge of the basics of machine learning is helpful but not required
• Interest in natural science topics is required
• Basic knowledge of python is recommended. It has to be acquired during the semester through self-study

M 4.52 Module: Machine Learning in Climate and Environmental Sciences [M-INFO-106470]

Responsible: TT-Prof. Dr. Peer Nowack
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Area of Specialization: Data Science
Elective Studies in Informatics

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

Mandatory			
T-INFO-113083	Machine Learning in Climate and Environmental Sciences	6 CR	Nowack
T-INFO-113085	Machine Learning in Climate and Environmental Sciences - Pass	0 CR	Nowack

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Learning objectives:

Students will be able to effectively address complex data science challenges. They can design and use robust strategies/modelling pipelines for machine learning applications in the climate and environmental sciences, which are transferable to other disciplines.
Their acquired knowledge will include major classes of machine learning techniques, how to choose and differentiate among algorithms in a variety of problem settings, ways of assessing important data properties that could for example help or interfere with modelling goals, and methods to combine data-driven modelling with prior scientific system understanding to increase performance and trustworthiness of machine learning.

Students will learn how to implement these approaches in Python, using major machine learning software packages.

Content
This module covers key concepts for real-world applications of machine learning, focusing on environmental data science. These include:

• foundations of machine learning (e.g., curse of dimensionality, cross-validation, cost functions, feature engineering)
• several widely applied regression, classification, and unsupervised learning algorithms (e.g., LASSO, random forests, Gaussian processes, neural networks, LSTMs, transformers, self-organizing maps)
• time series forecasting and causal inference.
• explainable AI (e.g., SHAP value analyses, feature permutation methods, intrinsically interpretable methods).

These concepts will be discussed in applied contexts, using current research examples from the climate and environmental sciences, including: climate change modelling, machine learning emulation of numerical models, forecasting air pollution and wildfires, understanding coupled dynamical systems such as global teleconnections in climate science, challenges in modelling non-stationary systems (e.g., predicting extreme weather events under global warming), and anomaly detection in measurement data.

The lectures are accompanied by computer exercises in which students learn how to implement and modify machine learning modelling pipelines first-hand.

Workload
Concerning in-person events, this is a 4 SWS module: 2 SWS for lectures, 2 SWS for exercises

Overall:

(2 SWS lectures + 2 SWS exercises + 1.5 x 4 SWS preparation and homework) x 15 +30 h preparation for the exam = 180 h = 6 ECTS

Recommendation
• Previous programming experience, e.g. in scientific contexts or in computer science, is required.
• Knowledge of fundamentals about machine learning is an advantage.
• Knowledge of the Python programming language is an advantage.
• Good knowledge of mathematical concepts such as linear algebra is an advantage.
• An interest in scientific questions important for the climate- and environmental sciences.

M 4.53 Module: Mobile Communication (24643) [M-INFO-107245]

Responsible: Prof. Dr. Oliver Waldhorst
Prof. Dr. Martina Zitterbart

Organisation: KIT Department of Informatics

Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-114271	Mobile Communication	4 CR	Waldhorst, Zitterbart

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students

- know the basic concepts of mobile communication and can evaluate basic methods and influencing factors of wireless communication

- are familiar with the structure and functionality of prominent, practically relevant mobile communication systems (e.g. GSM, UMTS, WLAN)

- know typical problems in mobile communication systems and can evaluate, select and apply suitable methods to solve them

Students are familiar with typical problems in wireless transmission (e.g. signal propagation, attenuation) and can explain these using examples and relate them to each other. They can also recognize where these problems typically occur when designing different communication systems.

Students are familiar with a portfolio of methods for modulating digital data, multiplexing, coordinating competing media access and mobility management. They will be able to explain these in their own words, evaluate them and select suitable candidates when designing mobile communication systems.

Students master the basic concepts of wireless local networks according to IEEE 802.11 and wireless personal networks with Bluetooth. They can explain these and compare the respective variants with each other. They will also be able to analyze and evaluate media access in detail.

Students master the structure of digital telecommunications systems such as GSM, UMTS and LTE as well as the individual tasks of the respective components and their detailed interaction in the overall system. They are familiar with the conceptual differences between the systems presented and can explain in their own words why certain methods from the portfolio are used in the respective systems.

Students will be familiar with basic routing methods in self-organizing wireless ad hoc networks and will be able to analyse these comprehensively and evaluate their use depending on the application scenario. Furthermore, they master the basic concepts of mobility support on the Internet (Mobile IP and Mobile IPv6).

Content
The lecture first discusses typical problems in wireless transmission, such as signal propagation, attenuation, reflections and interference. Based on this, it develops a portfolio of methods for modulation of digital data, multiplexing, coordination of competing media accesses and mobility management. To illustrate where and how these methods are used in practice, typical mobile communication systems of great practical relevance are presented in detail. These include wireless local area networks according to IEEE 802.11, wireless personal networks with Bluetooth as well as wireless telecommunication systems such as GSM, UMTS with HSPA and LTE. Discussions of mechanisms at the network layer (mobile ad-hoc networks and MobileIP) and transport layer round off the lecture.

Workload
Lecture with 2 SWS plus follow-up/exam preparation, 4 CP.

4 CP corresponds to approx. 120 working hours, of which

approx. 30 hours lecture attendance

approx. 60 hours preparation/follow-up work

approx. 30 hours exam preparation

M 4.54 Module: Mobile Communications [M-ETIT-105971]

Responsible: Prof. Dr.-Ing. Peter Rost
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Minor Studies: Electrical Engineering

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

Mandatory			
T-ETIT-112127	Mobile Communications	4 CR	Rost

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

Prerequisites
none

Competence Goal
Students are enabled to analyze and assess functionalities of mobile communication systems. They learn how to apply and implement fundamental methods of the lecture “Communications Engineering I” in mobile radio networks. Furthermore, students will be enabled to understand requirements and limitations of mobile applications.

Content
At the beginning, this course describes exemplary applications of mobile communications and elaborates on resulting requirements. Based on a solid understanding of those requirements, selected approaches and techniques will be presented that are solving the respective challenges in mobile communication systems. To this end, algorithms as well as system architectures are discussed in order to acquire solid knowledge on the radio network, the core network and the integration with applications and services.

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

Workload
1. Attendance time in lectures: 15 * 2 h = 30 h
2. Preparation and follow-up of lectures: 15 * 2 h = 30 h
3. Attendance time in excercises: 15 * 1 h = 15 h
4. Preparation and follow-up of excercises: 15 * 1 h = 15 h
5. Preparation for the oral exam: 30 h

In total: 120 h = 4 LP

Recommendation
Knowledge of basic engineering as well as basic knowledge of communications engineering and Previous attendance of the lecture "Communication Engineering I" is recommended. Sound English language skills are required.

4.55 Module: Model-Driven Software Development [M-INFO-106931]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-113896	Model-Driven Software Development	3 CR	Burger, Reussner

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
* Students understand model-driven approaches for software and systems development, and they can use and assess them.
* Students can create metamodels and transformations using established model-driven development processes and standards of the OMG (MOF, QVT, XMI, UML, etc.), as well as state-of-the-art languages and tool} (Xtext, Xtend, Xpand, etc.)
* Students know the theoretical background of model transformation languages.
* Students know practical applications of model-driven technologies.
* Students can assess standards and technologies and can estimate their respective advantages and disadvantages.

Content
Model-driven software development pursues the development of software systems on the basis of models. The models are not only used to document, design and analyse an initial system, as is usual in conventional software development, but rather serve as primary development artefacts from which the final system can be generated in its entirety if possible. This focus on models offers a number of advantages, such as an increase in the level of abstraction at which the system is specified, improved communication options that can extend to the end customer through domain-specific languages (DSL), and an increase in the efficiency of software development through automated transformations of the created models to the source code of the system. However, there are still some unresolved challenges in the use of model-driven software development, such as model versioning, evolution of DSLs, maintenance of transformations or the combination of teamwork and MDSD. Although MDSD is already used in practice due to the advantages mentioned, the challenges mentioned also offer opportunities for current research.

The lecture introduces concepts and techniques that are part of MDSD. As a basis, the systematic creation of meta-models and DSLs including all necessary components (concrete and abstract syntax, static and dynamic semantics) is introduced. This is followed by a general discussion of the concepts of transformation languages and an introduction to some selected transformation languages. The embedding of MDSD in the software development process provides the necessary foundations for their practical use. The remaining lectures deal with further issues such as model versioning, model coupling, MDSD standards, teamwork based on models, testing of model-driven software, as well as the maintenance and further development of models, meta-models and transformations. Finally, model-driven methods for analysing software architecture models are covered as an advanced unit. The lecture deepens concepts from existing courses such as software engineering or compiler construction or transfers and extends them to model-driven approaches. Furthermore, formal techniques are applied in transformation languages, such as graph grammars, logical calculi or relational algebrae.

Workload
(2 SWS + 1.5 x 2 SWS) x 15 + 15 h exam preparation = 90 h

4.56 Module: Modern Methods in Combinatorics [M-MATH-106957]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: Minor Studies: Mathematics

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

Mandatory			
T-MATH-113911	Modern Methods in Combinatorics	6 CR	Aksenovich

Competence Certificate
The module examination takes the form of an oral examination (approx. 30 min).

Prerequisites
None

Competence Goal
The students understand and are able to use powerful modern methods in Combinatorics.

Content
The course is concerned with modern methods in Combinatorics including probabilistic or algebraic ones. Every presented method is illustrated with several applications.

The probabilistic part includes the following topics: random graphs, linearity of expectation, second moment method, and Lovasz Local Lemma. The algebraic part includes: polynomial methods, spectral methods, and linear algebraic techniques.

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

Workload
Total workload: 180 hours

Attendance time: 60 hours

- Course including module examination during the course of study

Self-study: 120 hours

- Deepening the study content by working on the lecture content at home
- completion of exercises
- In-depth study of the course content using suitable literature and internet research
- Preparation for the module examination during the course of study

Recommendation
Some knowledge of linear algebra and probability theory is strongly recommended. The courses *Graph Theory* and *Combinatorics* are recommended but not required.

M 4.57 Module: Module Master's Thesis [M-INFO-106828]

Responsible: Prof. Dr. Bernhard Beckert
Organisation: KIT Department of Informatics
Part of: Master‘s Thesis

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

Mandatory			
T-INFO-113697	Master's Thesis	30 CR	Beckert

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Modeled Conditions
The following conditions have to be fulfilled:

1. You need to have earned at least 60 credits in the following fields:
   - Area of Specialization: Algorithm Engineering
   - Area of Specialization: Computer Graphics and Geometry Processing
   - Area of Specialization: Cryptography and Security
   - Area of Specialization: Data Science
   - Area of Specialization: Design of Embedded Systems and Computer Architectures
   - Area of Specialization: Human-centred Machine Intelligence
   - Area of Specialization: Parallel Computing
   - Area of Specialization: Robotics and Automation
   - Area of Specialization: Software Engineering and Compiler Construction
   - Area of Specialization: System Architecture
   - Area of Specialization: Telematics
   - Area of Specialization: Theoretical Foundations
   - Elective Studies in Informatics
   - Interdisciplinary Qualifications
   - Minor Studies: Economics
   - Minor Studies: Electrical Engineering
   - Minor Studies: Law
   - Minor Studies: Mathematics
   - Minor Studies: Mechanical Engineering
2. You need to have earned at least 15 credits in the following fields:
   - Area of Specialization: Algorithm Engineering
   - Area of Specialization: Computer Graphics and Geometry Processing
   - Area of Specialization: Cryptography and Security
   - Area of Specialization: Data Science
   - Area of Specialization: Design of Embedded Systems and Computer Architectures
   - Area of Specialization: Human-centred Machine Intelligence
   - Area of Specialization: Parallel Computing
   - Area of Specialization: Robotics and Automation
   - Area of Specialization: Software Engineering and Compiler Construction
   - Area of Specialization: System Architecture
   - Area of Specialization: Telematics
   - Area of Specialization: Theoretical Foundations

Competence Goal

- In the Master's thesis, students work independently on a topic in computer science in line with the current state of research.
- Students demonstrate a comprehensive understanding of the scientific methods and procedures relating to the topic.
- Students select suitable methods and apply them correctly. If necessary, they adapt them accordingly or develop them further.
- Students critically compare their results with other approaches and evaluate their results.
- Students form a scientific opinion and are able to present and defend this and their results in discussions.

Content

- The Master's thesis should demonstrate that students are able to work on a problem from their subject independently and within a limited period of time using scientific methods that reflect the current state of research.
- The completion period is six months. Upon justified request by the student, the Examination Board may extend the completion time by a maximum of three months. The Master's thesis can also be written in English in agreement with the supervisor.
- If the Master's thesis is to be written outside the faculty, this requires the approval of the Examination Board.
- The Master's thesis may also be approved in the form of a group thesis if the contribution of the individual students to be assessed as examination performance is clearly distinguishable.
- When submitting the Master's thesis, students must confirm in writing that they have written the thesis independently and have not used any sources or aids other than those specified by them, that they have identified the passages taken verbatim or in terms of content as such and that they have observed the statutes of the Karlsruhe Institute of Technology (KIT) for ensuring good scientific practice in the currently valid version.
- The date of issue of the topic and the date of submission of the Master's thesis must be recorded.

4.58 Module: Motion in Human and Machine - Seminar [M-INFO-102555]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence

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

Mandatory			
T-INFO-105140	Motion in Human and Machine - Seminar	3 CR	Asfour

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student knows procedures for modelling human motion, as well as possibilities for its processing and analysis. He/she knows methods for learning motion primitives and mapping human motion to robots that have different kinematics and dynamics and can apply them in new contexts.

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

Content
This interdisciplinary block seminar deals with methods of modelling, generating and controlling movements in humans and robot systems. Students get an insight into this interdisciplinary field and learn the basics of biological motion, biomechanical simulation, robotics, and machine learning. In the introduction, motion generation as effect of muscle contraction is discussed. It will be shown how movement patterns can be identified and categorized based on the observation of human movements and how these patterns can be reproduced on a humanoid robot. Finally, methods for the learning of movement primitives from human demonstration will be presented and their application for the generation of motion for humanoid robots will be explained.

Annotation
The block internship is an interdisciplinary event in co-operation with the University of Stuttgart and the University of Heidelberg.

Workload
Seminar with 3 SWS, 3 LP
3 LP corresponds to 90 hours, including
30 hours attendance time
15 hours group work
20 hours literature research
20 hours manuscript preparation
5 hours video creation

Recommendation
Programming experience in C++, Python or Matlab is recommended.
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics, Mechano-Informatics and Robotics and Wearable Robotic Technologies is recommended.

M 4.59 Module: Nano- and Quantum Electronics [M-ETIT-105604]

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

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 4.60 Module: Natural Language Processing [M-INFO-107178]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114207	Natural Language Processing	6 CR	Niehues

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- To familiarise the student with the problems that exist in natural language processing
- The student should be introduced to the basic techniques for solving the problems.
- The student should gain an insight into current research in the field of natural language processing and be able to use the language processing and can use the acquired knowledge to work on current research topics

Content
Summarise today's lecture? When were neural networks invented? Artificial intelligence that can answer these questions has long been a dream of mankind. And today we are seeing the first programmes that can solve these problems. In this lecture we will provide the skills and knowledge to develop solutions to these problems of natural language processing using state-of-the-art methods.
After an introduction to the challenges of natural language processing, the different tasks in natural language processing are discussed. One focus of the course is on methods from the field of deep learning. Firstly, sequence classification tasks such as sentiment analysis are covered. Next, methods of sequence labelling are discussed, such as those used in the recognition of proper names or the determination of part-of-speech tags. The lecture will then discuss sequence-to-sequence methods. These models are used in many natural language processing tasks, such as machine translation, automatic summarisation and automatic question answering.
In this course, the important challenges in the development of systems will be addressed: The representation of words, neural architectures to model language, methods to train complex models, and finding the most likely output.

Workload
180h

4.61 Module: Natural Language Processing and Software Engineering [M-INFO-107233]

Responsible: Prof. Dr.-Ing. Anne Koziolek
Organisation: KIT Department of Informatics
Part of: Elective Studies in Informatics

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

Mandatory			
T-INFO-114257	Natural Language Processing and Software Engineering	3 CR	Koziolek

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know basic concepts of linguistics such as syntax, semantics and pragmatics, and can explain and compare them. They are familiar with lexical relations such as polysemy, homonymy, and troponymy and can identify relevant examples. Furthermore, they can identify and compare connections between the relations.

Students are familiar with basic concepts of computational linguistics. Basic techniques such as part-of-speech tagging, lemmatization, word similarities and disambiguation can be explained. Associated methods (lexical, rule-based, or probabilistic) can be described and their respective strengths and weaknesses assessed. Different parsing methods can be named, explained and conceptually reproduced.

Students can describe and compare the structure, content and benefits of different knowledge bases. In addition to the overarching concepts of ontology, lexical databases and other knowledge representations, they are also familiar with specific representatives, such as WordNet, DBpedia and similar, and can use them.

Students understand the connection between the functionality of basic computational linguistics techniques and their applicability in software engineering. In addition, they can break down tool chains into individual components and evaluate them. In particular, students will be able to analyze and evaluate different applications. These include automated modeling, improving requirements specifications, and traceability link recovery. In addition, students can explain the concept of large language models (LLMs) and their application and use in the field of language processing. Students can identify application scenarios in software engineering for text analysis systems and design their own solutions.

Content
This lecture provides the basics for the automated processing of natural language texts. Language processing is becoming increasingly important.

Linguistic input plays a critical role in interactive systems, such as voice commands, assistance systems, and query interfaces. Additionally, the analysis and processing of text-based software artifacts represents an important field of research. Computational linguistics is therefore not only of great importance for software applications, but also for software engineering itself.

The aim of this lecture is to provide basic knowledge of natural language processing (NLP) and its potential applications in the development of software systems. Key topics include the automated analysis of texts, the challenges posed by the inherent ambiguity of natural language, the translation of natural language texts into software models, and the use of large language models (LLMs) in software engineering. The lecture will also explore current research developments and trends in the field.

Workload
3 ECTS correspond to approximately 90 hours of work, including:

approx. 30 hours of attending lectures

approx. 45 hours of preparation and follow-up work

approx. 15 hours of exam preparation

4.62 Module: Network Security: Architectures and Protocols [M-INFO-107218]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-114238	Network Security: Architectures and Protocols	4 CR	Zitterbart

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students

- know basic challenges, protection goals and cryptographic building blocks that are relevant for the design of secure communication systems
- are proficient in security-relevant communication protocols (e.g. Kerberos, TLS, IPSec) and can identify and explain basic security mechanisms
- have the ability to analyze and evaluate communication protocols from a security perspective
- have the ability to assess and evaluate the quality of security mechanisms in relation to the required security objectives

In particular, students are familiar with typical attack techniques such as eavesdropping, interception or replaying and can explain these using examples. In addition, students are familiar with cryptographic primitives such as symmetric and asymmetric encryption, digital signatures, message authentication codes and can apply these in particular for the design of secure communication services.

Students are familiar with the Kerberos distributed authentication service and can explain the protocol flow in their own words and name basic concepts (e.g. tickets). In addition, students are familiar with relevant communication protocols for protecting communication on the Internet (e.g. IPsec, TLS) and can explain these and analyze and evaluate their security properties.

Students know different methods for network access protection and can explain and compare common authentication methods (e.g. CHAP, PAP, EAP). Furthermore, students are proficient in methods for protecting wireless access networks and can analyze and evaluate methods such as WEP, WPA and WPA2.

Students master different trust models and can explain and apply basic technical concepts (e.g. digital certificates, PKI) in their own words. In addition, students develop an understanding of data protection aspects in communication networks and can explain and apply technical procedures to protect privacy.

Content
The lecture "Network Security: Architectures and Protocols" looks at challenges and techniques in the design of secure communication protocols as well as data protection and privacy issues. Complex systems such as Kerberos are examined in detail and their design decisions with regard to security aspects are highlighted. Special focus is placed on PKI fundamentals, infrastructures and specific PKI formats. Further emphasis is placed on the common security protocols IPSec and TLS/SSL as well as protocols for infrastructure protection.

Workload
Lecture with 2 SWS plus follow-up/exam preparation, 4 CP.

4 CP corresponds to approx. 120 working hours, of which

approx. 30 hours lecture attendance

approx. 60 hours preparation/follow-up work

approx. 30 hours exam preparation

M 4.63 Module: Next Generation Internet (24674) [M-INFO-100784]

Responsible: Dr.-Ing. Roland Bless
Prof. Dr. Martina Zitterbart

Organisation: KIT Department of Informatics

Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-101321	Next Generation Internet	4 CR	Bless, Zitterbart

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students

know the basic properties and architectural concepts of the Internet as well as its limitations.
know newer transport protocols and current approaches to increase the flexibility of Internet-based communication and can apply this knowledge in practice.
are familiar with concepts for quality of service support and group communications and can apply mechanisms for their implementation on the Internet
have the ability to analyze and evaluate peer-to-peer systems and advanced routing protocols
are familiar with concepts of satellite networking and quantum Internet
In particular, students know important architectural concepts and design principles that are used on the Internet and can explain these using examples or apply them themselves when designing systems. In addition, students know the concept of quality of service and important quality of service parameters, are familiar with basic mechanisms for supporting
quality of service (e.g. classifiers, traffic shapers, queuing and scheduling strategies, resource reservation), can analyze and evaluate them and can apply them to the design of communication systems.
Moreover, students know the requirements and challenges for today's transport protocols and newer congestion control algorithms and can analyze and assess trade-offs of the presented approaches.

Students know the characteristics of peer-to-peer systems, can explain them and can compare different forms of organization.
Furthermore, students master routing procedures in such decentrally organized peer-to-peer systems and can explain how they work in detail in their own words. Similarly, students know inherent trade-offs for routing in the Internet and can explain newer approaches in their own words.

In addition, students develop an understanding of the functioning of newer approaches to increase the flexibility of communication networks (e.g. network virtualization, software-defined networking, service function chaining) and can analyze, explain, and apply technical procedures for their implementation. Moreover, students know properties of satellite and quantum networks and their corresponding challenges.

Content
The lecture focuses on current developments in Internet-based network technologies. First, architectural principles of today's Internet are presented and discussed, subsequently nowadays and future challenges are motivated.
The lecture also discusses approaches and paradigms beyond the current Internet architecture, methods for quality-of-service support, newer transport protocols and congestion control approaches as well as group communication support. Deployments of the presented technologies in IP-based networks are discussed. The lecture presents advanced approaches such as programmable networks, network virtualization as well as newer approaches and protocols for routing, satellite networking, and peer-to-peer networks. A brief introduction to the technology of a future quantum Internet is provided as well.

Workload
Lecture with 2 SWS plus follow-up/exam preparation, 4 CP.

4 CP corresponds to approx. 120 working hours, of which

approx. 30 hours lecture attendance

approx. 60 hours preparation/follow-up work

approx. 30 hours exam preparation

Literature
J.F. Kurose, K.W. Ross; Computer Networking: A Top-Down Approach. Pearson, 2022, 8th Edition, ISBN 978-1292405469

M 4.64 Module: Optical Engineering [M-ETIT-100456]

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

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

Mandatory			
T-ETIT-100676	Optical Engineering	4 CR	Stork

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

Prerequisites
none

Competence Goal
The students from different backgrounds refresh and elaborate their knowledge of engineering optics and photonics. They will get to know the basic principles of optical designs. They will connect these principles with real-world applications and learn about their problems and how to solve them. The students will know about the human view ability and the eye system. After the module they will be able to judge the basic qualities of an optical system by its quantitative data.

After the course, students will:

- understand fundamental optical phenomena and apply it to solve optical engineering problems;
- work with the basic tools of optical engineering, i.e. ray-tracing by abcd-matrices;
- get a broad knowledge on real-world applications of optical engineering;
- learn about the potential of optical design for industrial, medical and day-to-day applications;
- know up-to-date optical engineering problems and its solutions.

Content
The course "Optical Engineering" teaches the practical aspects of designing optical components and instruments such as lenses, microscopes, optical sensors and measurement systems, and optical disc systems (e.g. CD, DVD, HVD). The course explains the layout of modern optical systems and gives an overview over available technology, materials, costs, design methods, as well as optical design software. The lectures will be given in the form of presentations and accompanied by individual and group exercises. The topics of the lectures include:

I. Introduction (Optical Phenomena)

II. Ray Optics (thin/thick lenses, principal planes, ABCD-matrices, chief rays, examples: Eye, IOL)

III. Popular Applications (Magnifying glass, microscope, telescope, Time-of-flight)

IV. Wave Optics (Interference, Diffraction, Spectrometers, LDV)

V. Aberrations I (Coma, defocus, astigmatism, spherical aberration)

VI. Fourier Optics (Periodical patterns, FFT spectrum, airy-patterns)

VII. Aberration II (Seidel and Zernike Aberrations, MTF, PSF, Example: Eye)

VIII. Fourier Optics II (Kirchhoff + Fresnel, contrast, example: Hubble-telescope)

IX. Diffractive Optics Applications (Gratings, holography, IOL, CD/DVD/Blu-Ray-Player)

X. Interference (Coherence, OCT)

XI. Filters and Mirrors (Filters, antireflection, polarization, micro mirrors, DLPs)

XII. Laser and Laser Safety (Laser principle, laser types, laser safety aspects)

XIII. Displays (Pico projectors, LCD, LED, OLED, properties of displays)

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 selfstudies

Recommendation
Solid mathematical background.

Literature

E. Hecht: Optics

J.W. Goodmann: Introduction to Fourier optics

K.K. Sharma: Optics - Principles and Applications

M 4.65 Module: Optimization and Synthesis of Embedded Systems (ESI) [M-INFO-107229]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-114253	Optimization and Synthesis of Embedded Systems (ESI)	3 CR	Henkel

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student can develop embedded systems. They can specify, synthesize and optimize their own hardware. They learn the hardware description language and are familiar with the special boundary conditions of the design of embedded systems.

Content
The cost-effective and error-free development of embedded systems represents a challenge that should not be underestimated and which is having an ever greater influence on the added value of the overall system. In Europe in particular, the design of embedded systems is playing an increasingly important economic role in many sectors of the economy, such as the automotive industry, so that a number of well-known companies are already involved in the development of embedded systems.

The lecture deals comprehensively with all aspects of the development of embedded systems at hardware, software and system level. This includes diverse areas such as modelling, optimization and synthesis of systems.

Workload
90 hrs.

4.66 Module: Optimization Methods for Machine Learning and Engineering [M-INFO-105329]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-110809	Optimization Methods for Machine Learning and Engineering	5 CR	Beyerer, Pfrommer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are able to formulate practical tasks as optimisation problems and solve them using suitable algorithmic methods.
Learning objectives: The students know
- The most important categories of (convex) optimisation problems and their mathematical foundations
- The associated algorithmic solution methods and their runtime complexity
- Techniques for modelling practical tasks as optimisation problems (machine learning, engineering, finance)
- Methods for transforming and approximating optimisation problems for the use of resource-efficient methods

Content
The term optimization refers to techniques for the identification of the best solution in a complex problem setting. Many applications from machine learning and engineering are based on solving an optimization problem. This lecture introduces the major theoretical and algorithmic tools for solving of convex optimization problems. Practical problems for machine learning, engineering and further application domains are used as illustration. The students apply their knowledge to practical optimization problems in tutorial exercises.

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

Literature

- Boyd, Stephen, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.
- Luenberger, David G. Optimization by vector space methods. John Wiley & Sons, 1969.
- Sra, Suvrit, Sebastian Nowozin, and Stephen J. Wright, eds. Optimization for machine learning. MIT Press, 2012.

M 4.67 Module: Parallel Algorithms (2400053) [M-INFO-107199]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114221	Parallel Algorithms	4 CR	Sanders
T-INFO-114222	Parallel Algorithms Pass	1 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students acquire a systematic understanding for algorithmic problems and their solutions in the field of parallel algorithms, building on existing knowledge in algorithmics. Additionally, they are able to apply learned techniques to related problems and to interpret and comprehend current research topics.

After successful attendance of the course, the students are able to

• explain terms, structures, basic problem definitions and algorithms from the lecture;
• decide which algorithms and data structures are suitable for solving a given problem and, if necessary, adapt them to the requirements ofa specific problem;
• execute algorithms and data structures, conduct a mathematically precise analysis, and prove their algorithmic properties;
• explain machine models from the lecture and analyze algorithms and data structures in them;
• analyze new problems from application contexts, reduce them to their algorithmic core and design an abstract model; design own solutions in this model using concepts and techniques from the lecture, analyze them and prove the algorithmic properties.

Content
Models and their relation to real machines:
• shared memory - PRAM
• message passing - BSP
• circuits

Analysis: speedup, efficiency, scalability

Basic techniques:
• SPMD
• parallel divide-and-conquer
• collective communication
• load balancing

Concrete algorithms (examples):
• collective communication (including large data volumes): broadcast,
• reduce, prefix sums, all-to-all exchange
• matrix computations
• sorting
• list ranking
• minimum spanning trees
• load balancing: master worker with adaptive problem size, random
• polling, random distribution

Workload
Lecture and exercise with 3 semester hours per week, 5 ECTS correspond to approx. 150 working hours, consisting of
• approx. 30 h attendance of the lecture and exercise session / block seminar
• approx. 60 h preparation and follow-up work
• approx. 30 h working on exercise sheets / preparation of seminar presentation
• approx. 30 h exam preparation

Recommendation
The partial achievement **Parallel Algorithms Exercise** must be started before.

4.68 Module: Parameterized Algorithms [M-INFO-107167]

Responsible: TT-Prof. Dr. Thomas Bläsius
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114194	Parameterized Algorithms	6 CR	Bläsius
T-INFO-114195	Parameterized Algorithms - Pass	0 CR	Bläsius

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students acquire a systematic understanding of the parameterised approach in the runtime analysis of algorithms, as well as the associated techniques for algorithm design, which build on existing knowledge in theoretical computer science and algorithmics. After successfully completing the course, students will be able to
- reproduce and explain basic algorithmic techniques and analysis techniques in the field of parameterised algorithms,
- execute parameterised algorithms by way of example, analyse them with mathematical precision and prove their properties,
- select which algorithms or algorithmic techniques are suitable for a given parameterised problem,
- analyse unknown problems with regard to their parameterised complexity.

Content
Many problems that arise in practice are NP-hard and therefore generally (presumably) cannot be solved in polynomial time. Nevertheless, these problems can often be solved efficiently because the inputs are "benign". One way to formally capture this benignity of the instances is to consider the parameterised complexity. This involves associating a parameter k with each instance, which represents a measure of the complexity of the input. The aim is then to find an algorithm whose runtime depends only polynomially on the input size n but possibly exponentially on the parameter k. Compared to the rough classification of a problem as polynomially solvable or NP-hard, the parameterised approach offers a much more differentiated view of hard problems.

Workload
Lecture with tutorial with 4 SWS, 6 CP
6 CP corresponds to approx. 180 working hours, of which
approx. 60 hours attending the lecture and tutorial
approx. 30 hours of preparation and follow-up work
approx. 60 hours working on the exercise sheets
approx. 30 hours exam preparation

Recommendation
Basic knowledge of algorithms and data structures (e.g. from the lectures Algorithms 1 + 2) is helpful.

M 4.69 Module: Participatory Technology Design [M-INFO-107170]

Responsible: Prof. Dr. Kathrin Gerling
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114199	Participatory Technology Design	6 CR	Gerling
T-INFO-114200	Participatory Technology Design - Pass	0 CR	Gerling

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
After completing the course, students will be able to reproduce basic and advanced theoretical concepts from human-machine interaction and participatory technology design. Furthermore, they will be able to apply relevant methods for participatory design and evaluation to given problems, taking into account the needs of users and ethical aspects, and derive concrete design recommendations from the results. Finally, students are able to recognise and critically reflect on the connections between participation, design, implementation and evaluation of technologies.

Content

In human-machine interaction, the participatory development of new technologies - i.e. the direct and equal involvement of users in the development process - is becoming increasingly important. It is used, for example, in the development of body-centred and wearable systems, or contributes to the design of solutions in the field of smart and assisted living and personal robotics. Participation is often realised through interviews, focus groups and design workshops; new technologies are also regularly evaluated as part of user studies. The direct involvement of users is intended to ensure that the resulting technologies are better adapted to people's needs and that their benefits and relevance for individuals and society can be increased as a result.
The lecture deals with current research approaches to the participatory design of new technologies and covers the following topics in particular, while continuously taking ethical aspects into account:

- Design approaches, in particular theory-driven design, ethical approaches such as value-sensitive design, and future-oriented approaches such as speculative design and design fiction
- Typical methods of participation in the design and development of technologies, and reflection on the associated challenges and opportunities
- Participatory and user-centred evaluation of technologies and implications for society, research and development

In the associated exercise, students actively develop relevant concepts and reflect on theoretical aspects in their application in the context of practical examples. In addition, current research publications are analysed as part of the exercise.

Workload
The total workload for this course is approx. 180 hours (6 credits).
Approximately...
28h for attending the lecture,
24 hours for attending the exercises,
40h for preparation and follow-up of the lecture,
40h for preparation and follow-up of the exercise,
48h for exam preparation.

Recommendation
Knowledge of the basics of human-machine interaction is helpful.

4.70 Module: Practical Course on Network Security Research [M-INFO-107244]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-114270	Practical Course on Network Security Research	3 CR	Hock, Zitterbart

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are able to understand, justify, evaluate and classify the selected topic or the selected focus from the field of network security.
They know the basic principles relevant to the selected topic and can apply these in practice. Students are also able to derive concrete work steps from a task description and to document, summarize and present the results obtained.

Content
The research practical course on network security is offered alongside the module Network Security: Architectures and Protocols [M-INFO-100782]. The practical course gives students the opportunity to selectively deepen a specific topic from the above-mentioned lecture with current research relevance. The topic may vary and will be announced when registering for the practical course (example: "Attacks and Anomalies in the context of the Border Gateway Protocol").
The practical course consists of five sections:

- Familiarization with the topic
- Selection of a suitable practical focus in coordination
- with the supervising chair
- Practical implementation of the focus
- Presentation of the results in a colloquium (lecture)
- Preparation of a research report (3-5 pages)

Workload
3 ETCS:
Attendance time / meetings in large and small groups: 15h
Selection of the focus: 10h
Conception + specification of the focus: 10h
Implementation of the focus: 20h
Research report and colloquium: 20h

Recommendation
The module Network Security: Architectures and Protocols [M-INFO-100782] should have been started or completed.

M 4.71 Module: Practical Course on Telematics Research [M-INFO-107220]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-114239	Practical Course on Telematics Research	3 CR	Zitterbart

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are able to understand, justify, evaluate and classify the selected topic or focus from the field of telematics.

They know the basic principles relevant to the selected topic and can apply these in practice. Students are also able to derive concrete work steps from a task description and to document, summarize and present the results obtained.

Content
The telematics research internship is offered alongside the telematics module [M-INFO-100801]. The internship gives students the opportunity to selectively deepen a specific topic from the above-mentioned lecture with current research relevance. The topic may vary and will be announced when registering for the practical course (example: "Visualization and anomaly detection in the context of the Border Gateway Protocol").

The practical course consists of the following sections:

- Familiarization with the topic
- Selection of a suitable practical focus in coordination with the supervising chair
- Practical implementation of the focus
- Presentation of the results (colloquium, research report)

Workload
Attendance time / meetings in large and small groups: 15h

Selection of the focus: 10h

Conception + specification of the focus: 10h

Implementation of the focus: 20h

Research report / colloquium: 20h

Recommendation
A pronounced scientific interest in the topics of network security is a prerequisite: no prefabricated exercises are worked on, instead the internship requires a high degree of personal initiative.

M 4.72 Module: Practical Course: Advanced Topics in High Performance Computing, Data Management and Analytics [M-INFO-105870]

Responsible: Prof. Dr. Achim Streit
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-111803	Practical Course: Advanced Topics in High Performance Computing, Data Management and Analytics	6 CR	Streit

Competence Certificate
See partial achivements (Teilleitung)

Prerequisites
See partial achivements (Teilleitung)

Competence Goal
Students know and can apply tools and techniques in the fields of high-performance computing, data management and data analysis. They acquire the possibility to analyze complex scenarios and develop solutions for this. Besides working on the content, students improve their competences in communication and presentation.

Content
Participants will have the chance to deepen their knowledge of high-performance computing, data management and data analysis and to apply it in a practical way. The tasks to be worked on come from the subfields:
• HPC simulations (e.g., parallelization, MPI, performance engineering)
• HPC systems and operating environment (e.g., On Demand File Systems, Infiniband Networks, Job Scheduling)
• Machine Learning and Data Mining (e.g., RapidMiner, scikit)
• Data-Intensive Computing (e.g., Hadoop, Spark).
• HPC and data analysis with Python (e.g., Numpy, Scipy, Pandas, Dask, Parsl)
• Distributed & Parallel File Systems (e.g., glusterFS, BeeGFS)
• Object Storage (e.g., S3, CEPH)
• Data Management System (e.g., dCache, iRods)
• Databases (e.g., SQL, NoSQL)
• Workflow management systems for HPC and data analysis (e.g., FireWorks, AiiDA, SimStack)
• Opportunistic resource integration and utilization (e.g., using COBalD/TARDIS)
• Authentication and authorization infrastructure (e.g., OpenID, SAML)

Students are individually supervised by scientific staff of the Scientific Centre for Computing and can apply their skills in a practical and research-oriented way by being involved in current research tasks (e.g., Helmholtz program, BMBF and EU projects).

Workload
3 SWS = 150 h per semester
• 12 h in meetings during the semester (kick-off, regular meetings with the supervisor, final meeting including presentation)
• 18 h preparation of meetings
• 120 h working on the topic and preparation of the exam

Recommendation
Knowledge in the area of databases, data management, data analytics, parallel computing is helpful.

M 4.73 Module: Practical Course: AI for Climate and Weather Predictions [M-INFO-106800]

Responsible: TT-Prof. Dr. Peer Nowack
Organisation: KIT Department of Informatics
Part of: Elective Studies in Informatics

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

Mandatory			
T-INFO-113659	Practical Course: AI for Climate and Weather Predictions	6 CR	Nowack

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students will be able to
- define current opportunities and challenges in building advanced AI models for climate and weather predictions.
- explain advanced AI model architectures.
- generate and critically assess output of state-of-the-art AI models.
- professionally present their results both orally and in a concise scientific paper.

Content
Students will learn how to work with state-of-the-art AI models for climate science and weather forecasting.

For example, typical AI models will include recent releases of

- Foundation models for climate science and weather forecasting.
- Generative AI models for tasks such as ensemble generation of weather forecasts and of climate change simulations for uncertainty quantification.
- Transformer and graph neural network models for weather forecasting.
- Climate model emulators.

Each student will be able to select from a variety of topics to explore in their practical experiments. These could include, but are not limited to:

- The representation of physical concepts in data-driven AI models (e.g., does the model indirectly learn to “understand physics”?).
- Detecting and understanding failure modes of AI models.
- Forecast accuracy and uncertainty quantification for AI-generated ensembles of simulations.
- Effective solutions to post-processing AI results and/or to modifying AI model architectures.
- Assessing if certain AI architectures perform significantly better for specific tasks.

Workload
In-person introductory session, individual and group meetings, final presentation sessions: 30h

Practical tasks – getting started, implementation, experiments, analysis: 100h

Write up results in the style of a scientific paper and preparation of final presentation: 50h

Recommendation
- Knowledge of the Python programming language.
- Good knowledge of mathematical concepts such as linear algebra is an advantage.
- An interest in scientific questions around climate science and weather forecasting.

4.74 Module: Practical Course: Application Security [M-INFO-106996]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Elective Studies in Informatics

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

Mandatory			
T-INFO-113958	Practical Course: Application Security	4 CR	Müller-Quade

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Qualification objective:

Students are able to identify security-relevant weaknesses and errors in a program analysis and suggest corrections.

Learning objectives:

- Students know and understand the programming model of x86 processors and their assembly language and can apply it.
- Students know and understand common error types, attack techniques and countermeasures and can reproduce these independently.
- Students are able to read and analyze a compiled program and examine it for vulnerabilities.
- Students are able to independently carry out attacks in simple scenarios to prove the relevance of the programming error.

Content
This module is dedicated to techniques for exploiting programming errors and common countermeasures, such as:

- Buffer overflows
- Shellcode Injection
- Return Oriented Programming
- Address Space Layout Randomization
- Stack Canaries

Workload
Attendance time: 15 h
Solving the tasks: 75
Preparation for exam: 30
(1 SWS + 5 SWS) x 15 + 30 h exam preparation = 120 h

Recommendation

- The basics of IT security are assumed.
- The content of the lectures "Computer Organization" and "Operating Systems" should be known.

M 4.75 Module: Practical Course: Artificial Intelligence & Security Lab (AISEC-Lab) [M-INFO-106867]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113760	Practical Course: Artificial Intelligence & Security Lab (AISEC-Lab)	4 CR	Wressnegger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know how to apply basic concepts of artificial intelligence and machine learning, and are able to evaluate the performance of such systems on real-world data from computer security research.

- Students know and understand concepts of machine learning for computer security.
- Students are able independently design, implement, and evaluate learning-based systems.
- Students understand limits of learning-based approaches.

Content
In this practical course, the students develop learning-based systems for different computer security tasks, thereby intensifying their knowledge gained in the corresponding lectures. The students have the unique opportunity to design, implement, and evaluate systems based on real-world data used in computer security research.

The module is composed of multiple units with several individual tasks/challenges covering different topics from classical computer security research to security of artificial intelligence. In each unit, the students develop an approach, train and validate it on known data, and submit their solution to the course platform, where the approach is tested against unknown data.

Workload
- 30h attendance time
- 70h Time to complete the exercises
- 15h Preparation of final presentation
- 5h attendance time (final event)

Recommendation
The basics of IT security and artificial intelligence are a prerequisite.

M 4.76 Module: Practical Course: Chip Design I [M-INFO-107265]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-114298	Practical Course: Chip Design I	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Hands-on, practical learning by working on hardware-related projects

Content
The Project Lab is a unique opportunity for students to engage in hands-on, practical learning by working on hardware-related projects from various fields, including
- Hardware-based Neural-Networks implementation
- Neuromorphic computing
- Printed Electronics
- Computation in Memory
- Open-source electronic design automation (EDA) tools extension
- Field Programmable Gate Arrays (FPGA)
- Risc-V architecture
- Hardware Security
- Reliability and T est
- other Emerging T echnologies
-
…
Students can work individually or in groups of 2-4, collaborating to tackle challenges based on a selected topic. The lab accepts a limited number of participants each term based on the number of offered projects, ensuring a focused and immersive experience for everyone involved.
Project topics are carefully defined and curated each term to align with active research initiatives within the Chair of Dependable Nano Computing (CDNC). Participants not only contribute to these projects but also have the potential to co-author research papers and make tangible contributions to the academic community.
The lab emphasizes practical skills, especially in hardware-related fields, offering students access to state-of-the-art tools and technologies. It provides an invaluable opportunity to bridge the gap between theory and practice while preparing for a future in research, development, or industry.

Workload
4 SWS of practical workload including meetings with the supervisor. 90h

4.77 Module: Practical Course: Chip Design II [M-INFO-107266]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-114299	Practical Course: Chip Design II	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Hands-on, practical learning by working on hardware-related projects

Content
The Project Lab is a unique opportunity for students to engage in hands-on, practical learning by working on hardware-related projects from various fields, including
- Hardware-based Neural-Networks implementation
- Neuromorphic computing
- Printed Electronics
- Computation in Memory
- Open-source electronic design automation (EDA) tools extension
- Field Programmable Gate Arrays (FPGA)
- Risc-V architecture
- Hardware Security
- Reliability and T est
- other Emerging T echnologies
-
…
Students can work individually or in groups of 2-4, collaborating to tackle challenges based on a selected topic. The lab accepts a limited number of participants each term based on the number of offered projects, ensuring a focused and immersive experience for everyone involved.
Project topics are carefully defined and curated each term to align with active research initiatives within the Chair of Dependable Nano Computing (CDNC). Participants not only contribute to these projects but also have the potential to co-author research papers and make tangible contributions to the academic community.
The lab emphasizes practical skills, especially in hardware-related fields, offering students access to state-of-the-art tools and technologies. It provides an invaluable opportunity to bridge the gap between theory and practice while preparing for a future in research, development, or industry.

Workload
4 SWS of practical workload including meetings with the supervisor. 90h

4.78 Module: Practical Course: Digital Design & Test Automation Flow [M-INFO-102570]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-105565	Practical Course: Digital Design & Test Automation Flow	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The objective of this lab is to have a hands-on practice on major steps in digital design and test automation flow, from system-level specification to physical design and verification.

Content
Electronic Design Automation (EDA) is used to develop nearly all novel electronic systems that we use in our daily lives, such as smartphones or laptops. In order to manage the high complexity of these systems, all steps in the design and verification phases are done automatically with the help of EDA tools.
The objective of this lab is to have a hands-on practice on major steps in digital design and test automation flow, from system-level specification to physical design and verification, using industrial EDA toolsets which are predominantly used in the industry and academia.
The students will work on some sample designs and go through all major design and test steps, one by one, in different sessions of the lab. So, by the end of this lab, they become familiar with the steps and tool chain in the digital design and test automation flow. The topics include system-level specification and simulation; high-level synthesis; logic-level synthesis and simulation; design for testability; test pattern generation and fault simulation; physical design and verification; timing analysis and closure; area, delay, and power estimation and analysis.

Workload
4 SWS / 3 CP = 90 h/week

Recommendation
Knowledge of “Dependable Computing” and “Fault Tolerant Computing” and Computer Architecture is helpful.

4.79 Module: Practical Course: Efficient Parallel C++ [M-INFO-107203]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Algorithm Engineering
Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-114228	Practical Course: Efficient Parallel C++	6 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students
- can use the methods of algorithm engineering in order to implement and evaluate given algorithmic problems and data structures in C++.
- recognize factors that lead to inefficient code and can, if possible, replace them with more efficient constructions.
- understand how to use the presented techniques for parallelization and to generate thread-safe codes with the given means.
- know the features of the standard library and are able to use them selectively.
- can test the codes generated by them for correctness and performance, furthermore they can represent and analyze the obtained results.

Content
In this practical course students solve multiple programming tasks in C++. The main focus is on the efficient implementation and their evaluation through extensive experiments. The programming tasks are motivated by scientific work in the field of algorithm engineering.
They cover complex algorithms as well as advanced data structures, furthermore advanced programming techniques and parallelization (thread management capabilities of the standard library).

Workload
~ 10h attendance time
~ 10h discussion/assessment of the regular solutions (with preparation)
~ 15h designing the individual final assignment
~ 25h presentation of the individual final task
~ 120h working on the tasks (implementation and evaluation)

M 4.80 Module: Practical Course: Fine-grained Algorithm Design and Engineering [M-INFO-106784]

Responsible: Prof. Dr.-Ing. Marvin Künnemann
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-113635	Practical Course: Fine-grained Algorithm Design and Engineering	6 CR	Künnemann

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students should be able to apply knowledge in the specializations “Algorithmtechnik” and “Theoretische Grundlagen” to derive fast algorithms and their implementations for a given algorithmic problem.

This includes:
– modeling a given problem of interest as a well-defined algorithmic problem as well as identifying reasonable relaxations
– performing a literature search to identify algorithmic ideas previously proposed for a given problem
– researching a given algorithmic or conditional lower bound technique and investigating its applicability on a given problem
– implementing resulting algorithms efficiently
– creating reasonable benchmark data sets (generated randomly, via reductions or from real-world data sources)
– evaluating an implementation on benchmark data and gaining insights on possible improvements of the model, algorithm or implementation.

Furthermore, the students can constructively engage in a team setting and are able to clearly communicate their ideas and results.

Content
Each group of students will receive a topic among a list of possible algorithmic problems with relevance for fine-grained and parameterized complexity (usually from the fields of graph theory, computational geometry or string problems). In some cases, the proposed topic is the subject of an ongoing algorithmic contest (e.g., the PACE challenge), providing an opportunity of participation as part of the practical course.

Under supervision, each group will:
– research the theoretical state-of-the-art for their algorithmic problem and/or design a novel algorithm,
– implement one or more algorithmic approaches
– evaluate and improve them using appropriate benchmark data sets.

The course aims to investigate the connections between worst-case upper & conditional lower bounds and fast practical implementations.

Workload
6 CP correspond to ~ 180 h, distributed roughly as follows:
~ 40 h meetings, literature review, etc.
~ 100 h implementation and evaluation
~ 40 h preparation of presentation and report

Recommendation
- Basic knowledge of algorithms and data structures is assumed.
- Knowledge of fine-grained complexity is helpful, but not required.

M 4.81 Module: Practical Course: FPGA Programming [M-INFO-102661]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-105576	Practical Course: FPGA Programming	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students will learn to design and to simulate digital circuits with FPGA.

Content
This lab emphasizes on the practical aspects of Field Programmable Gate Arrays (FPGAs). In the beginning, a short background introduction on FPGAs is given, followed by a tutorial on the workflow of configuring and programming an FPGA. This lab includes FPGA design using schematic layouts as well as several example of VHDL/Verilog programming to implement some sample digital circuits. Students will learn to design and to simulate digital circuits with FPGA. The design will be compiled on run a FPGA. The lab is designed around the DE2-115 prototyping board, which provides a programmer, program memory, and array of switches, buttons, LEDs, an LCD, and several I/O ports.

Workload
4 SWS / 3 CP = 90 h/week

Recommendation
Knowledge of “Dependable Computing” and “Fault Tolerant Computing” and Computer Architecture is helpful.

4.82 Module: Practical Course: General-Purpose Computation on Graphics Processing Units (24911) [M-INFO-100724]

Responsible: Prof. Dr.-Ing. Carsten Dachsbacher
Organisation: KIT Department of Informatics
Part of: Elective Studies in Informatics

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

Mandatory			
T-INFO-109914	Practical Course: General-Purpose Computation on Graphics Processing Units	3 CR	Dachsbacher

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students should acquire the ability to use programmable graphics hardware using suitable interfaces (e.g. OpenCL, CUDA) to solve scientific and technical calculations. The students should thereby acquire the practical ability to systematically develop a parallel, efficient programme on the basis of suitable algorithms. Students learn basic algorithms for parallel architectures, are able to analyse and evaluate them, and practice their use in practical applications.

Content
The practical course covers basic concepts for the use of modern graphics hardware for technical and scientific calculations and simulations. Starting with basic algorithms, e.g. parallel reduction or matrix multiplication, the practical course imparts knowledge about the properties and capabilities of modern graphics processors (GPUs). As part of the practical course, students work on smaller sub-projects in which they acquire knowledge about the algorithms used and apply them to a specific problem; OpenCL or CUDA, for example, is used as a programming interface.

Workload
Attendance time = 12h
Preparation/post-processing = 78h

M 4.83 Module: Practical Course: Internet of Things (IoT) [M-INFO-103706]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-107493	Practical Course: Internet of Things (IoT)	4 CR	Henkel

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- Students will understand the core concepts of IoT systems, including design objectives, application domains, and requirements.

- They will gain skills in developing software programs for IoT embedded devices, debugging, and testing software on hardware.

- They will be capable of integrating and evaluating IoT systems comprising sensors, processors, wireless communication modules, and data storage.

Content
- The lab provides hands-on experience in IoT system design and development, focusing on the following aspects:
- Embedded, machine learning algorithms, intelligence, and connectivity in IoT systems.
- Challenges and optimization techniques for embedded software in resource-constrained IoT devices.
- Practical design and implementation of IoT devices with applications in smart environments, healthcare, and more.
- Integration of IoT components: sensors, processors, wireless radios, and storage systems.

Workload
Attendance time: 45 hours

Final project: 55 hours

Final
presentation & Report: 20 hours

Total = 120 hours = 4 ECTS

Recommendation
- Familiarity with other (than C) languages like Python could be helpful as well.
- Basic knowledge from the modules “Design and Architectures of Embedded Systems (ESII)” and “Optimization and Synthesis of Embedded Systems (ESI)” are helpful but not essential for understanding the lab.

M 4.84 Module: Practical Course: Low Power Design and Embedded Systems [M-INFO-104031]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-108323	Practical Course: Low Power Design and Embedded Systems	4 CR	Henkel

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Upon completion of this lab, students will:

- Apply and evaluate different hardware/software optimization techniques for low power and energy consumption under given constraints (e.g., performance) on embedded systems.
- Develop a deep understanding of system-level resource management techniques in modern systems. They will learn to apply machine learning methods to automate and optimize complex resource allocation decisions, thereby acquiring practical skills in data collection, model training, and iterative system tuning.
- Collaborate effectively in a team to practically solve technical problems related to power, temperature and energy optimizations on a real hardware platform.

Content
This lab explores different software and hardware approaches for power reduction on modern embedded systems, considering other relevant metrics and constraints such as performance, power, temperature, chip area, among others, both on simulation and real-hardware platforms.

The course is divided in two main topics:
- Smart resource management (RM) for multi/-many-core computing systems: This topic covers system level techniques based on RM control knobs such as application mapping, dynamic task migration and dynamic voltage and frequency scaling (DVFS), using both from the heuristic and machine-learning methods.
- Hardware/Software design for low power systems: This topic includes the application of several design principles among the computing stack to optimize different metrics such as performance, power and energy in embedded systems. Techniques include compiler optimizations, HW/SW co-simulation, design-space exploration and high-level synthesis.

Workload
Attendance time:
40 hours

Project work:
60 hours

Final Report preparation:
20 hours

Total: 120 hours (4 ECTS)

Recommendation
Students should be familiar with software development practices under Linux-based systems. Practical knowledge in C/C++ as well as Python is required.

M 4.85 Module: Practical Course: Model-Driven Software Development [M-INFO-106932]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-113897	Practical Course: Model-Driven Software Development	6 CR	Burger, Reussner

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students can

- understand and apply the model-driven development process
- Express facts as a metamodel and create a suitable domain-specific language (DSL)
- Formulate restrictions in the OCL language
- Create and apply model-to-model transformations
- Create model-to-text transformations
- Create graphical editors for metamodels
- Develop textual syntaxes for metamodels and DSLs
- use current tools in the field of model-driven software development

Content
Model-driven development methods have become particularly popular thanks to the Eclipse Modelling Framework (EMF) and the OMG standards MOF, UML and QVT. Advanced software development concepts such as product lines, generative programming and model transformations now make it possible to develop software more flexibly and quickly and to use it on different platforms. Domain-specific languages (DSL) and the graphical and textual editors generated from them can be easily created.

This practical course deals with current techniques of model-driven software development (MDSD). Students work with current frameworks and languages such as EMF, QVT, ATL and XText and create a domain-specific language and model transformations.

Workload
96 working hours for exercises, 48 working hours for project work, 16 working hours for preparing the final presentation, 20 working hours for weekly meetings and final presentation. This results in a total of 180 working hours.

M 4.86 Module: Practical Course: Movement and Technology [M-INFO-106648]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

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

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

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

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

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

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

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

Programming skills.

M 4.87 Module: Practical Course: Natural Language Dialog Systems [M-INFO-107177]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114206	Practical Course: Natural Language Dialog Systems	6 CR	Niehues

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student

- is able to develop a dialogue system using state-of-the-art methods.
- develop a dialogue system.
- can evaluate dialogue systems.
- can present his/her findings in a scientific lecture.

Content
Thanks to major advances in the field of deep learning and, in particular, large language models, it is now possible to develop dialogue systems and chatbots that can support people in many situations.
As part of this internship, students will develop a personal assistant for various application scenarios. To do this, students must first deal with data collection and data preparation. This data should then be used to develop a chatbot for the addressed application using freely available pre-trained models. In addition, the students will investigate various options for evaluating the systems.
In the final part of the internship, students can independently choose a focus to improve their initial system. The final systems will be presented in a final presentation.

Workload
180h

M 4.88 Module: Practical Course: Real-world Vulnerability Discovery and Exploits [M-INFO-106627]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Elective Studies in Informatics

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

Mandatory			
T-INFO-113350	Practical Course: Real-world Vulnerability Discovery and Exploits	4 CR	Wressnegger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
← Students know and understand exploitation techniques.
← Students are able to independently research software vulnerabilities.
← Students are comfortable engaging with software vendors in vulnerability disclosure.

Content
Students understand modern exploitation techniques and can apply them. Furthermore, they get familiar with the vulnerability disclosure process of prominent software vendors, reporting their findings.

Workload
- 2h attendance time/ week (lectures)
- 5h project work/ week
- 10h preparation for final presentation
- 5h attendance time (final event)

Total 120h

Recommendation
Application security internship

4.89 Module: Practical Course: Security, Usability and Society [M-INFO-105453]

Responsible: Prof. Dr. Thorsten Strufe
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-110990	Practical Course: Security, Usability and Society	4 CR	Geiselmann, Strufe

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know established security and data protection programs, can implement them in apps and can carry out user studies.

Learning objectives:

- Students know and understand the methods for developing privacy-friendly apps and can apply them.
- Students are able to implement various applicable security measures in programs.
- Students can set up and conduct user studies.
- Students are able to prepare and present a report of their work.

Content
The internship "Security, Usability and Society" covers topics such as usable security and privacy programs as well as conducting user studies.
Topics include:

- Privacy-friendly apps
- Programming usable security measures
- Conducting usable security user studies

Workload
Attendance time: 15 h
Solving the tasks: 75
Preparation of presentation and report: 30

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

Responsible: Prof. Dr. Veit Hagenmeyer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

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

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
After successfully completing the course, students will be able to
- be able to explain the structure and objectives of a smart grid using the Energy Lab 2.0 and the Smart Energy System Simulation and Control Centre (SEnSSiCC),
- be able to name and categorise current research issues in the field of innovative, application-oriented information, automation and system technology for sustainable energy systems,
- analyse a problem from the current research questions of SEnSSiCC as part of a project and develop a strategy for a solution together in a team and
- be able to check, analyse and evaluate the feasibility of results in a laboratory.

Content
As part of the preparation for the internship, project topics are derived from the current research questions of the Smart Energy System Simulation and Control Centre of the Energy Lab 2.0 (https://www.iai.kit.edu/RPE.php). The topics are made available to the participating students in advance of the internship as a list, on the basis of which the students can express their preferences for the respective topics. Based on their stated preferences, the students are assigned to the respective project topics.
The two-week internship begins with a joint kick-off event, which includes an introduction and tour of the Energy Lab 2.0 and the SEnSSiCC as well as a brief presentation of all project topics. Students are provided with current scientific papers on their research topic. During the two-week internship, the groups of students work on their project topics under the supervision of the respective scientists. The students use a laboratory set-up to test their concepts and solutions. Particularly promising approaches can be tested on the real system under the supervision of the scientists. The block course ends with a joint final event at which the students present their solutions and work results.

After the internship, the students follow up the project work by preparing a report on the project topic they have worked on, categorising the work results and reflecting on the work process.
Working in a team is another important aspect of all project topics.
The work placement consists of the following sections:
- Familiarisation with the topic
- Selection of a suitable project topic in consultation with the supervising scientists
- Practical realisation of the project topic
- Presentation of the results (colloquium, research report)

Workload
6 credit points corresponds to approx. 180 working hours, of which
- Attendance time / meetings in large and small groups: 10h
- Select and carry out project work: 140h
- Writing a research report and preparing a presentation: 30 hours

Recommendation
- Knowledge of the fundamentals of energy informatics is a prerequisite.
- Knowledge of the fundamentals of electrical engineering and energy technology is required.
- Knowledge of the basics of mechatronics, data analysis and signal processing is helpful.
- Knowledge of power systems or power electronics is helpful.

4.91 Module: Practical Course: Software Defined Networking [M-INFO-107221]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-114240	Practical Course: Software Defined Networking	6 CR	Zitterbart

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student understands the concepts behind the SDN approach and applies this knowledge to design solutions for new problems. He/she is able to develop an application in group work that implements a specific functionality in an SDN network. From the outset, the student plans his/her solution approaches from the point of view of interoperability with the solutions of the other groups. The participants jointly decide on compromise solutions, if these are necessary, in order to be able to operate the applications of the different groups together without disruption.

Content
The internship deals with the realization of a software project in the field of Software-Defined Networking (SDN). With SDN, the control and monitoring of a network is outsourced to a controller. The actual forwarding hardware can then be programmed via the OpenFlow interface.

As part of the internship, we want to find out together to what extent this technology can also be used within our own four walls. To this end, we will design and develop an SDN home router that enables users to monitor and control their network using SDN applications. In small groups, we will build or recreate various functions from the home network sector, e.g. a firewall or parental control. A monitoring system that breaks down the Internet consumption of all connected computers is also conceivable. Or a traffic engineering mechanism that ensures that you can still enjoy YouTube even when your younger brother is downloading a 100 GB game. Many other variants are conceivable. We decide together in the internship what will be implemented in the end. Your own ideas are very welcome!

Workload
180h

M 4.92 Module: Practical Course: Visual Computing [M-INFO-101567]

Responsible: Prof. Dr.-Ing. Carsten Dachsbacher
Organisation: KIT Department of Informatics
Part of: Elective Studies in Informatics

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

Mandatory			
T-INFO-103000	Practical Course: Visual Computing	6 CR	Dachsbacher

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
In this course, practical problems from the core area of computer graphics and the broader field of visual computing are solved where graphics hardware is used. In individual sub-projects, or self-defined larger projects, the application of various computer graphics techniques and the use of modern graphics hardware are practised. In addition, students can work together in a team to solve the tasks of the work placement.

Content
The practical course deals with specific topics, some of which were addressed in corresponding lectures on the specialisation subject of computer graphics, and explores these in greater depth. Previous attendance of the respective lecture is helpful, but not a prerequisite for attendance.

Workload
Attendance time = 30h
Preparation/follow-up = 150h

Recommendation
Programming skills in C/C++ are recommended.

4.93 Module: Practical Introduction to Hardware Security [M-INFO-107241]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-114267	Practical Introduction to Hardware Security	6 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The goal of this course, which is a combination of lectures and lab assignments, is to have a hands-on experience on basic concepts and new developments in hardware security, by combining both theory and practice in a coherent course. The theoretical concepts for each topic will be presented to the students in form of lectures, followed by a set of lab assignments on both hardware and software platforms to be performed by the students for each topic.

Content
1. Hardware security primitives (PUF, TRNG)
2. Hardware Implementation of encryption modules (AES)
3. Passive Attack with side channel (on AES)
4. Active fault attack (on AES)

Workload
4 SWS / 6 ECTS = 180h

2 SWS lecture (1,5h) + 2 SWS practical course (1,5h) / week

Recommendation
Knowledge of Digital Design (lecture TI)

Practical Course “FPGA Programming”

4.94 Module: Practical SAT Solving [M-INFO-107238]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Elective Studies in Informatics

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

Mandatory			
T-INFO-114262	Practical SAT Solving	5 CR	Balyo, Iser, Sanders, Schreiber

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are able to evaluate combinatorial problems, assess their complexity, and solve them using computers.

Students learn how to solve combinatorial problems efficiently using SAT Solving. Students are able to assess the practical complexity of decision and optimization problems, encode problems as SAT problems, and implement efficient solution procedures for combinatorial problems.

Students gain insight into state-of-the-art solution methods for SAT and related problems and their implementations in SAT solvers.

Content
The problem of propositional satisfiability (SAT) is an outstanding problem of computer science from a theoretical as well as practical perspective. Being the first problem proven to be NP-complete, it serves as a fundamental tool for research in complexity theory. Moreover, SAT solving has been established as one of the most important fundamental methods in hardware and software verification, and is used to solve hard combinatorial problems in industrial practice as well. This module aims to provide students with the theoretical and practical aspects of SAT-Solving. Covered are:
1. basics, historical development
2. encodings, e.g. cardinality constraints
3. phase transitions in random problems
4. local search (GSAT, WalkSAT, ..., ProbSAT)
5. resolution, Davis-Putnam algorithm, DPLL algorithm, look-ahead algorithm
6. efficient implementations, data structures
7. heuristics in the DPLL algorithm
8. CDCL algorithm, clause learning, implication graphs
9. restarts and heuristics in the CDCL algorithm
10. preprocessing, inprocessing
11. generation of proofs and their checking
12. parallel SAT solving (guiding paths, portfolios, cube-and-conquer)
13. related problems: MaxSAT, MUS, #SAT, QBF
14. advanced applications: Bounded model checking, planning, satisfiability-modulo-theories

Workload
Lecture (2 SWS) + exercise (1 SWS)

(Preparation and follow-up: 4h/week, exercises: 2h/week, preparation for exam: 15h)

Total workload: (2 SWS + 1 SWS + 4 SWS + 2 SWS) x 15 h + 15h preparation = 9x15h + 15h = 150h = 5 ECTS

4.95 Module: Privacy Enhancing Technologies [M-INFO-105452]

Responsible: Prof. Dr. Thorsten Strufe
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-110989	Privacy Enhancing Technologies	6 CR	Geiselmann, Strufe

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Competence Goal
This course will provide students with a basic understanding of privacy risks, the most common technologies to tackle them and the human factors shaping their design. The course will analyze the adversary models and evaluation metrics underlying the design of privacy-enhancing technologies

• The students have a critical reasoning about privacy,
• have knowledge in the evaluation of privacy risks,
• understand the design aspects of privacy-enhancing technologies,
• are familiar with the latest research in the field
• are able to analyze and discuss the space of solutions to a given privacy problem

Content
The following topics will be covered
• Freedom of information, the surveillance economy, and other motivations for privacy
• Privacy metrics and adversary models
• Anonymous communications
• Data-perturbative privacy-enhancing technologies
• Anonymization algorithms for databases
• Homomorphic encryption and zero knowledge proofs
• Selective disclosure for identity management
• Usable privacy
• Applying privacy principles and case studies

Workload
Attendance time in lectures: 45 h
Preparation and follow-up of the same: 90 h
Exam preparation and attendance in the same: 45 h

M 4.96 Module: Probability and Computing [M-INFO-107168]

Responsible: TT-Prof. Dr. Thomas Bläsius
Prof. Dr. Peter Sanders

Organisation: KIT Department of Informatics

Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114196	Probability and Computing	5 CR	Bläsius, Katzmann, Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students
- understand when and why randomisation is useful or necessary for solving an algorithmic problem,
- can explain central design methods and analysis tools of randomised algorithms,
- can design and explain simple randomised algorithms and data structures for solving a problem,
- can decide which tools are suitable for the analysis of given randomised algorithms and data structures and apply them.

Content
Randomised algorithms and data structures make their approach dependent on random experiments. While the design of deterministic algorithms is often driven by a pessimistic view of worst-case behaviour, randomised algorithms rely on approaches that occasionally fail but usually perform much better.
The runtime of such algorithms as well as the solution quality (in the case of optimisation problems) and sometimes also the correctness (in the case of computational problems) are then subject to chance. A formal analysis therefore focusses on expected values and probabilities of success. We will look at classical examples as well as current research topics from the field of hashing and graph theory. Specific design methods (such as probability amplification) and advanced analysis tools of probability theory (such as coupling, Poissonisation and concentration bounds) will be applied. It will often turn out that randomised approaches are more efficient or simpler than all (or at least all known) deterministic approaches.
We will also briefly consider on the theoretical side how randomised complexity classes relate to known classes such as P and NP, and on the practical side we will clarify how randomised algorithms can be implemented on common (essentially deterministic) computers with pseudorandomness.

Workload
Lecture with exercise with 3 SWS, 5 LP
approx. 45h attendance of the lecture and exercise
approx. 30h preparation and follow-up work
approx. 45 hours working on the exercise sheets
approx. 30h exam preparation

Recommendation
Basic knowledge of algorithms and data structures (e.g. from the lectures Algorithms 1 + 2) as well as basic knowledge of probability theory (e.g. from the lecture Introduction to Stochastics) are helpful.

M 4.97 Module: Public International Law with an Economic Law Focus [M-INFO-107029]

Responsible: Sebastian Kasper
Organisation: KIT Department of Informatics
Part of: Minor Studies: Law

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

Mandatory			
T-INFO-113381	Public International Law	3 CR	Zufall

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Competency Goals:
- Participating students will be able to navigate the plethora of multilateral treaties to detect relevant international law for specific cases.
- They can develop solutions for legal problems based on case law of international courts and tribunals.
- Students will be able to read and comprehend international treaties and case law.
- They will have a fundamental understand of the interplay between various subfields of public international law.
- Students can identify and explain current issues in public international law.

Content
The lecture is designed to provide participating students with a general understanding of the foundations, subjects, and sources of public international law, its interplay with national legal regimes, and more detailed knowledge of particular subfields of public international law.

Since the lecture targets students of information systems, particular focus will be given to economic topics in international law, such as investment and trade law aspects. Due to the general importance of climate change for todays (economic) law, international climate change law and environmental law will form further focus areas.

In addition, a concise overview on human rights law, the law on State responsibility, and the peaceful settlement of disputes will be provided.

Throughout the lecture, important case law will be referenced and students are expected to read relevant cases in part to facilitate a discussion of such cases and their relevance for a subject field. Although the United Nations, including its principal judicial organ, the International Court of Justice, is one of the, if not the, key international organization in public international law, further international organizations (eg, Council of Europe, World Trade Organization) and their respective law(s) will also be touched.

Students are advised to have a statute book at hand that includes the most important international treaties and conventions (eg, Evans, Blackstone's International Law Documents, currently 15th ed 2021).

Conducting the lecture in English intends to facilitate students to link their ideas and arguments to current debates in international law.

Workload
90h

Recommendation
- General knowledge of (public) law (eg, through participating in public law or EU law modules) is helpful but not necessary.
- Interest in international affairs and politics is welcomed.

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

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Prof. Dr. Gerhard Neumann

Organisation: KIT Department of Informatics

Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-111255	Reinforcement Learning	6 CR	Lioutikov, Neumann

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- Students are able to understand the RL problem and challenges.
- Students can differentiate between different RL algorithm and understand their underlying theory
- Students will know the mathematical tools necessary to understand RL algorithms
- Students can implement RL algorithms for various tasks
- Students understand current research questions in RL

Content
Reinforcement Learning (RL) is a sub-field of machine learning in which an artificial agent has to interact with its environment and learn how to improve its behaviour by trial and error. For doing so, the agent is provided with an evaluative feedback signal, called reward, that he perceives for each action performed in its environment. RL is one of the hardest machine learning problems, as, in contrast to standard supervised learning, we do not know the targets (i.e. the optimal actions) for our inputs (i.e. the state of the environment) and we also need to consider the long-term effects of the agent's actions on the state of the environment. Due to recent successes, RL has gained a lot of popularity with applications in robotics, automation, health care, trading and finance, natural language processing, autonomous driving and computer games. This lecture will introduce the concepts and theory of RL and review current state of the art methods with a particular focus on RL applications in robotics. An exemplary list of topics is given below:

• Primer in Machine Learning and Deep Learning
• Supervised Learning of Behaviour
• Introduction in Reinforcement Learning
• Dynamic Programming
• Value Based Methods
• Policy Optimization and Trust Regions
• Episodic Reinforcement Learning and Skill Learning
• Bayesian Optimization
• Variational Inference, Max-Entropy RL and Versatility
• Model-based Reinforcement Learning
• Offline Reinforcement Learning
• Inverse Reinforcement Learning
• Hierarchical Reinforcement Learning
• Exploration and Artificial Curiosity
• Meta Reinforcement Learning

Workload
Approximately 180 hours, divided into:
• 45 hours of lecture attendance
• 15 hours of exercise attendance
• 90 hours of post-processing and working on exercise sheets
• 30 hours of exam preparation.

Recommendation

• Students should be familiar with the content of the "Foundations of Artificial Intelligence" lecture.
• Good Python knowledge is required.
• Good mathematical background knowledge is required.

M 4.99 Module: Reliable Computing I (24071) [M-INFO-100850]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-101387	Reliable Computing I	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The objective of this course is to become familiar with general and state of the art techniques used in design and analysis of fault-tolerant digital systems.

Content
The objective of this course is to become familiar with general and state of the art techniques used in design and analysis of fault-tolerant digital systems. The students will study and investigate existing fault-tolerant systems. Both Hardware and software methods will be studied and new research topics will be investigated.

This course overviews reliable (fault-tolerant) computing and the design and evaluation of dependable systems, and provides a base for research in reliable systems. Models and methods are used in the analysis and design of fault-tolerant and highly reliable computer systems will be taught in this course. Topics include faults and their manifestations, fault/error modeling, reliability, availability and maintainability analysis, system evaluation, performance-reliability trade-offs, system level fault diagnosis, hardware and software redundancy techniques, and fault-tolerant system design methods.

Workload
2 SWS: (2 SWS + 1,5 x 2 SWS) x 15 + 15 h preparation for the exam = 90 h = 3 ECTS

4.100 Module: Research Focus Class: Blockchain & Cryptocurrencies [M-INFO-106654]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-113400	Research Focus Class: Blockchain & Cryptocurrencies	3 CR	Hartenstein
T-INFO-113401	Research Focus Class: Blockchain & Cryptocurrencies - Seminar	3 CR	Hartenstein

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- Students are familiar with current issues in the field of blockchain and cryptocurrencies and can identify specific research questions.
- Students have the necessary basic knowledge to identify, discuss and scientifically address current issues in the subject area.
- Students are able to independently develop a research topic and find and process related literature.
- Students are familiar with research methods in the field of decentralized systems and have gained initial experience in a specific research topic.
- Students can write a paper according to scientific standards.
- Students can present and discuss a research topic in a colloquium.

Content
Blockchains such as Ethereum are decentralized systems that are currently receiving a lot of attention both in practice and in research. These systems can not only be used to carry out payment transactions in a decentralized manner, but also to programmatically record and enforce processes between mutually distrustful parties in so-called smart contracts. In particular, security and fairness properties as well as scalability in terms of transaction throughput play a key role.

This course begins with a lecture in which the basics of blockchains and Ethereum in particular are taught and current problems are introduced. After an introduction to the structure and functionality of Ethereum, advanced aspects that are necessary to address current research questions will be covered. The basics of scientific methodology in dealing with decentralized systems are also covered. The basic knowledge imparted in the lecture will be applied and consolidated in the seminar - the second part of the course - through the students' own research work.

The seminar offers the opportunity to work on a self-chosen topic in the field of blockchains and cryptocurrencies, which is facilitated by the previous lecture and direct consultation. The students' task is to find and process literature on the chosen topic and to work on the chosen topic. The results are documented in a paper according to scientific standards and presented in a colloquium.

Annotation
Places are limited. Information about the registration process is given in the first lecture. Registration is usually carried out via CampusPlus or Wiwi-Portal. A listing in one of them indicates that the module is offered in the current term.

Workload
6 ECTS = 180 hours
- Lecture attendance and discussion (20 hours)
- Lecture preparation and follow-up (20 hours)
- Literature research (20 hours)
- Implementation of self-chosen project (60 hours)
- Writing a scientific report (60 hours)

Recommendation
Knowledge from ‘Decentralized Systems: Fundamentals, Modeling, and Applications’ [M-INFO-105334] and skills from ‘Scientific Methods to Design and Analyze Secure Decentralized Systems’ [M-INFO-105780] are of advantage.

4.101 Module: Research Practical Course: Artificial Intelligence & Security [M-INFO-106866]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113759	Research Practical Course: Artificial Intelligence & Security	6 CR	Wressnegger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Qualifikationsziele: Students understand how to interpret results from state-of-the-art research and are able to actively contribute to timely research.

Lernziele:
← Students know and understand concepts of recent research at the intersection of artificial intelligence and computer security.
← Students are able independently research topics and methods in this field of research.
← Students understand limits of current approach in computer security research.

Content
In this practical course, the students work on a project at the intersection of artificial intelligence, machine learning, and computer security. They come in contact with and participate in timely and state-of-the-art research in this exciting field. In this scope, the students read up on a sub-field, design and implement a learning-based system, and conduct evaluations on real-world data.

Topics include but are not limited to adversarial machine learning, explainability of machine learning in computer security, learning-based attack detection, and vulnerability discovery.

Workload
- 140h Project work
- 20h Final report
- 15h Preparation of final presentation
- 5h attendance time (final event)

M 4.102 Module: Research Practical Course: Interactive Learning [M-INFO-106300]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-112772	Research Practical Course: Interactive Learning	6 CR	Lioutikov

Competence Certificate
See Partial achivements (Teilleistung).

Prerequisites
See Partial achivements (Teilleistung).

Competence Goal
Students learn to understand and scrutinise complex scientific topics and to reproduce and check published results.
and to reproduce and verify published results. Students gain in-depth knowledge in the field of interactive learning and experience with the use of novel learning methods.

Content
Each student will select a topic in the field of Interactive Learning and/or Explainable Artificial Intelligence. The organizers will suggest topics but the students are welcome suggest relevant topics. The students will then implement and evaluate several algorithms corresponding to the chosen topic. The experimental evaluation will be documented in a report and presented to their peers.
It is highly recommended to take this research project in combination with the "Interactive Learning" Seminar, where the students get the chance to acquire the required background on the literature.

Workload
Workload = 180h = 6 ECTS
- Attendance time: 15h
- Project work: 135h
- Writing scientific report + preparing presentation: 30h

Recommendation
We highly recommend to take this research project in combination with the "Interactive Learning" seminar.

It is highly recommended to attend the "Explainable Artificial Intelligence" lecture in parallel or prior to this project.

• Experience in Machine Learning is recommended, e.g. through prior coursework.
◦ The Computer Science Department offers several great lectures e.g., "Maschinelles Lernen - Grundlagen und Algorithmen" and "Deep Learning "
• A good mathematical background will be beneficial
• Python experience is recommended
• We might use the PyTorch deep learning library In the exercises. Some prior knowledge in this is helpful but not necessary.

M 4.103 Module: Research Project Deep Learning for Robotics [M-INFO-107174]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114203	Research Project Deep Learning for Robotics	6 CR	Neumann

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn to understand and scrutinise complex scientific topics and to reproduce and verify published results. Students gain in-depth knowledge in the field of learning with robots and experience with the use of novel learning methods.

Content
Each student has to choose one of the offered topics from the area of deep learning / robot learning / deep reinforcement learning / deep imitation learning. The students need to implement one or several algorithms and evaluate them against available baselines on standard benchmark tasks as well as on (custom-made) physically realistic simulations and/or a real robot platform. The experiments have to be documented in a report. Students will work in teams of 2. It is recommended to take this course together with the seminar “Deep learning for robotics” where the students will acquire the required background on the literature.

Workload
Workload: 180h

Attendance time: 15h

Project work: 135h

Writing a report + preparing a presentation: 30h

Recommendation
- Experience in Machine Learning is recommended.
- Python experience is recommended
- We will use the PyTorch deep learning library. Some prior knowledge in this is helpful but not necessary.

M 4.104 Module: Research Project: Generative AI for Autonomous Agents [M-INFO-107163]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114189	Research Project: Generative AI for Autonomous Agents	6 CR	Neumann

Competence Certificate
See partial achievements (Teilleistung)

Competence Goal
Students will learn to understand, question, and reproduce complex scientific topics and published results. They will gain in-depth knowledge in the field of learning for decision making and experience with the application of novel learning methods.

Content
This practical research course explores advanced machine learning methods and generative AI such as diffusion models to empower autonomous agents with intelligent decision-making capabilities. Students will delve into:

- Generative Models for Decision Making
- Reinforcement Learning (RL)
- Imitation Learning
- Multi-Agent Systems
- Uncertainty Quantification
- Learning Prediction Models of Physical Processes
- Time-Series Modeling
- Discovery and Inference of Latent Variables

Each student will choose one of the offered topics, implement one or several algorithms, and evaluate them against available baselines using standard benchmark tasks. The course emphasizes hands-on experimentation, requiring students to document their findings in a detailed report. Students will work in teams of two, closely collaborating with their supervisor with the aim of achieving publishable results. This course provides students with their first experience in running a research project in machine learning, including algorithm design, evaluation, benchmarking, deploying algorithms on HPC hardware, and paper writing.

Workload
Workload: 180h

Attendance time: 15h
Project work: 135h
Writing a report + preparing a presentation: 30h

Recommendation
- Experience in Machine Learning is recommended.
- Python experience is recommended
- We will use the PyTorch deep learning library. Some prior knowledge in this is helpful but not necessary.

4.105 Module: Resilient Networking [M-INFO-105591]

Responsible: Prof. Dr. Thorsten Strufe
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-111209	Resilient Networking	6 CR	Strufe

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
This course will provide students with a basic understanding of threats to the Internet, and the most common technologies to tackle them. The course will analyze the adversary models and evaluation metrics underlying their design.

- The students have a critical reasoning about network resilience,
- have knowledge in the evaluation of threats to network operation,
- understand the design aspects of protection measures,
- are familiar with the latest research in the field
- are able to analyze and discuss the space of solutions to a given challenge to Internet security and robustness

Content
The lecture resilient networking provides an overview on the basics of secure networks as well as on current threats and respective countermeasures. Especially bandwidth-depleting Denial of Service attacks represent a serious threat. Moreover, over the last years the number of targeted and highly sophisticated attacks on company and governmental networks increased. To make it worse, as a new trend at the moment, the interconnection of the Internet with cyber physical systems takes place. Such systems, e.g., the energy network (smart grid), trans- portation systems and large industrial facilities, are critical infrastructures with severe results in case of their failure. Thus, the Internet that interconnects these systems has evolved to a critical infrastructure as well.

The lecture introduces the current state-of-the-art in the research towards resilient networks. Resilience-enhancing techniques can be generally classified in proactive and reactive methods. Proactive techniques are redundancy and compartmentalization. Redundancy allows to tolerate attacks to a certain extent, while compartmentalization attempts to restrict the attack locally and preventing its expansion across the whole system. Reactive techniques follow a three step approach by comprising the phases of detecting an attack, mitigate its impacts, and finally restore a system's usual operation.

Based upon this categorisation of resilience strategies the lecture will give an excursus to graph theorie and will introduce generic strategies to increase the resilience of networks, e.g., proactively establishing backup routes and fast restoration strategies. Furthermore, the lecture will provide an overview on BGP routing and the Domain Name Service, as two essential Internet services. Both services are presented and current attacks as well as corresponding countermeasures are described. Moreover, Denial of Service attacks and their mitigation are observed in detail as well as mechanism for increasing the resilience of P2P networks. Finally, Intrusion Detection systems are covered as mechanisms to mitigate the impacts of successful attacks.

Workload
1. Attendance time in lectures: 45 h
2. Preparation and follow-up of the same: 90 h
3. Exam preparation and attendance in the same: 45 h

Recommendation
Knowledge of the basics of cryptography and computer networks is helpful.

M 4.106 Module: Robotics - Practical Course [M-INFO-107155]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114172	Practical Course: Robotics	6 CR	Asfour

Competence Certificate
See partial Achievements (Teilleistung)

Prerequisites
See partial Achievements (Teilleistung)

Competence Goal
The student knows concrete solutions for different problems in robotics. He/she uses methods of inverse kinematics, grasp and motion planning, and visual perception. The student can implement solutions in the programming languages C++ and Python with the help of suitable software frameworks.

Content
The practical course is offered as an accompanying course to the lectures Robotics I-III. Every week, a small team of students will work on solving a given robotics problem. The list of topics includes robot modeling and simulation, inverse kinematics, robot programming via state charts, collision-free motion planning, grasp planning, robot vision and robot learning.

Workload
Practical course with 4 SWS, 6 LP
6 LP corresponds to 180 hours, including
2 hours introductory event
18 hours initial familiarization with the software framework
120 hours group work
40 hours attendance time

Recommendation
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics and Mechano-Informatics and Robotics is recommended.

4.107 Module: Robotics I - Introduction to Robotics [M-INFO-107162]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Elective Studies in Informatics

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

Mandatory			
T-INFO-114190	Robotics I - Introduction to Robotics	6 CR	Asfour

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

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

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

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

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

4.108 Module: Robotics II - Humanoid Robotics [M-INFO-107123]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114152	Robotics II - Humanoid Robotics	3 CR	Asfour

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students have an overview of current research topics in autonomous learning robot systems using the example of humanoid robotics. They are able to classify and evaluate current developments in the field of cognitive humanoid robotics.

The students know the essential problems of humanoid robotics and are able to develop solutions on the basis of existing research.

Content
The lecture presents current work in the field of humanoid robotics that deals with the implementation of complex sensorimotor and cognitive abilities. In the individual topics different methods and algorithms, their advantages and disadvantages, as well as the current state of research are discussed.

The topics addressed are: Applications and real world examples of humanoid robots; biomechanical models of the human body, biologically inspired and data-driven methods of grasping, imitation learning and programming by demonstration; semantic representations of sensorimotor experience as well as cognitive software architectures of humanoid robots.

Workload
Lecture with 2 SWS, 3 CP.
3 LP corresponds to approx. 90 hours, thereof:
approx. 15 * 2h = 30 Std. Attendance time
approx. 15 * 2h = 30 Std. Self-study prior/after the lecture
approx. 30 Std. Preparation for the exam and exam itself

Recommendation
Having visited the lectures on Robotics I - Introduction to Robotics and Mechano-Informatics and Robotics is recommended.

M 4.109 Module: Robotics III - Sensors and Perception in Robotics (24635) [M-INFO-107130]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Elective Studies in Informatics

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

Mandatory			
T-INFO-114155	Robotics III - Sensors and Perception in Robotics	3 CR	Asfour

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Competence Goal
Students can name the main sensor principles used in robotics.

Students can explain the data flow from physical measurement through digitization to the use of the recorded data for feature extraction, state estimation and semantic scene understanding.

Students are able to propose and justify suitable sensor concepts for common tasks in robotics.

Content
The lecture supplements the lecture Robotics I with a broad overview of sensors used in robotics. The lecture focuses on visual perception, object recognition, semantic scene interpretation, and (inter-)active perception. The lecture is divided into two parts:

In the first part a comprehensive overview of current sensor technologies is given. A basic distinction is made between sensors for the perception of the environment (exteroceptive) and sensors for the perception of the internal state (proprioceptive).

The second part of the lecture concentrates on the use of exteroceptive sensors in robotics. The topics covered include tactile exploration and visual data processing, including advanced topics such as feature extraction, object localization,semantic scene interpretation, and (inter-)active perception.

Workload
Lecture with 2 SWS, 3 LP
3 LP corresponds to 90 hours, including
15 * 2 = 30 hours attendance time
15 * 2 = 30 hours self-study
30 hours preparation for the exam

Recommendation
Attending the lecture Robotics I – Introduction to Robotics is recommended.

M 4.110 Module: Sampling Methods for Machine Learning [M-INFO-107090]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114133	Sampling Methods for Machine Learning	6 CR	Hanebeck
T-INFO-114134	Sampling Methods for Machine Learning - Pass	0 CR	Hanebeck

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students will understand and be able to implement various sampling techniques, from basic random number generation to advanced methods like normalizing flows. They will develop the ability to evaluate sampling quality, optimize procedures, and select appropriate methods for specific machine learning tasks. Graduates will be capable of independently developing sampling solutions for complex problems and critically assessing different approaches. Their comprehensive understanding will enable them to engage with current developments in the field and apply their knowledge effectively in both research and practical applications. This will be supported via a digital exercise.

Content
Sample-based inference is the de-facto standard for solving otherwise infeasible problems in machine learning, estimation, and control under (unavoidable) uncertainties. Thus, it is an important foundation for further studies. This lecture gives a thorough overview of state-of-the-art sampling methods and discusses current developments from the research frontier.

The first part shows how to efficiently sample large numbers of random samples from given densities starting with the special cases of uniform and Gaussian distributions. For sampling from arbitrary densities, important techniques such as inverse transform sampling, Knothe-Rosenblatt maps, Markov chain Monte Carlo, normalizing flows, and Langevin equations are introduced.

The second part is concerned with deterministic or low-discrepancy sampling, where the goal is to find a set of representative samples of a given density. These are usually obtained by optimization, which, in contrast to random samples, leads to good coverage, high homogeneity, and reproducible results. To analyze and synthesize such samples, various statistical tests and discrepancy measures are presented. This includes scalar tests such as the Cramér-von Mises test, Kolmogorov-Smirnov test, and multivariate generalizations based on Localized Cumulative Distributions and Stein discrepancy.

Finally, advanced topics such as importance sampling and sampling from the posterior density in a Bayesian update are discussed. Typical applications of sample-based inference include Bayesian neural networks, information fusion, and reinforcement learning.

Workload
Per week:
2 SWS Presence
2h Follow-up
6h Digital exercise with programming tasks
2h Exam preparation
= 12h/week und 180h/semester

Recommendation
Knowledge of a higher programming language with sophisticated libraries for scientific-numerical computing (e.g. Julia, Matlab, Python) is advantageous.

M 4.111 Module: Scientific Methods to Design and Analyze Secure Decentralized Systems [M-INFO-105780]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-111568	Scientific Methods to Design and Analyze Secure Decentralized Systems	5 CR	Hartenstein

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
1. Philosophy of Science: The student understands epistemological principles like the scientific and mathematical process, within the context of networked and decentralized systems. The student knows about the current limits of scientific research, especially in regards to the security of a given decentralized system.
2. Empirical Methods: Observation / Monitoring: The student is able to construct setups to monitor system properties related to performance or security. The student knows how to observe a decentralized system like an overlay network without interference, i.e., without impact on the behavior to measure as well as the overall system functionality.
3. Combined Empirical / Formal Methods: The student has a fundamental understanding of Discrete Event Simulations, as well as stochastic modelling and random number generation. The student is able to conduct a simulation study consisting of observation, modelling, simulation, validation, and result analysis.
4. Formal Methods: The student knows how to apply formal methods like formal verification / model checking and model comparison / simulation-based proofs to decentralized systems. The student understands tradeoffs between empirical and formal methods, and can choose suitable methods for given research tasks.
5. Applications in Research: The student understands how the methods of this lecture are applied to practical examples, and knows how to apply the methods on problems of a researcher's everyday life.

Content
Decentralized Systems (like peer-to-peer- or blockchain-based systems) are systems controlled by multiple parties who make their own independent decisions to reach a common goal. However, not knowing which parties are trustworthy and which are betrayers requires a radically different way of thinking. Based on the lecture “Decentralized Systems: Fundamentals, Modeling, and Applications”, in this lecture, we cover the necessary scientific methods to analyze existing and to create new decentralized systems. We treat both, selected empirical and formal methods and their tradeoffs, as well as the overarching philosophy of science behind the research process. Together with its practical parts, this lecture provides the foundational scientific toolbox to work on the decentralized systems of the future.

Workload
1. Attendance time (Course, exercise,): 3 SWS: 15 x 3h = 45h
2. Self-study (e.g. independent review of course material,
work on homework assignments)
Weekly preparation and follow-up of the lecture/exercise: 15 x 3 SWS x 1,5h = 67,5hh
3. Preparation for the exam: 37,5h
Σ = 150h = 5 ECTS

Recommendation
Prior knowledge on the abstract concepts as well as concrete use cases of decentralized systems is strongly recommended. The “Decentralized Systems: Fundamentals, Modeling, and Applications” lecture covers all necessary aspects, but equivalent lectures and / or self-study can also be sufficient.

4.112 Module: Seminar Advanced Topics in Machine Translation [M-INFO-102725]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-105653	Seminar Advanced Topics in Machine Translation	3 CR	Niehues

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn to familiarise themselves independently with topics based on scientific literature and prepare them for presentations.
From the other presentations, students gain in-depth knowledge in sub-areas of machine translation and learn to critically analyse the work presented.

Content
Machine translation now makes it possible to automatically translate both written texts and spoken language into another language. In statistical approaches to machine translation, methods from machine learning are primarily used to train statistical models for the translation process.
In the seminar, current research results on various aspects of the systems will be discussed. Selected publications from the fields will be presented by the participants. Possible topics include improvement of word order and grammar of the target language, adaptation to topic or genre, treatment of spoken language phenomena, error correction, ...
Students are familiar with the DFG Code of Good Scientific Practice and successfully apply these guidelines when writing their scientific work.

Workload
90h

Recommendation
Previous knowledge from the lecture "Machine Translation" is an advantage.

4.113 Module: Seminar Dependable Computing [M-INFO-102662]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-105577	Seminar Dependable Computing	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The objective of this seminar is to become familiar with general and state of the art techniques used in design and analysis of fault-tolerant digital systems.

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

Content
Reliability plays a major role in design of contemporary and next generation electronics. In many safety-critical application domains, reliability is considered as the main design criteria. With nanoscale technologies, the reliability of individual devices is decreasing, therefore, reliable computing must be considered in the design flow in order to ensure correctness of computing.
The objective of this seminar is to become familiar with general and state of the art techniques used in design and analysis of fault-tolerant digital systems. This seminar overviews reliable (fault-tolerant) computing and the design and evaluation of dependable systems, and provides a base for research in reliable systems.
The topics include study and investigation of existing and classical fault-tolerant systems as well as current trend in the research of reliable computing. Since reliability spans from hardware to software, and from device-level to system-level, various topics can be envisioned in the scope of this seminar and the prospective students can choose specific topic from a wide range of areas based on their interests and background.

Workload
4 SWS / 3CP = 90h/week

Recommendation
Knowledge of “Fault Tolerant Computing” and Computer Architecture is helpful.

M 4.114 Module: Seminar in Privacy [M-INFO-107242]

Responsible: Prof. Dr. Thorsten Strufe
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Elective Studies in Informatics

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

Mandatory			
T-INFO-114268	Seminar in Privacy	4 CR	Strufe

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The seminar deals with current topics from the research field of technical data protection.
These include, for example:
- Attacks on private information in behavioral data
- Anonymous communication
- Publication of anonymized usage data (semantic/syntactic privacy)
- Understanding and supporting the use of online media
- Security in networks

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

Content
The student is able to
- carry out a literature search based on a given topic, identify and evaluate the relevant literature;
- independently compile research results from IT security and technical data protection;
- analyze and discuss scientific studies and place them in their context;
- carry out their own classifications and evaluations of scientific studies, report on them in writing and present the results in a short scientific presentation.

Workload
Workload attendance time in the seminar: 10h
Research and preparation of a paper: 75h
Reviewing and commenting on the preliminary papers of fellow students: 5h
Preparing the presentation: 30h

Recommendation
Fundamentals of IT security, computer networks and distributed systems are required

M 4.115 Module: Seminar Near Threshold Computing [M-INFO-102663]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-105579	Seminar Near Threshold Computing	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The aim of this seminar is to become familiar with the usual approaches but also the latest techniques in the field of NTC research and to provide a broad basis for further research in this area.

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

Content
While more and more transistors can be manufactured in ever smaller structure sizes, energy is becoming an increasingly important aspect to consider in chip design. Near-threshold computing (NTC) is a promising approach to reduce power and energy consumption. The basic idea behind NTC is to operate the system with a supply voltage just above the threshold voltage (transistor threshold voltage). Although this technique can save several orders of magnitude in power and energy, there are still some problems to overcome, such as low performance due to low achievable frequencies, lower reliability, and greater susceptibility to various production and runtime fluctuations.

The aim of this seminar is to become familiar with the common approaches but also the latest techniques in the field of NTC research, and to provide a broad basis for further research in this area.

Students can choose a specific topic from a wide range of different subtopics at different levels of abstraction (from transistors to complete systems), depending on their own interest and previous background knowledge. Topics include, but are not limited to:

Analyzing energy and performance trade-offs

Analyzing the effects of production variations, and other aspects of reliability, including possible solutions

Approximate computing techniques - computing with acceptable inaccuracies in the results

Workload
90 h as a block/week

M 4.116 Module: Seminar Non-volatile Memory Technologies [M-INFO-102961]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-105935	Seminar Non-volatile Memory Technologies	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The aim of this seminar is to familiarize students with the structure and challenges of current NVM storage technologies.

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

Content
Memory chips are an essential component of any computing system. Any improvements in the memory subsystem lead to direct improvements in power consumption and speed (performance) and have an impact on the cost of the entire computer system. Conventional memory technologies (such as SRAM and DRAM) are widely used at the various memory hierarchy levels. However, with additional technological advancements, these memory technologies are becoming increasingly critical in terms of reliability and power consumption. Non-volatile memory (NVM) technologies, which were primarily intended as a replacement for secondary memory, are now being considered for primary or even on-chip memory. There is a high demand for reliable NVM memory with low*leakage* as a replacement for conventional memory technologies in the next generation of computing systems for "normally-off, instant-on" computing.

The goal of this seminar is to familiarize participants with the structure and challenges of current NVM memory technologies, including Flash, PCM, STT-MRAM and R-RAM. This seminar provides an overview of how the next generation of computing systems at different architectural levels can benefit from NVMs and provides a basis for research in NVM computing systems. Students can choose a specific topic from a variety of topics on different NVM technologies from different hierarchy levels, depending on their interest and previous background knowledge.

Workload
90 h as a block/week

M 4.117 Module: Seminar: Advanced Topics on SAT Solving [M-INFO-107209]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114231	Seminar: Advanced Topics on SAT Solving	3 CR	Iser, Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

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

Content
With selected high-influence papers from the field of SAT solving, we take a close look at how SAT solvers evolved in the past decade and learn about the major cornerstones of modern and efficient large scale SAT solving systems.

Workload
Attendance time (3-4 dates): 4.5 - 6h
Reading, summarising and relating (2-3 papers): 30 - 40h
Preparation of the presentation: 16 - 24h
Total 90h

Recommendation
Knowledge of the basics from "SAT Solving in Practice" is helpful.

M 4.118 Module: Seminar: Algorithm Engineering [M-INFO-106086]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-112312	Seminar: Algorithm Engineering	4 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students can
- carry out a literature search based on a given topic, identify, locate, evaluate and finally analyse the relevant literature.
- prepare presentations in a scientific context. To this end, students master techniques that enable them to prepare and present the content to be presented to the audience.
- prepare their written seminar paper (as required later for further academic work) in accordance with the requirements and quality standards of academic writing, taking into account the format requirements specified by academic publishers for the publication of documents.

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

Content
This seminar covers various topics from the field of algorithm engineering. The focus can be on scalability, parallelism, efficiency or theoretical guarantees of algorithms. Example topics may include graph algorithms, sorting algorithms, string algorithms, SAT solvers, data structures or other algorithms. The exact focus of the seminar for the current semester will be announced in advance on the institute website by the chair of Prof. Sanders.
Participants in the seminar carry out their own literature research, present their results to their fellow students and prepare a paper.
The exact formalities will be announced at a kick-off event at the beginning of the semester, which will also be announced on the institute's website.

Workload
4 LP corresponds to approx. 120 working hours, of which
- 10h seminar attendance
- 45h Literature research, assessment and evaluation of relevant literature
- 25h preparation of own presentation
- 25h Preparation of the written paper
- 15h preparation and follow-up work

Recommendation
Knowledge of algorithms is an advantage. Exemplary lectures are Algorithms I, Algorithms II, Algorithm Engineering and Parallel Algorithms.

M 4.119 Module: Seminar: Applications and Extensions of Timed Systems [M-INFO-106512]

Responsible: Jun.-Prof. Dr. Maike Schwammberger
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-113132	Seminar: Applications and Extensions of Timed Systems	4 CR	Schwammberger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students can understand, model and analyse time-critical systems. Further on, they can apply the learned topics to real-world problems. They can independently work on a given topic in a team of two students and present the topic adequatly within a paper and in front of an audience. The students can also critically discuss the works of the other students in plenum discussions.

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

Content
Many of the (embedded) software systems we are confronted with in everyday life have time-critical functionalities. For example, in the event of an accident, an airbag should be activated within a specific, very short, period of time. As another example: we expect fast response times from our smartphones so that we can use them conveniently and purposefully.
When modeling software systems, "time" is therefore a decisive factor. In this seminar, various mechanisms to formalise and analyse so-called real-time systems are discussed. The lecture also focuses on applications of timed systems. For instance, the following topics are dealt with:

- Timed Games
- Applications of Timed Automata (e.g. UPPAAL in Space)
- Synthesising Strategies using UPPAAL Stratego
- Duration Calculus (e.g. Satisfiability, Calculus)
- Interval Temporal Logic vs Duration Calculus

The module will consist of an introductory lecture part, where some basic topics around timed systems are introduced. For the second half of the module, the students will prepare papers and topic talks each in teams of two students. Aditionally, a conference-style peer-review process for the papers is planned amongst the students. It is also expected that the students actively discuss their topics with their fellow students.

Workload
4 ECTS correspond to 120 working hours, of which
approx. 10 hours attendance of an introductory lecture incl. preparation and wrap-up
approx. 60 hours independent examination of a given topic + writing a paper
approx. 30 hours preparation of a lecture
approx. 20 hours block seminar, incl. preparation and follow-up (e.g. review)

Recommendation
Knowledge in areas of theoretical computer science and modeling of (embedded) software systems is helpful (e.g. CTL, finite automata, first order logic). It is also helpful, but not at all necessary, to have knowledge of the topics of the summer term lecture „Timed Systems“. Necessary topics from that lecture will also be introduced in the beginning of the winter term, if necessary.

M 4.120 Module: Seminar: Artificial Intelligence for Energy Systems [M-INFO-106490]

Responsible: TT-Prof. Dr. Benjamin Schäfer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113110	Seminar: Artificial Intelligence for Energy Systems	4 CR	Schäfer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
• Students obtained a foundational knowledge of AI in energy systems as an active research field and can name some ongoing challenges
• Students are able to independently conduct a literature review on a given topic.
• Students are able to present their knowledge in a written and structured report
• Students are able to orally present results and discuss topics of the seminar in the broader context of the field

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

Content
Artificial Intelligence (AI) is a key technology in many areas of society and research. Energy systems with the ongoing energy transition (“Energiewende”) make it a fascinating field for deploying AI methods. AI and machine learning algorithms can play a crucial role in improving energy efficiency, optimizing power generation and distribution or enhancing system stability while facilitating additional renewable energy integration. This seminar will explore fundamental AI algorithms and their applications in energy systems. Examples may include forecasting of energy demand or renewable generation, explainability of algorithms as well as optimization via AI.

Workload
20h attendance time (kick-off and talks by other students)
20h literature review
40h writing of own contribution
10h per-review for other students
30h preparation of the final presentation
120h=4ECTS

Recommendation
Previous participation in “Energieinformatik 1” and/or “Energieinformatik 2” is beneficiary but not mandatory.

4.121 Module: Seminar: Continuous Software Engineering [M-INFO-105309]

Responsible: Prof. Dr.-Ing. Anne Koziolek
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-110794	Seminar: Continuous Software Engineering	4 CR	Koziolek

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students can

- carry out a literature search based on a given topic, identify, locate, evaluate and finally analyze the relevant literature.

- prepare their seminar paper (and later their Bachelor's/Master's thesis) with a minimum of training, taking into account the format requirements specified by all publishers for the publication of documents.

- Preparing presentations in a scientific context. To this end, techniques are introduced that make it possible to prepare and present the content to be presented in an auditorium-appropriate manner.

present the results of their research in written form, as is generally the case in scientific publications.

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

Content
Modern software engineering takes place in short cycles that enable rapid feedback Technologies such as build servers and containerization enable fast, frequent and automatic deployment of software in productive operation and rapid feedback into development (DevOps).

The term "Continuous Software Engineering" summarizes the interlocking of the various activities.

The seminar will examine various current challenges in the field of continuous software engineering, including the engineering of applications with machine learning components.

Workload
25 working hours for the literature research
55 working hours for the preparation of the thesis and peer reviews
20 working hours for the preparation of the final presentation
20 working hours for the final block event and meeting with the supervisor.
This results in a total of 120 working hours

M 4.122 Module: Seminar: Critical Topics in AI [M-INFO-106958]

Responsible: TT-Prof. Dr. Pascal Friederich
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113915	Seminar: Critical Topics in AI	3 CR	Friederich

Competence Certificate
See partial achivements (Teilleistung)

Prerequisites
See partial achivements (Teilleistung)

Competence Goal
Qualification objectives:
• Students are able to work independently on literature about a topic of current research and to critically evaluate it, to find and understand relevant publications, and to classify and process their content accordingly in order to be able to present the chosen topic area in the form of a presentation and a written paper.

Learning Objectives
• Overview of positive as well as negative impact of AI technology
• Overview of scientific and related ethical issues in current AI research

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

Content
This seminar covers the technical as well as ethical aspects of critical issues in AI. Topics covered include bias in machine learning methods, ethically and socially critical applications of AI, and the impact of AI on society. The exact topics will be determined in each semester.

Students will work independently on an advanced topic and critically engage with it, presenting and discussing their findings in a lecture and summarizing them in a seminar paper.

Workload
Total 90 h, of which:
• Introductory courses: 4 h
• Literature research: 30 h
• Writing the report (10-15 pages) and preparing the presentation (30+15 minutes): 50 h
• Presentation of the results: 6 h

Recommendation
Interest in social topics and research questions is required

4.123 Module: Seminar: Current Trends in Theoretical Computer Science [M-INFO-107027]

Responsible: Prof. Dr.-Ing. Marvin Künnemann
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114091	Seminar: Current Trends in Theoretical Computer Science	4 CR	Künnemann

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are able to:
- perform a literature review on the basis of a given topic/scientific paper, to read and understand relevant scientific works in theoretical computer science and to identify the scientific context.
- present a scientific paper and its context.
- lead the discussion on the merits of the paper.
- create a written report of their topic in accordance to usual quality standards
for scientific writing

Content
This seminar discusses current trends and topics in theoretical computer science, with a focus on algorithms & complexity theory. This includes short deep-dives into hot topics of research, as well as possibly required background material. Topics covered in this class may well inspire subsequent research projects/thesis topics.

The seminar is organized in a reading group format: Each student is expected to perform a basic reading of the topic for each session. A designated session leader (either a student or non-student participant) has prepared the material more thoroughly and leads the discussion, usually including a basic presentation. Every student participant is expected to lead a session at least once.

The sessions usually take place in blocked format (i.e., on a small number of dates).

The specific contents vary, but often focus on 2-3 main themes of current research in the field.

Workload
4 CP amounts to 120 h, distributed as follows:
- about 15 h attendance in class
- about 45 h reviewing the literature
- about 40 h preparation of presentation/discussion
- about 20 h writing of scientific report

Recommendation
Basic knowledge of theoretical computer science and algorithm design is recommended.

4.124 Module: Seminar: Deep Learning for Robotics [M-INFO-107175]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114204	Seminar: Deep Learning for Robotics	3 CR	Neumann

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are able to independently understand a complex research topic, present the content in a concise and understandable way and prepare a scientific report summarizing the topic.

Students are able to independently understand a complex research topic, present the content in a concise and understandable way and prepare a scientific report summarizing the topic. Students get a deeper understanding of state-of-the art learning algorithms and get to know current research challenges.

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

Content
Each student has to choose one of the offered topics from the area of deep learning / robot learning / deep reinforcement learning / deep imitation learning. Each topic consists of several research papers for which the students have to prepare a presentation as well as a report in form of a scientific research paper. It is recommended to take the seminar together with the “Research Project Deep Learning for Robotics”, where the presented algorithms will be implemented and evaluated. Students will work in teams of 2.

Workload
Workload = 90 h = 3 ECTS
Attendance time: 15h
Self-study: 45h
Writing a scientific report: 20h
Prepare presentation: 10h

Recommendation
Attendance of the lecture "Machine Learning - Fundamentals and Algorithms" is recommended.

4.125 Module: Seminar: Embedded Systems I [M-INFO-107231]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-114255	Seminar: Embedded Systems I	3 CR	Henkel

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn the basics of scientific work in the form of literature research, writing a scientific paper and giving a presentation to a specialist audience.

Learning objectives:

Students learn to read conference papers, articles in specialist journals and standard literature. Furthermore, they interpret these texts in order to give an overview of the topic in their own words in a paper. Finally, they also present an overview of the topic to other computer scientists. In doing so, they are trained in scientific writing in the form of expression, text structure and reduction to the essentials.

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

Content
This module bundles the seminars at the Chair of Embedded Systems:

Internt of Things

Machine Learning

Embedded Security and Architectures

For current information, please check the course catalog and the Chair of Embedded Systems homepage at https://ces.itec.kit.edu.

Workload
90 h

M 4.126 Module: Seminar: Embedded Systems II [M-INFO-107232]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-114256	Seminar: Embedded Systems II	3 CR	Henkel

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Qualification objective: Students learn the basics of scientific work in the form of literature research, writing a scientific paper and giving a presentation to a specialist audience.

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

Learning objectives:Students learn how to read conference papers, articles in specialist journals and standard literature. Furthermore, they interpret these texts in order to give an overview of the topic in their own words in a paper. Finally, they also present an overview of the topic to other computer scientists. In doing so, they are trained in scientific writing in the form of expression, text structure and reduction to the essentials.

Content
This module bundles the seminars at the Chair of Embedded Systems:
Internet of Things (IoT) for Healthcare

Internet of Things (IoT) in Embedded Systems

Approximate Computing

Thermal-aware Embedded Systems

Dependability in Internet of Things (IoT)
Performance Optimization for Multicore Chips
Power Efficient Reliability

Distributed Decision Making

Low Power Design for Embedded Systems

Reconfigurable Embedded Systems

Mixed Criticality Systems

Security in Internet of Things (IoT)

For current information, please refer to the course catalog and the Chair of Embedded Systems homepage at http://ces.itec.kit.edu.

Annotation
This is identical to the module 'Seminars: Embedded Systems I' and enables participation in a second seminar at the CES Chair.

Workload
90 h

M 4.127 Module: Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society [M-INFO-106651]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113398	Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society	3 CR	Bruno

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

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

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

Content
The students choose a topic from the field of robotics (e.g. remote control, behavior-based robotics, human-robot interaction, the “uncanny valley,” natural language understanding, machine learning) and conduct a research on it that, building on literature findings, also includes and addresses the perspectives of society and the general media (as given by science fiction books, movies and games, as well as media and news outlets) and technology assessment (including social/societal expectations and needs, ethical implications, and risks/benefits analyses).
Students work under the guidance of a scientific supervisor. At the end of the semester, they present the results and write an elaboration in English in the form of a scientific publication.

Workload
Seminar with 2 SWS, 3 LP.
3 LP corresponds to approx. 90 hours, of which
approx. 45 hours of literature research
approx. 25 hrs. elaboration
approx. 10 hrs. preparation of presentation
approx. 10 hrs. compulsory attendance

Recommendation
Knowledge of the content of modules Robotics I - Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics is helpful.

M 4.128 Module: Seminar: Fine-Grained Complexity Theory & Algorithms [M-INFO-106645]

Responsible: Prof. Dr.-Ing. Marvin Künnemann
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-113392	Seminar: Fine-Grained Complexity Theory & Algorithms	4 CR	Künnemann

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are able to:
- perform a literature review on the basis of a given topic/scientific paper, to read and understand relevant scientific works in algorithms & complexity theory and to identify the scientific context.
- present a scientific paper and its context. This includes competency in tools and techniques for making the content accessible for a target audience.
- create a written report of their topic in accordance to usual quality standards for scientific writing

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

Content
Selected topics from the field of fine-grained complexity theory & algorithm design. This consists of recent papers on fine-grained hardness assumptions, conditional lower bounds and algorithmic results for important problems from various sub-areas.

Each student will present a topic and summarize it in a scientific report.

Workload
4 CP amounts to 120 h, distributed as follows:
- about 10 h attendance in class
- about 40 h literature search and review
- about 40 h preparation of presentation
- about 30 h writing of scientific report

Recommendation
Basic knowledge of theoretical computer science and algorithm design is recommended.

Concurrent or previous attendance of the lecture “Fine-Grained Complexity Theory & Algorithms” is helpful, but not required. This seminar can be attended independently.

M 4.129 Module: Seminar: Hot Topics in Artificial Intelligence & Security 1 [M-INFO-106868]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113761	Seminar: Hot Topics in Artificial Intelligence & Security 1	4 CR	Wressnegger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know basic concepts artificial intelligence and machine learning in computer security, and are able to understand/interpret results from state-of-the-art research.

- Students know and understand basic concepts of combining artificial intelligence and computer security.
- Students are able independently research topics and methods.
- Students understand limits of current methods and applications

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

Content
This seminar is concerned with the combination of artificial intelligence, machine learning and computer security in practice. Many tasks in the security landscape are based on manual labor, such as searching for vulnerabilities or analyzing malware. Here, machine learning can be used to establish a higher degree of automation, providing more "intelligent" security
solutions (AI for Security). However, also these learning-based systems can be attacked and need to be secured (Security of AI).

This module is part of a seminar series to intensifies the contents of the AISEC lecture. It can be attended individually and in no particular order. The module puts focus on timely topics from recent research and teaches students to work up results from state-of-the-art research. To this end, the they will read up on a sub-field, prepare a seminar report, and present their work at the end of the term to their colleagues.

Workload
- 30h Literature research
- 60h Elaboration of the seminar paper
- 20h Preparation of final presentation
- 10h attendance time

Recommendation
The basics of IT security and artificial intelligence are a prerequisite.

M 4.130 Module: Seminar: Hot Topics in Artificial Intelligence & Security 2 [M-INFO-106869]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113762	Seminar: Hot Topics in Artificial Intelligence & Security 2	4 CR	Wressnegger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know basic concepts artificial intelligence and machine learning in computer security, and are able to understand/interpret results from state-of-the-art research.

- Students know and understand basic concepts of combining artificial intelligence and computer security.
- Students are able independently research topics and methods.
- Students understand limits of current methods and applications

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

Content
This seminar is concerned with the combination of artificial intelligence, machine learning and computer security in practice. Many tasks in the security landscape are based on manual labor, such as searching for vulnerabilities or analyzing malware. Here, machine learning can be used to establish a higher degree of automation, providing more "intelligent" security
solutions (AI for Security). However, also these learning-based systems can be attacked and need to be secured (Security of AI).

This module is part of a seminar series to intensifies the contents of the AISEC lecture. It can be attended individually and in no particular order. The module puts focus on timely topics from recent research and teaches students to work up results from state-of-the-art research. To this end, the they will read up on a sub-field, prepare a seminar report, and present their work at the end of the term to their colleagues.

Workload
- 30h Literature research
- 60h Elaboration of the seminar paper
- 20h Preparation of final presentation
- 10h attendance time

Recommendation
The basics of IT security and artificial intelligence are a prerequisite.

M 4.131 Module: Seminar: Hot Topics in Bioinformatics (2400011) [M-INFO-100750]

Responsible: Prof. Dr. Alexandros Stamatakis
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-101287	Seminar: Hot Topics in Bioinformatics	3 CR	Stamatakis

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Participants will be able to understand, critically evaluate and compare current scientific publications in the field of sequence-based bioinformatics. They are able to present, understand, and critically assess the algorithms and models from current publications orally and in writing at a level that corresponds to the quality of scientific publications and conference presentations. They are able to suggest possible extensions to existing work and assess if the results are reproducible.

Content
The field of Bioinformatics is by now established as an independent application area of computer science. One of the main objectives of classical bioinformatics is to generate biological knowledge (usually from molecular data, e.g., DNA data sets) using appropriate models and algorithms. The so-called molecular data flood, which is being driven by increasingly faster and cheaper methods for extracting DNA, presents bioinformatics with new challenges regarding data storage and processing. These challenges range from discrete algorithms on strings and trees to parallel processing of data and large numerical simulations on supercomputers. The aim of the module is to provide an insight into the many facets of current bioinformatics research.

Workload
10 hours of topic selection + 10 hours of attending the seminar lectures + 30 hours of reading and understanding the paper(s) + 10 hours of lecture preparation + 30 hours for writing the report = 90 hours = 3 ECTS

4.132 Module: Seminar: Hot Topics in Decentralized Systems [M-INFO-104891]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-109922	Seminar: Hot Topics in Decentralized Systems	3 CR	Hartenstein

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student is familiar with the current state of research in the field of decentralised systems.
The student is able to familiarise him/herself independently with a current research topic and the associated fundamentals by identifying relevant literature and processing it in a structured manner.
The student is able to write a paper according to scientific standards.
The student is able to present and discuss a scientific topic in a colloquium.
The student is able to consider the challenges of a specific technical problem in the context of decentralised systems and transfer existing solution approaches to the given problem and evaluate them with regard to performance and security.
Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and successfully apply these guidelines in the preparation of their scientific work.

Content
The seminar deals with current work in the field of decentralised systems. Based on current research work, challenges and approaches are identified. Corresponding solutions are analysed and compared. Finally, the reference to related domains is established.

Workload
Kick-off events: 4h
Meeting with the supervisor: 4h
Presentation dates: 8h
Literature research: 25h
Writing the paper and preparing the presentation: 50h
Total: 91h = 3 ECTS points

Recommendation
Knowledge of the basics of IT security management for networked systems and the basic security module is helpful.

4.133 Module: Seminar: Hot Topics in Explainable Artificial Intelligence (XAI) [M-INFO-106392]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-112917	Seminar: Hot Topics in Explainable Artificial Intelligence (XAI)	4 CR	Wressnegger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students know concepts of explainable machine learning and are able to understand/interpret results from state-of-the-art research.

- Students know and understand concepts of methods for explaining machine learning algorithms.
- Students are able independently research topics and methods in the field of explainable machine learning.
- Students understand limits of current approaches for explaining machine learning.

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

Content
This seminar is concerned with explainable machine learning in computer security. Learning-based systems often are difficult to interpret, and their decisions are opaque to practitioners. This lack of transparency is a considerable problem in computer security, as black-box learning systems are hard to audit and protect from attacks.

The module introduces students to the emerging field of explainable machine learning and teaches them to work up results from recent research. To this end, the students will read up on a sub-field, prepare a seminar report, and present their work at the end of the term to their colleagues.

Topics cover different aspects of the explainability of machine learning methods for the application in computer security in particular.

Workload
- 24h literature research
- 48h Elaboration of the seminar paper
- 24h Review of preliminary work by fellow students
- 16h preparation of final presentation
- 8h attendance time

In total 120h

M 4.134 Module: Seminar: Human-Robot Interaction [M-INFO-106498]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113116	Seminar: Human-Robot Interaction	3 CR	Bruno

Prerequisites
See partial achievements (Teilleistung)

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

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

Content
The students choose a topic from the field of human-robot interaction, e.g. attention modelling, socially-aware navigation, social gestures generation or metrics for HRI experiments. They conduct a literature research on this topic under the guidance of a scientific supervisor. At the end of the semester, they present the results and write an elaboration in English in the form of a scientific publication.

Workload
Seminar with 2 SWS, 3 LP.
3 LP corresponds to approx. 90 hours, of which
approx. 45 hours of literature research
approx. 25 hrs. elaboration
approx. 10 hrs. preparation of presentation
approx. 10 hrs. compulsory attendance

Recommendation
Knowledge of the content of modules Robotics I - Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics is helpful.

M 4.135 Module: Seminar: Interactive Learning [M-INFO-106301]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-112773	Seminar: Interactive Learning	3 CR	Lioutikov

Competence Certificate
See Partial Achivements (Teilleistung).

Prerequisites
See Partial Achivements (Teilleistung).

Competence Goal
Qualifikationsziel:Students are able to independently understand a complex research topic, present the content in a concise and understandable way and prepare a scientific report summarizing the topic.
Lernziele:Students are able to independently understand a complex research topic, present the content in a concise and understandable way and prepare a scientific report summarizing the topic. Students get a deeper understanding of state-of-the art learning algorithms and get to know current research challenges.

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

Content
Each student will select several related papers in the field of Interactive Learning. The organizers will suggest several papers but the students will be encouraged to indentify and research additional relevant papers during the semester. The students will then prepare a presentation and a basic scientific research paper.
It is highly recommended to take this seminar in combination with the “Interactive Learning” Research Project (Forschungspraktikum), where the students get the chance to deepen their understanding, implement and evaluate their presented work.

Workload
Workload = 90 h = 3 ECTS
- Attendance time: 15hr
- Self-study: 45h
- Writing a scientific report: 20h
- Prepare presentation: 10h

Recommendation
We highly recommend to take this seminar in combination with the “Interactive Learning” research project (Forschungspraktikum).

It is highly recommended to attend the “Explainable Artificial Intelligence” lecture in parallel or prior to this seminar.

• Experience in Machine Learning is recommended, e.g. through prior coursework.
◦ The Computer Science Department offers several great lectures e.g., “Maschinelles Lernen - Grundlagen und Algorithmen” and “Deep Learning ”
• A good mathematical background will be beneficial
• Python experience is recommended
• We might use the PyTorch deep learning library In the exercises. Some prior knowledge in this is helpful but not necessary.

M 4.136 Module: Seminar: Interpretability and Causality in Machine Learning [M-INFO-107217]

Responsible: Jun.-Prof. Dr. Jan Stühmer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114237	Seminar: Interpretability and Causality in Machine Learning	3 CR	Stühmer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Qualification target:

Students acquire the foundations of scientific literature research, writing of a scientific report, and presenting their results in front of an audience.

Learning objectives:

Students independently acquire an understanding of their research topic from scientific literature such as conference papers, journal papers and textbooks.
They are able to independently present the content in a concise and understandable way in a written report and in a presentation in front of an audience.

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

Content
Topic of this Masterseminar are machine learning approaches and deep learning methods for learning of interpretable representations. These methods enable to reconstruct underlying principles from data, for example the reconstruction of generative factors of a dataset.
Starting from these methods for interpretable representations, we will discuss further methods for causal discovery, that enable the inference of causal dependencies in data.
Methods and algorithms covered include for example variational inference, contrastive learning, as well as statistical methods for factor analysis.
There will be a kick-off meeting at the beginning of the semester and 2-3 block seminars towards the end of the term.
Dates for both will still be determined.
The Masterseminar will be held in English language.

Workload
90h

Recommendation
Attendance of the lecture "Machine Learning - Fundamentals and Algorithms" is recommended.

4.137 Module: Seminar: Law and Legal Studies [M-INFO-107028]

Responsible: TT-Prof. Dr. Frederike Zufall
Organisation: KIT Department of Informatics
Part of: Minor Studies: Law

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

Mandatory			
T-INFO-114094	Seminar: Law and Legal Studies	3 CR	Gil Gasiola

Competence Certificate
See partial archievements (Teilleistung)

Prerequisites
See partial archievements (Teilleistung)

Competence Goal
The student

- deals with a defined problem in the field of law,
- analyzes and discusses problems within the framework of the courses and in the final seminar papers,
- discusses, presents and defends subject-specific arguments within a given task,
- organizes the preparation of the final seminar papers largely independently.

Accompanied by the relevant examiners, the student practises independent scientific work when writing the final seminar papers and presenting them.

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

Content
The module consists of a seminar that is thematically related to law. A list of approved courses will be published on the Internet.

Workload
The total workload for this module is approx. 90 hours (3 credits) for attendance time, preparation and follow-up work as well as the course examination.

The actual workload varies depending on the specific seminar chosen and is described for the individual course.

M 4.138 Module: Seminar: Machine Learning in Climate and Environmental Sciences [M-INFO-106719]

Responsible: TT-Prof. Dr. Peer Nowack
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-113519	Seminar: Machine Learning in Climate and Environmental Sciences	3 CR	Nowack

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students will learn to:
- independently discuss current research topics on machine learning in climate and environmental sciences.
- summarize published research in a structured way and explain it in their own words, in group discussions and in the form of a presentation.
- contrast modern problem-solving approaches and methods and propose suitable solutions for a variety of subject-relevant issues.
- Optional: students are invited to develop their own research ideas on the basis of what they have learned and to refine them in discussion with their supervisors. Such ideas could be pursued as a project internship, in the "Practical Research course" or in the form of a master's thesis.

Content
Machine learning (ML) methods are already ubiquitous in many areas of society and research. This is especially true for climate and environmental sciences, where ML algorithms help e.g. to improve predictions of climate change and weather, or to optimize energy supply systems. In this session, we will discuss cutting-edge publications on ML applications in climate and environmental sciences, as well as the underlying theory behind the classes of algorithms. While organizers will suggest initial papers, students will be encouraged to seek out additional relevant literature throughout the semester.
The seminar will cover both the in-depth study of the climate/environmental sciences topic as well as of the specific machine learning method(s) employed in the literature. It will include two short and one longer final presentation from each student. The first presentation will focus solely on the chosen climate or environmental event or phenomenon, while the second presentation will cover the machine learning methods employed in studying it. Next to suggested reading by the module organizers, students will be encouraged to seek out additional relevant literature throughout the semester.
Towards the end, students will compile their findings into the final presentation accompanied by a scientific report, presenting the results in the form of a lecture.

Workload
Total 90 h, consisting of:
Seminar attendance and personal meetings with the supervisors: 10 h
Literature research: 30 h
Writing the seminar paper and preparing the final presentation: 50 h

Recommendation
- An interest in climate and environmental sciences topics is a prerequisite.

M 4.139 Module: Seminar: Operating Systems [M-INFO-107205]

Responsible: Prof. Dr.-Ing. Frank Bellosa
Organisation: KIT Department of Informatics
Part of: Elective Studies in Informatics

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

Mandatory			
T-INFO-114230	Seminar: Operating Systems	3 CR	Bellosa

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students analyse and present scientific work in the field of operating systems.
In addition to techniques of scientific work, key qualifications are also taught in an integrative manner by attending the seminars.
Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and successfully apply these guidelines when writing their scientific work.

Content
The seminar is dedicated to a current area of operating system research.

Workload
30 h = 2 SWS * 15 attendance
30 h preparation
10 h Presentation
20 h elaboration
90 h = 3 ECTS

M 4.140 Module: Seminar: Post-Quantum Cryptography [M-INFO-105585]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Elective Studies in Informatics

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

Mandatory			
T-INFO-111200	Seminar: Post-Quantum Cryptography	3 CR	Müller-Quade

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student

- can describe the mathematical foundations of different quantum-hard problems
- knows basic post-quantum cryptosystems
- analyzes and discusses specific problems within the scope of his seminar paper
- presents technical arguments and is able to defend them within the scope of a certain assignment
- manages and prepares his seminar paper and his presentation largly independent

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

Content
The Seminar deals with the foundations of post-quantum cryptography and quantum hard problems.

First, the mathematical basics describing several quantum-hard problems are introduced in introductionary lectures. Subsequently, different post-quantum cryptosytems and common cryptographic notions will be introduced. Furthermore the seminar covers related topics, such as provability in the event of quantum adversaries.

Workload
Attendance time in seminar: 15 h
Writing the paper: 30 h
Designing and preparing the presentation: 45 h

Recommendation
Basic knowledge of IT-Security and cryptography are recommended.

4.141 Module: Seminar: Practical Graph Algorithms [M-INFO-107264]

Responsible: Prof. Dr. Henning Meyerhenke
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114297	Seminar: Practical Graph Algorithms	4 CR	Meyerhenke

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students are able to:
- perform a literature review on the basis of a given topic/scientific paper, to read and understand relevant scientific works in algorithm engineering for graph problem and to identify the scientific context.
- present a scientific paper and its context. This includes competency in tools and techniques for making the content accessible for a target audience.
- create a written report of their topic in accordance to usual quality standards for scientific writing
- critically assess the work of other participants and make constructive suggestions for improvement.
- Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and successfully apply these guidelines in the preparation of their scientific work.

Content
This seminar covers various topics from the field of practical graph algorithms such as small subgraph detection, graph robustness, centrality computations, and related ones. The exact focus of the seminar for the current semester will be announced in advance on the website of Prof. Meyerhenke's chair. Participants in the seminar carry out their own literature research, present their results to their fellow students and prepare a paper.

The seminar will be held in several blocks, partially online, partially on-site. The exact formalities will be announced at an online kick-off event at the beginning of the semester, which will also be announced on the course website mentioned above.

Workload
4 LP corresponds to approx. 120 working hours, of which
- 15h seminar attendance
- 35h Literature research, assessment and evaluation of relevant literature
- 35h preparation of own presentation
- 35h preparation of the scientific report

Recommendation
Knowledge of algorithms, in particular graph algorithms, is a clear advantage. Exemplary lectures are Algorithms I and Algorithms II.

M 4.142 Module: Seminar: Privacy and Security [M-INFO-107216]

Responsible: Prof. Dr. Thorsten Strufe
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Elective Studies in Informatics

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

Mandatory			
T-INFO-114236	Seminar: Privacy and Security	4 CR	Strufe

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student is able to
- conduct a literature search based on a given topic, identify and evaluate the relevant literature;
- independently compile research results from IT security and technical data protection;
- analyze and discuss scientific studies and place them in their context;
- conduct their own classifications and evaluations of scientific studies, report on them in writing and present the results in a short scientific presentation.

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

Content
The seminar deals with current topics from the research field of data protection and security.
These include, for example:
- Privacy attacks on communication
- Network security
- Anonymized online services
- Evaluation of the anonymity of online services
- Anonymized publication of data (differential privacy, k-anonymity)
- Transparency/awareness-enhancing systems
- Behavioral analysis of media use
- Biometric authentication

Workload
Seminar attendance time: 10h
Researching and writing a paper: 75h
Reviewing and commenting on the preliminary papers of fellow students: 5h
Preparing the presentation: 30h

Recommendation
Fundamentals of IT security, computer networks and distributed systems are required

M 4.143 Module: Seminar: Proofs from THE BOOK [M-INFO-103306]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Elective Studies in Informatics

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

Mandatory			
T-INFO-106604	Seminar: Proofs from THE BOOK	3 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The students learn to follow and understand complex mathematical proofs on their own. They learn to represent these proofs in an appealing manner and present the proofs to the other participants using a blackboard.

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

Content
According to the Hungarian mathematician Paul Erdős, God is keeping a book – the BOOK – under wraps that contains the most elegant mathematical proofs. Erdős' loftiest goal was to find such proofs from the BOOK.
After Erdős' death in 1996, Martin Aigner and Günter Ziegler published the book "Proofs from THE BOOK" in 1998. The book has also been published in German with the title "Das BUCH der Beweise". In Aigner and Ziegler's collection, there are some 40 of the most elegant proofs which are handled as candidates for BOOK-proofs.

In this seminar, the participants will present and discuss proofs from "Proofs from THE BOOK" and other well known and well studied proofs in the area of mathematics and informatics.

Workload
Seminar with 2 SWS, 3 LP
3 LP correspond to about 90h of work, split into

about 20h attendance
about 60h preparation for seminar
about 10h follow-up

Recommendation
The German version "Das Buch der Beweise" is available online at the KIT library within the KIT network. The English version "Proofs from THE BOOK" is available as a physical copy at the KIT library. We recommend having a look inside either version before registering for this seminar.

4.144 Module: Seminar: Quantum Information Theory [M-INFO-105408]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Elective Studies in Informatics

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

Mandatory			
T-INFO-110904	Seminar: Quantum Information Theory	3 CR	Müller-Quade

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student…
• understands the basics of Quantum Information Theory.
• understands formalizing quantum states via state vectors and is able to autonomously use the state vector formalism to design and analyze quantum algorithms.
• knows and understands the quantum gates introduced in the seminar.
• knows the visual quantum circuit tool “Quirk” and is able to autonomously apply it to design and analyze quantum algorithms.
• knows and understands the quantum problems and algorithms discussed in the seminar and is able to explain them and relate them to one another.
• knows and understands the impact quantum algorithms have on classic cryptography.
• knows and understands the basics of and presented protocols for quantum key distribution.
• is able to autonomously apply the techniques presented in the seminar, e.g. to prove correctness of simple quantum algorithms.

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

Content
• Basics of Quantum Information Theory
• Formalism for dealing with quantum systems
• “Quirk”
• Important quantum problems and algorithms
• Quantum key distribution
• Quantum walks

Workload
Seminar attendance time: 18h
Preparation and follow-up work: 12h
Preparation of a presentation: 30h
Preparation of a written examination: 30h

Recommendation
Students should be familiar with the contents of the module "Linear Algebra 1 and 2", as well as the basics of IT security.

4.145 Module: Seminar: Recent Highlights in Algorithms [M-INFO-107172]

Responsible: TT-Prof. Dr. Thomas Bläsius
Prof. Dr. Peter Sanders

Organisation: KIT Department of Informatics

Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114201	Seminar: Recent Highlights in Algorithms	4 CR	Bläsius, Sanders, Ueckerdt

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students can,
- carry out a literature search based on a given topic, identify, locate, evaluate and finally analyse the relevant literature.
- prepare presentations in a scientific context. To this end, students master techniques that enable them to prepare and present the content to be presented in a manner suitable for an audience.
- prepare their written seminar paper (as required later for further academic work) in accordance with the requirements and quality standards of academic writing, taking into account the format requirements specified by academic publishers for the publication of documents.
- critically assess the work of other participants and make constructive suggestions for improvement.

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

Content
The seminars offered as part of this seminar module deal with current topics in algorithm technology and explore them in depth. As a rule, the prerequisite for passing the module is the preparation of a written paper of max. 15 pages and an oral presentation of at least 45 minutes.

Workload
Seminar with 2SWS, 4LP
4 LP corresponds to approx. 120 working hours, of which
approx. 10h seminar attendance
approx. 40 hours of literature research, assessment and evaluation of relevant literature
approx. 30h preparation of own presentation
approx. 30 hours writing the paper
approx. 10h Reading two papers and formulating constructive criticism and suggestions for improvement in writing

M 4.146 Module: Seminar: Recent Topics of Machine Learning in Materials Science and Chemistry [M-INFO-106284]

Responsible: TT-Prof. Dr. Pascal Friederich
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence

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

Mandatory			
T-INFO-112740	Seminar: Recent Topics of Machine Learning in Materials Science and Chemistry	3 CR	Friederich

Competence Certificate
See partial Achievements (Teilleistung).

Prerequisites
Basic knowledge in AI and Machine Learning, e.g.

BA Informatics: Introduction to artificial intelligence

Competence Goal
• Students obtain an overview of current machine learning methods developed for and used in material science and chemistry
• Students are able to independently familiarize themselves with a topic of current research, to find and understand relevant publications
• Students are able to classify and process the content of recent publications and compare it to other literature
• Students are able to present the selected topic in the form of a lecture and a written report
• Optional: Students are encouraged to develop independent ideas to advance research in the area of their chosen topic. This may then eventually take the form of a project internship, participation in the Practice of Research course, or a master's thesis.

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

Content
This seminar covers the theoretical and practical aspects of recent developments of machine learning with application specifically in materials science and chemistry. Topics covered in this seminar include state-of-the-art models for the prediction of properties of materials and molecules, new developments of generative models, machine learned potentials and force fields for atomistic simulations, relevant new datasets and benchmarks, questions of uncertainty quantification, active learning, interpretability, as well as new developments in the area of autonomous experimental labs.

Students will work independently on advanced topics, compare related scientific publications, and present and discuss their findings in a presentation and written seminar report.

Workload
Total 90 h, of which:
• Introductory courses: 4 h
• Literature research: 30 h
• Writing the report (10-15 pages) and preparing the presentation (30+15 minutes): 50 h
• Presentation of the results: 6 h

Recommendation
Participation in Machine Learning for Natural Sciences (M-INFO-105630) or other advanced machine learning lectures

M 4.147 Module: Seminar: Scalable Parallel Graph Algorithms [M-INFO-105330]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Elective Studies in Informatics

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

Mandatory			
T-INFO-110810	Seminar: Scalable Parallel Graph Algorithms	4 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students can
- carry out a literature search based on a given topic, identify, locate, evaluate and finally analyse the relevant literature.
- prepare presentations in a scientific context. To this end, students master techniques that enable them to prepare and present the content to be presented to the audience.
- prepare their written seminar paper (as required later for further academic work) in accordance with the requirements and quality standards of academic writing, taking into account the format requirements specified by academic publishers for the publication of documents.
- critically assess the work of other participants and make constructive suggestions for improvement.
Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and successfully apply these guidelines in the preparation of their scientific work.

Content
We will investigate the best known algorithm for solving fundamental graph problems on parallel computers. Particular focus will be on scalability to a large number of processors. The typical contribution will be a synthesis of several papers on one graph problem.

Example problems are

- connected components
- minimum spanning trees
- coloring
- strongly connected components
- breadth-first-search
- maximum flows
- matchings
- graph partitioning
- graph clustering
- shortest paths
- ear decomposition and its applications
- Delaunay triangulation
- graph generators
- reachability data structures
- centrality measures (e.g., betweenness)

Workload
4 LP corresponds to approx. 120 working hours, of which
10h seminar attendance
46h Literature research, assessment and evaluation of relevant literature
27h Preparation of own presentation
27h Composing the written paper
10h Reading two papers and formulating constructive criticism and suggestions for improvement in writing

Recommendation
Knowledge of the basics of graph theory, algorithm technology and parallel algorithms is helpful.

M 4.148 Module: Seminar: Secure Multiparty Computation [M-INFO-105761]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Elective Studies in Informatics

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

Mandatory			
T-INFO-111501	Seminar: Secure Multiparty Computation	3 CR	Müller-Quade

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn to familiarize themselves thoroughly with scientific papers, to present them to other students and to deal with questions on their topic in a subsequent discussion round.

Students will be able to differentiate between different protocols for secure multiparty computation and weigh up their advantages and weaknesses.

Students will be able to present academic publications from the research field of secure multiparty computation in a suitable manner, place them in the historical context of the research field and critically examine the results and findings presented.

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

Content
In the setting of secure multiparty computation, two or more parties with private inputs wish to compute some joint function of their inputs. The security requirements of such a computation are privacy (meaning that the parties learn the output and nothing more), correctness (meaning that the output is correctly distributed), independence of inputs, and more. Due to its generality, secure computation is a central tool in cryptography.

In this seminar, we examine modern protocols for secure multiparty computation of arbitrary functions.

Workload
Attendance time in seminar: 15 h

Meeting with supervisors: 5 h

Independent work in relation to the individual seminar topic: 70 h

Recommendation
Knowledge of the content of the lecture Cryptographic Protocols is assumed.

4.149 Module: Seminar: Software Architecture, Security and Privacy [M-INFO-107236]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-114260	Seminar: Software Architecture, Security and Privacy	4 CR	Reussner

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students can,

- carry out a literature search based on a given topic, identify, locate, evaluate and finally analyze the relevant literature.
- prepare their seminar paper (and later their Bachelor's/Master's thesis) with a minimum of training, taking into account the format requirements specified by all publishers for the publication of documents.
- Preparing presentations in a scientific context. To this end, techniques are introduced that make it possible to prepare and present the content to be presented in an auditorium-appropriate manner.
- present the results of their research in written form, as is generally the case in scientific publications.

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

Content
Anyone who processes personal data automatically must effectively protect this data from unauthorized access in order to act in accordance with data protection laws, but also to prevent damage to reputation and trustworthiness should data protection violations become public. Protecting personal data from unauthorized access and complying with other data protection obligations is therefore actually one of the most important goals in software design and operation.

However, looking at data protection in isolation does not do justice to reality. If an attacker gains access to personal data, voluntary commitments and internal data protection regulations no longer apply. In case of doubt, the operator of the software is liable for severe fines. Effective security precautions are therefore indispensable as a mainstay for protecting personal data.

Security-critical vulnerabilities must be identified at an early stage, ideally before the vulnerability is introduced. Such quality assessments are performed by software architecture-based analyses. How security can be described and analyzed at the software architecture level is the subject of ongoing research, as is the question of whether - and how - security can be expressed in figures.

In this seminar, students deal with these questions and the state of research at the interface between data protection, security and software architecture. Possible topics are located in one or more of these areas.

Workload
25 working hours for literature research
55 working hours for writing the thesis and preparing peer reviews
20 working hours for preparing the final presentation
20 working hours for the final block event and meeting with the supervisor.
This results in a total of 120 working hours

M 4.150 Module: Seminar: Speech-to-Speech Translation [M-INFO-107179]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114208	Seminar: Speech-to-Speech Translation	3 CR	Niehues

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn to familiarise themselves independently with topics based on academic literature and prepare them for presentations.
From the other presentations, students gain in-depth knowledge in sub-areas of language-to-language translation
By evaluating the presentations of their fellow students, students improve their social skills.
Students are familiar with the DFG Code of Conduct "Guidelines for Safeguarding Good Scientific Practice" and successfully apply these guidelines in the preparation of their scientific work.

Content
Speech-to-speech translation is a popular application that combines automatic speech recognition and machine translation. However, a user-friendly combination requires more than just a linear connection of the individual techniques.
In this seminar, students work independently on individual topics from the fields of automatic speech recognition, machine translation and their combination into speech-to-speech translation systems using the literature provided and present the summarised findings to the other participants in the seminar in the form of a slide-based presentation.

Workload
90 h

M 4.151 Module: Service Design Thinking (WW4BWLKSR2) [M-WIWI-101503]

Responsible: Prof. Dr. Gerhard Satzger
Prof. Dr. Orestis Terzidis

Organisation: KIT Department of Economics and Management

Part of: Minor Studies: Economics

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

Mandatory			
T-WIWI-102849	Service Design Thinking	9 CR	Satzger, Terzidis

Competence Certificate
The assessment is carried out as a general exam (according to Section 4(2), 3 of the examination regulation). The overall grade of the module is the grade of the examination (according to Section 4(2), 3 of the examination regulation).

Prerequisites
None

Competence Goal
Students

- Gain a comprehensive understanding of the globally recognized innovation approach “Design Thinking” as introduced and promoted by the Stanford University
- Apply the learned approach in the context of a real innovation project provided by a partner organization
- Conceive new, creative solutions through extensive need finding of relevant service users
  Develop prototypes early and independently, test them and improve them iteratively to solve the challenge provided by the partner organization
- Communicate, present and network in interdisciplinary and international environments.

Content
Course phases (roughly 4 weeks each):

Design Space Exploration:

- Exploring the problem space by questioning the given innovation challenge from practice.
- Familiarization with the topic area of the respective challenge.
- Gathering first impressions of the requirements and needs of people related to the problem.

Critical Function Prototype:

- Building an intensive understanding of the needs of the target group of the respective challenge.
- Deriving critical functions from the customer's perspective that could help solve the overall problem.
- Building prototypes for the critical functions and testing them in real customer situations.

Dark Horse Prototype:

- Reversal of assumptions and experiences made so far. The goal is to develop radically new and unconventional ideas.
- Implementation of the ideas into simple prototypes and subsequent testing.

Funky Prototype:

- Integration of the individual successfully tested functions from the critical function and dark horse phase into solution concepts. These are also tested and further developed.

Functional Prototype:

- Selection of successful funky prototypes and development of these towards high-resolution prototypes. The final solution approach for the project is written down in detail and feedback is obtained.

Final Prototype:

- Implementing the final prototype and presenting it to the practical partner as well as the SUGAR Network.

Annotation
Due to practical project work as a component of the program, access is limited. The module (as well as the module component) spans two semesters. It starts in September every year and runs until end of June in the subsequent year. Entering the program is only possible at its beginning - after prior application in May/June. For more information on the application process and the program itself are provided in the module component description and the program's website (https://sdtkarlsruhe.de/). Furthermore, the lecturers provide an information event for applicants every year in May.This module is part of the KSRI Teaching Program.

Workload
The workload for this module is approx. 2 days per week over a period of 9 months. The workload for this practical module is therefore comparatively high. The reason for this is that the participants work in international teams with students from other universities and partner organizations and solve real innovation challenges.

The workload of approx. 270 hours is spread over approx. 105 hours (3.5 CP) in the first semester and 165 hours (5.5 CP) in the second semester.

Recommendation
This course is held in English – proficiency in writing and communication is required.

Our past students recommend to take this course at the beginning of the masters program.

M 4.152 Module: Software Architecture and Quality (24667) [M-INFO-107237]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-114261	Software Architecture and Quality	3 CR	Reussner

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students can explain the role of components and explicit software architecture descriptions for engineering software development.

They can also explain the basic concepts of component-based software development.

Students are familiar with advanced concepts of view-based metamodeling and can apply these to the scenarios of the software development domain.

In addition, they can use procedures for the documentation, evaluation and reuse of software architectures, such as architecture patterns or architecture styles.

Furthermore, they can differentiate between and use different software development processes.

Students can design models for software quality characteristics such as performance.

The effects of architecture design decisions on software quality characteristics such as performance can also be analyzed.

Content
In many software development projects, the software architecture is the main determining factor for software quality. Runtime properties such as performance or reliability, as well as maintainability, essentially depend on the architecture of a software system.

In the lecture, students learn about and apply modern approaches to software architecture modeling and analysis, which can be used to predict the quality characteristics of the system at design time. The lecture thus lays the scientific foundations for software design as an engineering discipline, as the methods learned enable an understanding of the effects of architectural design decisions on software quality. In particular, software qualities such as performance, reliability and maintainability are discussed.

In connection with software architecture, software components are also introduced as "software building blocks". In particular, techniques for the reuse of architectural knowledge such as patterns, styles and reference architectures and product lines are discussed.

The lecture deals with the Palladio component model as a description language for software components and architectures.

Using the Palladio component model, role models for the design and development of component-based software are presented in addition to quality prediction.

Its use is demonstrated using industry-related case studies and techniques for evaluating the quality of your software architecture are illustrated.

The lecture covers technologies such as MOF, OCL and architecture-centered, model-driven software development (AC-MDSD). Modern middleware from practice such as Java EE / EJB is also presented.

Workload
(2 SWS + 1.5 x 2 SWS) x 15 + 15 h exam preparation = 90 h

M 4.153 Module: Software Engineering II (IN4INSWT2) [M-INFO-107235]

Responsible: Prof. Dr.-Ing. Anne Koziolek
Prof. Dr. Raffaela Mirandola
Prof. Dr. Ralf Reussner

Organisation: KIT Department of Informatics

Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-114259	Software Engineering II	6 CR	Koziolek, Mirandola, Reussner

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal

Software processes: Students understand evolutionary and incremental development and can describe the advantages over the sequential approach. They can describe the phases and disciplines of the unified process.

Requirements engineering: Students can describe the terms of requirements engineering and name activities in the requirements engineering process. They can classify and assess requirements according to the facets of type and representation. They can apply basic guidelines for specifying natural language requirements and describe prioritization procedures for requirements. Describe the purpose and elements of use case models. You can classify use cases according to their granularity and objectives. You can create use case diagrams and use cases. They can derive system sequence diagrams and operation contracts from use cases and can describe their role in the software development process.

Software architecture: Students can reproduce and explain the definition of software architecture and software components. They can explain the difference between software architecture and software architecture documentation. They can describe the advantages of explicit architecture and the factors influencing architecture decisions. You can assign design decisions and elements to the layers of an architecture. You will be able to describe what component models define. They can describe the components of the Palladio component model and discuss some of the design decisions made.

Enterprise Software Patterns: Students can characterize enterprise applications and decide for a described application which properties it fulfills. They know patterns for structuring domain logic, architectural patterns for data access and object-relational structure patterns. They can select a suitable pattern for a design problem and justify the selection based on the advantages and disadvantages of the patterns.

Software design: Students can assign the responsibilities resulting from system operations to classes or objects in object-oriented design using the GRASP patterns and thus design object-oriented software.

Software quality: Students know the principles for readable program code, can identify violations of these principles and develop proposals for solutions.

Model-driven software development: Students can describe the goals and the idealized division of labor of model-driven software development (MDSD) and reproduce and explain the definitions for model and metamodel. They can discuss the goals of modeling. You will be able to describe the model-driven architecture and express constraints in the Object Constraint Language. You can express simple transformation fragments of model-to-text transformations in a template language. You can weigh up the advantages and disadvantages of MDSD.

Embedded systems: Students will be able to explain the principle of a real-time system and why they are usually implemented as parallel processes. They can describe a rough design process for real-time systems. They can describe the role of a real-time operating system. They can distinguish between different classes of real-time systems.

Reliability: Students can describe the various dimensions of reliability and categorize a given requirement. They can illustrate that unit tests are not sufficient to evaluate software reliability and can describe how usage profile and realistic error data have an influence.

Domain-driven design (DDD): Students are familiar with the design metaphor of ubiquitous language, Closed Contexts, and Strategic Design. They can describe a domain using the DDD concepts, entity, value objects, services, and improve the resulting domain model using the patterns of aggregates, factories, and depots. They know the different types of interactions between Closed Contexts and can apply them.

Security (in the sense of security): Students can describe the basic ideas and challenges of security assessment. They can recognize common security problems and propose solutions.

Content

Requirements engineering, software development processes, software quality, software architectures, MDD, Enterprise Software Patterns software maintainability, software security, dependability, embedded software, middleware, domain-driven design

Annotation

The Software Engineering II module is a basic module.

Workload

Preparation and follow-up time 1.5 h / 1 SWS

Total workload:
(4 SWS + 1.5 x 4 SWS) x 15 + 30 h exam preparation = 180 h = 6 ECTS

M 4.154 Module: Software Product Line Engineering [M-INFO-107212]

Responsible: Prof. Dr.-Ing. Ina Schaefer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-114234	Software Product Line Engineering	3 CR	Schaefer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students understand the essential concepts (such as modularity, variation point, feature model, feature mapping, configuration, product generator, and product) and techniques (such as feature-oriented domain analysis, variant extraction, delta modelling, variant space analyses, product generation, testing of software product lines) of the development of software product lines, their relationships and their assignment to problem and solution spaces. They are able to understand and apply the different methods for designing software product lines, such as feature-orientated domain analysis or variant extraction. Students are familiar with various product generation strategies and know their advantages and disadvantages in practical use. Students are familiar with techniques for the maintenance of software product lines, such as variant space analysis, the generation of product samples and the testing of software product lines, and are able to apply these. In addition, students are familiar with current results and issues from the research field of software product lines and understand their significance, e.g. results from the field of language product lines.

Learning objectives: Students are able to independently design, implement and maintain a software product line. Students can apply feature-orientated domain analysis to a given domain and design a software product line based on a domain description and implement it in practice with tool support. Students can use variant extraction independently and with tool support to design a software product line from a series of product variants of a software system and implement it by refactoring. Students can select a suitable product generation strategy for a given domain and implement it with tool support. Students can analyse and improve the variant space of a given software product line. Students know different techniques to maintain a software product line and can analyse the variant space, generate product samples and develop tests for a given software product line.

Content
This module teaches students the procedures and techniques for the development and maintenance of multi-variant software systems using software product lines. The lecture will provide an overview of the basic goals, processes, concepts and techniques in the development and maintenance of software product lines. It is subdivided into the subject areas of the problem space and the solution space. In the first topic area, topics such as feature-oriented domain analysis, feature models and analyses of the variant space are dealt with, whereas in the second topic area, different techniques for product generation and testing of product lines are discussed and demonstrated in practice.
In addition, current results and questions from software product line research are presented and discussed.

Workload
(2 SWS + 1.5 x 2 SWS) x 15 + 15 h exam preparation = 90 h

Recommendation
Basic knowledge from the lectures Software Engineering II [T-INFO-101370] and Formal Systems [T-INFO-101336] is helpful.

4.155 Module: Software Security Engineering [M-INFO-106344]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Cryptography and Security
Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-112862	Software Security Engineering	3 CR	Gerking, Reussner

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Qualification target: Participants will be able to apply measures to detect or avoid vulnerabilities in different development phases.

Learning objectives:

- Participants acquire the ability to name criteria from security standards and evaluate their fulfillment.
- They master central security principles and their application to specific use cases.
- They can formalize security policies (based on security models) and recognize violations of policies.
- They are familiar with the handling and processing of security incidents.

Content
The course deals with the engineering of cyber security along the development cycle of software systems. This includes constructive and analytical development measures to achieve protection goals through systematic prevention and detection of vulnerabilities. The course familiarizes participants with the adoption and implementation of security measures in various development phases. Relevant fundamentals from the field of formal security models are introduced.

Workload
(2 SWS + 1.5 x 2 SWS) x 15 + 15 h exam preparation = 90 h

Recommendation
Knowledge of Software Engineering I and Software Engineering II is recommended.

M 4.156 Module: Software Test and Quality Management (SQM) [M-INFO-107239]

Responsible: Prof. Dr.-Ing. Ina Schaefer
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-114263	Softwaretest and Quality Management (SQM)	5 CR	Schaefer

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
After completing the module, participants will be familiar with the basic principles of software testing. They will be able to apply the general testing process and master the activities and techniques to support it. Participants will be able to specify test cases in all phases of the software life cycle. They know test procedures and methods with which they can prepare and carry out software tests efficiently. They are familiar with common methods of test management methods and test tools for automating test activities.

Content
1. Basics (introduction, definition of terms, principles of software testing, fundamental test process, psychology of testing)
2. Testing in the software life cycle (general V-model, component test, integration test, system test, acceptance test, testing of new product versions, overview of test types)
3. Static testing (structured group tests, static analyses, metrics)
4. Dynamic testing (black-box procedure, white-box procedure, experience-based test case determination)
5. Test management (test organisation and planning, economic aspects, test strategy, management of test work, error management, requirements for configuration management).
6. Testing tools (types, selection, introduction)
7. Modern test procedures (model-based testing, regression testing, testing of variant-rich systems)
8. Debugging

Annotation
At the end of the course there is also the opportunity to be certified as an "ISTQB - Certified Tester - Foundation Level". A date and the modalities for the exam will be agreed on in the lecture.

Workload
150h

4.157 Module: Software-Evolution (24164) [M-INFO-100719]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: Elective Studies in Informatics

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

Mandatory			
T-INFO-101256	Software-Evolution	3 CR	Reussner

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students learn about the particular challenges of long-lived software systems and the possibilities of influencing the future development of a software system through targeted software evolution. Students will learn which tools and concepts they can use in the context of software evolution and which factors have an impact on the software development process. In addition to the theoretical basics, students will gain insight into practical examples and suitable tools that simplify the handling of software evolution. A cross-section of implementation aspects, techniques, management and concepts will be conveyed to the participants of the lecture. Students are enabled to analyze, evaluate and improve software systems.

Content
The lecture Software Evolution covers: Software development processes, special features of long-lived software systems, evolution scenarios for software systems, software architecture development, software refurbishment, implementation techniques, architecture patterns, traceability, software evaluation methods, maintainability analyses and tools to support software evolution.

Workload
(2 SWS + 1.5 x 2 SWS) x 15 + 15 h exam preparation = 90 h

4.158 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: Minor Studies: Electrical Engineering

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

Mandatory			
T-ETIT-110291	Innovation Lab	9 CR	Hohmann, Nahm, Sax, Stork, Zwick
T-WIWI-102864	Entrepreneurship	3 CR	Terzidis
T-WIWI-110166	SIL Entrepreneurship Project	3 CR	Terzidis

Competence Certificate
This module consists of an approx. 60-minute written exam on the contents of the Entrepreneurship lectures, as well as 5 other types of exams on the contents of the seminar Entrepreneurship and Innovation Lab in the form of term papers and presentations. All exams results are graded.

In addition, smaller, ungraded term papers are due during the course to monitor progress.

Prerequisites
none

Competence Goal
Personal competence

- Reflection faculty:
  The students are able to analyze, evaluate and develop an alternative for action for certain elements of action in social interaction
- Decision-making ability:
  The students are able to prepare a decision template in time and to provide the necessary arguments for alternative decisions and therefore are able to decide in time.
- Interdisciplinary teamwork
  Students are able to detect their limits of competence in one domain and to adjust to a the non-specialist domain. The students are able to detect a lack in competence and to compensate this lack via competences of other team members. The students are able to communicate their domain-specific knowledge and develop a basic understanding of other domains.
- Value-based action:
  The students are able to use selected psychological tools to determine their own values. They are able to match these values with team members and reflect if their offer fits these values.

Social competence

- Ability to cooperate:
  The students are able to analyze and judge their cooperative behavior in a group.
- Communication competence:
  The students are able to present their information in persuasive, focused and target group oriented way.
- Ability to deal with conflicts:
  The students are able to detect conflicts in advance, analyze them and name solution concepts.

Innovation and entrepreneurship competence

- Agile product development:
  The students are able to apply methods of agile product development e.g. Scrum.
- Methodical innovation retrieval:
  The students are able to conduct processes for user- and technology-centered innovation to develop sustainable value propositions for certain target groups (e.g. Design Thinking (DT), Technology Application Selection (TAS)-process).
- Orientation on management of new technology-based firms (NTBF):
  The students are able to name central concepts of intellectual property and legal structures. The students are able to name the most important tasks of entrepreneurial leadership. They are able to name the most common form of business modeling and to setup a business plan. The students know important approaches to establish an organization. The students are able to determine the ownership structure in an investment situation. The students are able to name marketing concepts and setup a business model.
- Generate investment readiness:
  The students are able to setup rudimentary revenue and cost plan. Furthermore, they are able to establish a project plan for a company in order to derive an investment plan. The students are able to present their business proposal to investors and develop empathy for the investors.
- Competence to develop a business model:
  The students are able to apply respective tools for business modeling e.g. Business Model Canvas. The students are able to develop and assess alternative business models.
- Risk handling:
  The students are able to name basic risks w.r.t. requirements, technical limitations and profitability. The students are able to apply methods of customer interaction for evaluation of requirements and willingness to pay. The students are able to setup a rudimentary competitors analyze. The students are able to name and identify risks and present potential reactions.

Systemic technical competence

- Problem solution competence:
  The students are able to analyze, assess and structurally solve a technical problem.
- Agile methodology of system development:
  The students are able to name and apply different system development processes.
- Validation in volatile environment:
  The students are able to conduct technical and economical validation under volatile constraints. For this, they are able to name the constraints and interpret the results of the validation.
- Functional decomposition:
  The students are able to identify, interpret and derive functional requirements from complex customer needs.
- Architecture development:
  The students are able to recognize coherences from the functional requirements and derive a suitable system architecture.

Content
This module strives to combine technical, social and personal competences from the technical and entrepreneurial domain. The objective is to prepare students as best as possible for entrepreneurial activity within or outside of an established organization. Our teaching methods are research-based with a practical orientation.

The lecture Entrepreneurship as the essential component offers the theoretical basis and provides insight in important theoretical concepts and empirical evidence. Currently released case studies and practical experiences of successful founders support the theoretical and empirical content. In order to run a company for the long term additional knowledge is important. That's why the lecture also teaches basic principles for opportunity recognition, business modeling, an introduction to entrepreneurial marketing and leadership. Customer-based design methods from the lean startup approach as well as methods of technology-centered innovation are presented. Future founders have to be able to develop and handle resources such as financial and human capital, infrastructure and intellectual property. Further aspects tackle the establishment of an organization and funding of the own project.

The knowledge taught in the lecture Entrepreneurship will be applied in an application-oriented seminar and the labs. Hence we use an action learning approach to extend the taught knowledge by practical skills and reflection capabilities. In an team of five, the students will experience their way from the ideation process to the final pitch in front of investors.

The students are able to choose between the following options concerning the labs:

- The Automation Innovation Lab offers drones as an innovation platform for cooperative swarm solutions.
- The Industry 4.0 Innovation Lab enables innovation in the context of the next industrial revolution via mobile robot platforms.
- In the Interconnected Intelligent Systems Lab innovations in the context of Assisted Living and Smart Housing are enabled by providing a rich assembly set of mobile robots, actuators and sensors.
- The Computer Vision for Health Lab offers a selection of state-of-the-art imaging devices and powerful computing hardware for innovative image-based applications for medicine and healthcare.

The module also presents methods of agile system development (Scrum) along with associated validation methods as well as methods for functional prototyping. Gate plans are used within the module to determine the progress of the project. Methods for single person work and teamwork are presented and applied. Additionally group-specific knowledge of the different roles of team members, solutions to conflict situations and interdisciplinary teams are presented.

Module grade calculation
The module grade consists of the written exam of the Lecture Entrepreneurship (40%), of the submissions and presentation of the Innovation Lab (40%) and of the submissions and presentation of the SIL Entrepreneurship Project (20%).

Annotation
An application is required to participate in this module. Information about the application: www.kit-student-innovation-lab.de**.**

Workload
Lecture Entrepreneurship: 32h attendance time, 48h preparation and follow-up time, 10h preparation time for assessment

Seminar Entrepreneurship: 34h attendance time, 3h preparation and follow-up time, 53h preparation time for assessment.

Innovation Lab: 8h attendance time, 213h preparation and follow-up time, 49h preparation time for assessment.

This results in a total of 450 hours and a total of 15 LPs for both semesters (15*30/2 = 225).

Recommendation
It is recommended to attend the lecture Entrepreneurship at the same time as the seminar Entrepreneurship Project and the Innovation Lab in the winter semester.

Learning type
Related courses:

Lecture Entrepreneurship
Seminar Entrepreneurship Project
Innovation Labs
Please note that the courses must be booked in parallel.

Related exams:

Written exams covering the content of lecture Entrepreneurship
Presentation of the Value Profile (seminar Entrepreneurship)
Submission of the Business Plan (seminar Entrepreneurship)
Submission of a Technical Report with requirements list and system architecture (Innovation Lab)
Submission of the reflection of the Gate Plans (Innovation Lab)
Presentation of the High-fidelity (Innovation Lab)

4.159 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: Minor Studies: Electrical Engineering

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

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

Competence Certificate
Written exam, approximately 90 minutes.

Students are given the opportunity to earn a grade bonus through separate task assignments. If the grade of the written exam is between 4.0 and 1.3, the bonus improves the grade by a maximum of one grade level (0.3 or 0.4). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. Bonus points do not expire and remain valid for exams taken at a later date.

Prerequisites
none

Competence Goal
• Students are able to analyse and explain the functional principles and applications of embedded systems.

• Students are able to evaluate and apply maturity models as well as Software Development Life Cycle models including the waterfall model, V-model, prototyping model, agile models, and DevOps.

• Students are able to apply various creativity techniques to develop innovative solutions to problems. They will be able to derive and analyse requirements.

• Students are familiar with diagram formats software modelling languages; they can evaluate and create these based on problem descriptions of an application area. They will be able to create and evaluate functional, data-oriented, algorithmic, state-oriented, and object-oriented views.

• Students are able to understand and apply various aspects of the realization of embedded systems. They will be able to consider implementation alternatives: hardware, co-design and scheduling aspects.

• Students are familiar with the various testing phases in a project and can explain them. They can assess the reliability of a system and understand the concept of functional safety.

Content
The focus of the course is on processes and methods for the design of systems composed of electrical, electronic and electronically programmable systems that contain software, hardware and mechanical components. The desired competencies of the course include the knowledge and goal-oriented use of modeling techniques, design processes, description and representation tools as well as specification languages that correspond to the current state of the art.

Module grade calculation
The grade is determined by the written exam and the bonus points.

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

Workload
For each Credit Point (CP), 30h of work is scheduled. The resulting 150h are distributed as follows:

- 15 weeks of 1.5h attendance in lecture and 2h preparation and follow-up per week = 52.5h
- 15 weeks of 1.5h attendance in each exercise and at least 2h preparation (includes processing of exercise sheets and the processing of tasks for the acquisition of bonus points) per week = 52.5h
- Preparation for the exam = 45h

Recommendation
Knowledge in Digital Technology and Information and Automation Technology (e.g. module M-ETIT-102102 and M-ETIT-106336)

M 4.160 Module: Systems Engineering for Automotive Electronics [M-ETIT-100462]

Responsible: Hon.-Prof. Dr. Jürgen Bortolazzi
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Minor Studies: Electrical Engineering

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

Mandatory			
T-ETIT-100677	Systems Engineering for Automotive Electronics	4 CR	Bortolazzi

Prerequisites
none

M 4.161 Module: Telematics (24128) [M-INFO-107243]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-114269	Telematics	6 CR	Zitterbart

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students

- master protocols, architectures, and methods and algorithms that are used on the Internet for routing and for establishing a reliable end-to-end connection, as well as various media allocation procedures in local networks.
- have an understanding of the systems and the problems that appear in a global, dynamic network as well as the mechanisms used to remedy them.
- are familiar with current developments such as SDN and data center networking.
- know methods to manage and administrate networks.

Students master the basic protocol mechanisms for establishing reliable end-to-end communication. Students have detailed knowledge of the mechanisms used in TCP for congestion and flow control and can discuss the issue of fairness with multiple parallel transport streams. Students can analytically determine the performance of transport protocols and know methods that fulfill special requirements of TCP, such as high data rates and short latencies. Students are familiar with current topics such as problems introduced by utilization of middle boxes in the Internet, the use of TCP in data centers and multipath TCP. Students can use transport protocols in practice.

Students know the functions of routers in the Internet and can reproduce and apply common routing algorithms. Students can reproduce the architecture of a router and know different approaches to buffer placement as well as their advantages and disadvantages.

Students understand the distinction of routing protocols into interior and exterior gateway protocols and have detailed knowledge of the functionality and properties of common protocols such as RIP, OSPF and BGP. The students are familiar with current topics such as SDN.

Students know the function of media allocation and can classify and analytically evaluate media allocation processes. Students have in-depth knowledge of Ethernet and are familiar with various Ethernet forms and their differences, especially current developments such as real-time Ethernet and data center Ethernet. Students can reproduce and apply the spanning tree protocol.
Students can reproduce the technical characteristics of DSL. Students are familiar with the concept of label switching and can compare existing approaches such as MPLS.

Content

- Introduction
- End-to-end data transport
- Routing protocols and architectures
- Media allocation
- Bridges
- Data transmission
- Further selected examples
- Network management

Workload
Lecture with 3 SWS plus follow-up/exam preparation, 6 CP.

6 CP corresponds to approx. 180 working hours, of which

approx. 60 hours lecture attendance

approx. 60 hours preparation/follow-up work

approx. 60 hours exam preparation

M 4.162 Module: Testing Digital Systems I (24637) [M-INFO-100851]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-101388	Testing Digital Systems I	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The course provides the basic techniques for testing digital circuits

Content
Testing of digital circuits plays a critical role during the design and manufacturing cycles. It also ensures the quality of parts shipped to the customers. Test generation and design for testability are integral parts of automated design flow of all electronics products. The objective of this course is to provide the foundations for developing test methods for digital systems and provides the techniques necessary to practice design for testability.

This course encompasses the theoretical and practical aspects of digital systems testing and the design of easily testable circuits. Topics include Introduction to Testing (testing definition, types of test, automatic test equipment, test economics, and quality models), Failures and Errors (definitions, failure modes, failure mechanisms, reliability defects), Faults (fault models, stuck-at faults, bridging faults, timing faults, transistor-level faults, functional-level faults, effectiveness of different fault models based on real data), Logic and Fault Simulation (fault equivalence and fault collapsing, true-value simulation, fault simulation algorithms, statistical methods), Test Generation for Combinational Circuits (algebraic methods, path-tracing (D-alg, PODEM, FAN), testability metrics, test file compression), Digital Design-For-Testability and Internal Scan Design (ad-hoc methods, scan architectures, scan-based test methodology).

Workload
2 SWS: (2 SWS + 1,5 x 2 SWS) x 15 + 15 h preparation for the exam = 90 h = 3 ECTS

4.163 Module: Testing Digital Systems II [M-INFO-102962]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Design of Embedded Systems and Computer Architectures
Elective Studies in Informatics

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

Mandatory			
T-INFO-105936	Testing Digital Systems II	3 CR	Tahoori

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The objective of this course is to provide more advanced topics on testing of digital systems and complement the foundation covered in Testing Digital Systems I.

Content
Testing of digital circuits plays a critical role during the design and manufacturing cycles. It also ensures the quality of parts shipped to the customers. Test generation and design for testability are integral parts of automated design flow of all electronic products. The objective of this course is to provide more advanced topics on testing of digital systems and complement the foundation covered in Testing Digital Systems I.
Topics include Functional and Structural Testing (design verification vectors, exhaustive test, pseudo-exhaustive test, pseudo-random testing), Essentials of Test Generation for Sequential Circuits (state-machine initialization, time-frame expansion method), Built-in Self Test (test economics of BIST, test pattern generation, output response analysis, BIST architectures), Boundry Scan (Boundry scan architectures, BS test methodology), Delay Testing (path delay test, hazard-free, robust, and non-robust delay tests), transition faults, delay test schemes), Current-Based Testing (motivation, test vectors for IDDQ, variations of IDDQ), Memory Test (memory test algorithm, memory BIST, memory repair), and DFT for System-on-Chip.

Workload
2 SWS: (2 SWS + 1.5 x 2 SWS) x 15 + 15 h exam preparation = 90 h = 3 ECTS

Recommendation
Knowledge of Digital Design and Computer Architecture is helpful.

4.164 Module: Text Indexing [M-INFO-107202]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Algorithm Engineering
Elective Studies in Informatics

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

Mandatory			
T-INFO-114226	Text-Indexing	4 CR	Sanders
T-INFO-114227	Text-Indexing Project/Experiment	1 CR	Sanders

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students acquire a systematic understanding of algorithmic issues and solution approaches in the area of text indexing, building on existing knowledge in the subject area of algorithms. They will also be able to
apply learned techniques to related problems and interpret and comprehend current research topics in the area of text indexing.

Upon successful completion of the course, students will be able to:
• explain terms, structures, basic problem definitions, and algorithms from the lecture;
• select which algorithms and data structures are suitable for solving a problem and, if necessary, adapt them to the requirements of a specific problem;
• use algorithms and data structures, analyze them mathematically, and prove the algorithmic properties.

Content
In this lecture we deal with algorithms and data structures for texts, especially text indices. Text indices are data structures that provide additional information about a text in order to accelerate queries regarding this text. These can be simple pattern matching queries ("Does a pattern occur in the text?") or more complex data mining queries ("Which pattern of a certain length occurs most often in the text?").

Furthermore, we deal with text compression. Here, we want to represent a text as space-efficiently as possible. However, we have to make sure that the original text can be reconstructed completely. Here, we speak of lossless compression. In the lecture, we will learn about techniques that are used in compression programs such as gzip.

Workload
The lectures including the project/experiment with 5 ECTS corresponds to 150 working hours, which are divided approximately as follows:
• ca. 30 hours attending lectures
• ca. 60 hours preparing and following-up lectures
• ca. 30 hours working on the project/experiment
• ca. 30 hours preparing for the examination

Recommendation
The lecture builds on parts of the contents of the lectures Algorithms I and Algorithms II. Corresponding knowledge is therefore helpful.

4.165 Module: Timed Systems [M-INFO-106293]

Responsible: Jun.-Prof. Dr. Maike Schwammberger
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Theoretical Foundations
Area of Specialization: Software Engineering and Compiler Construction
Elective Studies in Informatics

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

Mandatory			
T-INFO-112754	Timed Systems	6 CR	Schwammberger

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students can independently model and analyze software systems with time components. To this end, they can select the appropriate modeling method for the application area from a range of different modeling methods. With the help of formal methods and practical tools (UPPAAL), students analyze their modeling with regard to correctness. Students can transfer the methods they have learned to current problems.

Content
Many of the (embedded) software systems we are confronted with in everyday life have time-critical functionalities. For example, an airbag should be activated within a certain, very short period of time in the event of an accident. Similarly, we expect fast response times from the various apps on our smartphones in order to use them conveniently and effectively.
"Time" is therefore a decisive factor when modeling software systems. This lecture describes various mechanisms for formalizing so-called real-time systems. In addition to modeling, the lecture also focuses on the analysis of systems. The following topics are covered in particular:

- Timed automata (an extension of finite automata by time)
- Model checking of timed automata with the help of UPPAAL
- Duration calculus (a logic that talks about time intervals)
- Extensions and applications of timed systems

The weekly lecture consists of both theoretical and applied parts. For application and transfer of the contents, voluntary exercises are offered, which are discussed in the bi-weekly exercise.

Workload
4 SWS lecture
6 ECTS equals 180 working hours, of which
approx. 40 hours attending the lecture (theoretical and applied part)
approx. 70 hours preparation and follow-up
approx. 40 hours working on in-depth exercises
approx. 30 hours exam preparation

Recommendation
Basic knowledge in areas of theoretical computer science and modeling of (embedded) software systems is helpful (e.g. temporal logics, finite automata, predicate logic), but is not required.

Literature
The book "E.-R. Olderog, H. Dierks: Real-Time Systems" is used as reading material for some of the lecture contents (https://doi.org/10.1017/CBO9780511619953).

4.166 Module: Ubiquitous Computing (24146) [M-INFO-107161]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: Area of Specialization: Telematics
Elective Studies in Informatics

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

Mandatory			
T-INFO-114188	Ubiquitous Computing	5 CR	Beigl

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The aim of the lecture is to impart knowledge of the fundamentals and advanced methods and techniques of ubiquitous computing. After completing the lecture, students will be able to
reproduce and discuss what they have learnt about existing ubiquitous computing systems.
evaluate the general knowledge of ubiquitous systems and transfer statements and laws to special cases.
evaluate and assess different methods for design processes and user studies and select suitable methods for the development of new solutions.
invent, plan, design and evaluate new ubiquitous systems for use in everyday or industrial process environments and assess the costs and technical implications.

Content
The lecture provides an overview of the history and teaches the concepts, theories and methods of ubiquitous information technology (ubiquitous computing). Based on the appliance concept, students then design their own appliances in the exercise, plan the construction and then develop them. The necessary technical and methodological basics such as hardware for ubiquitous systems, software for ubiquitous systems, principles of context recognition for ubiquitous systems, networking of ubiquitous systems and design of ubiquitous systems and in particular information appliances are discussed. Methods of design and testing for human-machine interaction and human-machine interfaces developed in ubiquitous computing are explained in detail. There is also an introduction to the economic aspects of a ubiquitous system.

In the practical part of the lecture, the understanding of ubiquitous systems is deepened through practical application of the knowledge base of the lecture. The students design and develop their own appliance and test it. The aim is to have gone through the steps towards a prototypical and possibly marketable appliance.

Workload
The total workload for this course unit is approximately 150 hours (5.0 credits).
Activity
Workload
Attendance time: Attendance of the lecture
15 x 90 min
22 h 30 min
Attendance time: Attendance of the exercise
15 x 45 min
11 h 15 min
Preparation / follow-up of the lecture and exercise
15 x 90 min
22 h 30 min
Developing a self-developed concept for an information appliance
33 h 45 min
Go through set of slides 2x
2 x 12 h
24 h 00 min
Prepare exam
36 h 00 min
TOTAL
150 h 00 min
Workload for the course unit "Ubiquitous Information Technologies

4.167 Module: Wearable Robotic Technologies [M-INFO-107113]

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

Organisation: KIT Department of Informatics

Part of: Area of Specialization: Robotics and Automation
Area of Specialization: Human-centred Machine Intelligence
Elective Studies in Informatics

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

Mandatory			
T-INFO-114145	Wearable Robotic Technologies	4 CR	Asfour, Beigl

Competence Certificate
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
The student has received fundamental knowledge about wearable robotic technologies and understands the requirements for the design, the interface to the human body and the control of wearable robots. He/she is able to describe methods for modelling the human neuromusculoskeletal system, the mechatronic design, fabrication and composition of interfaces to the human body. The student understands the symbiotic human–machine interaction as a core topic of Anthropomatics and has knowledge of state-of-the-art examples of exoskeletons, orthoses and prostheses.

Content
The lecture provides an overview of wearable robot technologies (exoskeletons, prostheses and ortheses) and their potentials. It starts with the basics of wearable robotics and introduces different approaches to the design of wearable robots and their related actuator and sensor technology. The lecture focuses on modeling the neuromusculoskeletal system of the human body, the interfaces of wearable robots to the human body and the physical and cognitive human-robot interaction for tightly-coupled hybrid human-robot systems. Examples of current research and various applications of lower, upper and full body exoskeletons as well as prostheses are presented.

Workload
Lecture with 2 SWS, 4 LP
4 LP corresponds to 120 hours, including
15 * 2 = 30 hours attendance time
15 * 3 = 45 self-study
45 hours preparation for the exam

Recommendation
Attendance of the lecture Mechano-Informatics in Robotics is recommended.

5 Courses

T 5.1 Course: Access Control Systems: Models and Technology [T-INFO-112775]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: M-INFO-106303 - Access Control Systems: Models and Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	1

Events					
ST 2025	2400147	Access Control Systems: Models and Technology	3 SWS	Lecture / Practice (/ 🗣	Hartenstein, Leinweber
Exams					
WT 24/25	7500192	Access Control Systems: Models and Technology			Hartenstein

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 Nr. 1 SPO) lasting 60 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (§ 6 Abs. 3 SPO) whether the examination takes place

- in the form of an oral examination lasting 30 minutes pursuant to § 4 Abs. 2 Nr. 2 SPO or
- in the form of a written examination lasting 60 minutes in accordance with § 4 Abs. 2 Nr. 1 SPO.

Prerequisites
None.

Recommendation
Basics according to the lectures "Information Security" and "IT Security Management for Networked Systems" are recommended.

T 5.2 Course: Advanced Artificial Intelligence [T-INFO-114220]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107198 - Advanced Artificial Intelligence

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

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

Prerequisites
None.

T 5.3 Course: Advanced Bayesian Data Analysis [T-INFO-113673]

Responsible: Prof. Dr. Nadja Klein
Organisation: KIT Department of Informatics
Part of: M-INFO-106812 - Advanced Bayesian Data Analysis

Type	Credits	Grading scale	Version
Written examination	5	Grade to a third	1

Events					
WT 24/25	2400120	Advanced Bayesian Data Analysis	3 SWS	Lecture / Practice (/ 🗣	Klein
Exams					
WT 24/25	7500210	Advanced Bayesian Data Analysis			Klein
WT 24/25	7500399	Advanced Bayesian Data Analysis			Klein

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 90 minutes.

A bonus can be acquired through successful participation in the exercise as a success control of a different kind (§4(2), 3 SPO 2008) or study performance (§4(3) SPO 2015). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4). The bonus is only valid for the main and post exams of the semester in which it was earned. After that, the grade bonus expires.

Recommendation
- Knowledge in R or Python
- Mathematics-heavy lecture. The basics will be reviewed, but mathematical proficiency is helpful

T 5.4 Course: Advanced Data Structures [T-INFO-114223]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-107200 - Advanced Data Structures

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Modeled Conditions
The following conditions have to be fulfilled:
1. The course T-INFO-114224 - Advanced Data Structures Project/Experiment must have been started.

Recommendation
The lecture builds on parts of the contents of the lectures Algorithms I and Algorithms II. Corresponding knowledge is therefore helpful.

T 5.5 Course: Advanced Data Structures Project/Experiment [T-INFO-114224]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-107200 - Advanced Data Structures

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

Competence Certificate
The examination takes place in the form of an an examination of another type (§ 4 Abs. 2 No. 3 SPO) in form of a project/experiment.

An overall grade is awarded.

Prerequisites
None.

Recommendation
The lecture builds on parts of the contents of the lectures Algorithms I and Algorithms II. Corresponding knowledge is therefore helpful.

T 5.6 Course: Advanced Machine Learning and Data Science [T-WIWI-111305]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105659 - Advanced Machine Learning and Data Science

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	9	Grade to a third	Each term	5

Exams			
WT 24/25	7900291	Advanced Machine Learning and Data Science	Ulrich

Competence Certificate
The assessment is carried out in form of a written thesis based on the course "Advanced Machine Learning and Data Science".

Annotation
The course is targeted to students with a major in Data Science and/or Machine Learning. It offers students the opportunity to develop hands-on knowledge on new developments in data science and machine learning. Please apply via the link: https://portal.wiwi.kit.edu/forms/form/fbv-ulrich-msc-project.

Workload
270 hours

5.7 Course: Algorithm Engineering [T-INFO-101332]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-100795 - Algorithm Engineering

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

Events					
ST 2025	2400022	Algorithm Engineering	3 SWS	Lecture / 🗣	Sanders, Hermann, Witt

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

Competence Certificate
The assessment is carried out as an oral examination lasting 20 minutes (§ 4 Abs. 2 Nr. 2 SPO).

Prerequisites
none.

Modeled Conditions
The following conditions have to be fulfilled:
1. The course T-INFO-111856 - Algorithm Engineering Pass must have been started.

T 5.8 Course: Algorithm Engineering Pass [T-INFO-111856]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-100795 - Algorithm Engineering

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 2 Abs. 2 Nr. 3).

The exercise can be evidenced by various performance records. This is determined individually during the lecture. Usually, the student prepares a seminar presentation and/or works on a practical tasks with written elaboration and evaluation (the main performance consists of the programming, documented by the source code that is to be handed in and supplemented by a short written report).

Students may redraw from the examination during the first four weeks after they have been assigned a task.

An overall grade is awarded.

Prerequisites
None.

T 5.9 Course: Algorithmic Graph Theory [T-INFO-113918]

Responsible: Dr. rer. nat. Torsten Ueckerdt
Organisation: KIT Department of Informatics
Part of: M-INFO-106960 - Algorithmic Graph Theory

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

Events					
ST 2025	2400028	Algorithmic Graph Theory	3 SWS	Lecture / Practice (/	Ueckerdt

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Knowledge of the basics of graph theory and algorithm technology is helpful

T 5.10 Course: Algorithms for Visualization of Graphs [T-INFO-113919]

Responsible: Dr. rer. nat. Torsten Ueckerdt
Organisation: KIT Department of Informatics
Part of: M-INFO-106961 - Algorithms for Visualization of Graphs

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Knowledge of the basics of graph theory and algorithm technology is helpful.

T 5.11 Course: Algorithms II [T-INFO-114225]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-107201 - Algorithms II

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Prerequisites
None.

T 5.12 Course: Artificial Intelligence & IT-Security [T-INFO-113668]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: M-INFO-106810 - Artificial Intelligence & IT-Security

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

Events					
WT 24/25	2424000	Artificial Intelligence & IT-Security	4 SWS	Lecture / Practice (/ 🗣	Wressnegger
Exams					
WT 24/25	7500059	Artificial Intelligence & IT-Security			Wressnegger

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Depending on the number of participants, it will be announced six weeks before the examination performance (§ 6 Abs. 3 SPO) whether the performance review will be

- in the form of an oral examination according to § 4 Abs. 2 no. 2 SPO **or**
- in the form of a written examination according to § 4 Abs. 2 Nr. 1 SPO

takes place.

Prerequisites
None.

Recommendation
The basics of IT security and artificial intelligence are a prerequisite.

T 5.13 Course: Automated Planning and Scheduling [T-INFO-109085]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-104447 - Automated Planning and Scheduling

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 30 minutes.

Prerequisites
None.

T 5.14 Course: Autonomous Learning for Intelligent Robot Perception [T-INFO-113327]

Responsible: Prof. Dr. Rudolph Triebel
Organisation: KIT Department of Informatics
Part of: M-INFO-106608 - Autonomous Learning for Intelligent Robot Perception

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

Events					
WT 24/25	2400213	Autonomous Learning for Intelligent Robot Perception	2 SWS	Lecture / Practice (/ 🗣	Triebel
Exams					
WT 24/25	7500373	Autonomous Learning for Intelligent Robot Perception			Triebel

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Prerequisites
None.

Recommendation
A basic understanding of probability theory and linear algebra is required

T 5.15 Course: Channel Coding: Algebraic Methods for Communications and Storage [T-ETIT-111244]

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

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

Events					
ST 2025	2310546	Channel Coding: Algebraic Methods for Communications and Storage	2 SWS	Lecture / Blended	Schmalen
Exams					
WT 24/25	7310546-1	Channel Coding: Algebraic Methods for Communications and Storage			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 5.16 Course: Channel Coding: Graph-Based Codes [T-ETIT-111245]

Responsible: Prof. Dr.-Ing. Laurent Schmalen
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105617 - Channel Coding: Graph-Based Codes

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

Events					
WT 24/25	2310520	Channel Coding: Graph-Based Codes	3 SWS	Lecture / 🧩	Schmalen
WT 24/25	2310521	Exercise for 2310520 Channel Coding: Graph-Based Codes	1 SWS	Practice / 🧩	Schmalen
Exams					
WT 24/25	7310520-1	Channel Coding: Graph-Based Codes			Schmalen
ST 2025	7310520-1	Channel Coding: Graph-Based Codes			Schmalen

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

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

Prerequisites
none

Recommendation
Previous attendance of the lectures "Communication Engineering I" and "Theory of Probability" is recommended. Knowledge from the lectures "Applied Information Theory" and "Verfahren der Kanalcodierung" is helpful.

T 5.17 Course: Combinatorics [T-MATH-105916]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-102950 - Combinatorics

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	3

Exams			
WT 24/25	7700086	Combinatorics	Aksenovich

Prerequisites
none

T 5.18 Course: Compiler Design [T-INFO-113925]

Responsible: Prof. Dr. André Platzer
Organisation: KIT Department of Informatics
Part of: M-INFO-106966 - Compiler Design

Type	Credits	Grading scale	Recurrence	Version
Written examination	9	Grade to a third	Irregular	2

Events					
ST 2025	2400055	Compiler Design	4 SWS	Lecture / 🗣	Platzer
Exams					
ST 2025	7500151	Compiler Design			Platzer

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

Competence Certificate
The assessment is usually carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.
- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO or
- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO
takes place.

In order to receive a bonus, you must earn at least 50% of the points for solving the exercises. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4).

Prerequisites
None.

Recommendation
Students are expected to have significant experience in a high-level programming language. Students are also expected to follow the lecture notes.

T 5.19 Course: Computational Geometry [T-INFO-114251]

Responsible: TT-Prof. Dr. Thomas Bläsius
Organisation: KIT Department of Informatics
Part of: M-INFO-107228 - Computational Geometry

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

Events					
ST 2025	2400119	Computational Geometry	4 SWS	Lecture / Practice (/ 🗣	Bläsius, Yi, Wilhelm, von der Heydt

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

PLUS: The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO). A total of two repetitions are possible.

Prerequisites
None.

Recommendation
Basic knowledge of algorithms and data structures (e.g., from the courses Algorithms 1 + 2) is expected.

5.20 Course: Computational Geometry - Pass [T-INFO-114252]

Responsible: TT-Prof. Dr. Thomas Bläsius
Organisation: KIT Department of Informatics
Part of: M-INFO-107228 - Computational Geometry

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

Events					
ST 2025	2400119	Computational Geometry	4 SWS	Lecture / Practice (/ 🗣	Bläsius, Yi, Wilhelm, von der Heydt

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

Competence Certificate
The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO). A total of two repetitions are possible.

Prerequisites
None.

Recommendation
Basic knowledge of algorithms and data structures (e.g., from the courses Algorithms 1 + 2) is expected.

T 5.21 Course: Computational Imaging [T-INFO-112573]

Responsible: Johannes Meyer
Organisation: KIT Department of Informatics
Part of: M-INFO-106190 - Computational Imaging

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each winter term	1

Events					
WT 24/25	2400173	Computational Imaging	3 SWS	Lecture / Practice (/ 🗣	Meyer, Beyerer
Exams					
WT 24/25	7500276	Computational Imaging			Beyerer
ST 2025	7500351	Computational Imaging			Beyerer

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

Competence Certificate
The assessment takes the form of a written examination, usually lasting 60 minutes in accordance with Section 4 (2) No. 1 SPO.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take place
- in the form of an oral examination in accordance with Section 4 (2) No. 2 SPO or
- in the form of a written examination in accordance with Section 4 (2) No. 1 SPO.

Prerequisites
None.

T 5.22 Course: Computational Risk and Asset Management [T-WIWI-102878]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105032 - Data Science for Finance

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Irregular	5

Competence Certificate
The module examination takes the form of an alternative exam assessment.
The alternative exam assessment consists of a Python-based "Takehome Exam". At the end of the third week of January, the student is given a "Takehome Exam" which he processes and sends back independently within 4 hours using Python. Precise instructions will be announced at the beginning of the course. The alternative exam assessment can be repeated a maximum of once. A timely repeat option takes place at the end of the third week in March of the same year. More detailed instructions will be given at the beginning of the course.

Prerequisites
None.

Recommendation
Basic knowledge of capital markt theory.

Workload
135 hours

T 5.23 Course: Constructive Logic [T-INFO-112704]

Responsible: Prof. Dr. André Platzer
Organisation: KIT Department of Informatics
Part of: M-INFO-106256 - Constructive Logic

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each summer term	1

Competence Certificate
The assessment is usually carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.
- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO or
- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO
takes place.

Prerequisites
None.

Recommendation
You will be expected to follow the lecture notes.

T 5.24 Course: Data Science and Artificial Intelligence for Energy Systems [T-INFO-113402]

Responsible: TT-Prof. Dr. Benjamin Schäfer
Organisation: KIT Department of Informatics
Part of: M-INFO-106655 - Data Science and Artificial Intelligence for Energy Systems

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

Exams			
WT 24/25	7500398	Data Science and Artificial Intelligence for Energy Systems	Schäfer

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting about 30 minutes.

Prerequisites
None.

Recommendation
Knowledge of AI basics is very helpful.
Previous participation in “Energieinformatik 1” and/or “Energieinformatik 2” is beneficiary but not mandatory.
Knowledge of Python is highly recommended.

T 5.25 Course: Decentralized Systems: Fundamentals, Modeling, and Applications [T-INFO-110820]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: M-INFO-105334 - Decentralized Systems: Fundamentals, Modeling, and Applications

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each summer term	5

Events					
ST 2025	2400089	Decentralized Systems: Fundamentals, Modeling, and Applications	4 SWS	Lecture / Practice (/ 🗣	Hartenstein, Jacob
Exams					
WT 24/25	7500013	Decentralized Systems: Fundamentals, Modeling, and Applications			Hartenstein

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

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

Depending on the number of participants, it will be announced six weeks before the examination (§ 6 Abs. 3 SPO) whether the examination takes place

in the form of an oral examination lasting 30 minutes pursuant to § 4 Abs. 2 Nr. 2 SPO or

in the form of a written examination lasting 60 minutes in accordance with § 4 Abs. 2 Nr. 1 SPO.

Prerequisites
None.

Recommendation
Basics according to the lectures "Information Security" and "Introduction to Computer Networks" are recommended.

T 5.26 Course: Deep Learning and Neural Networks [T-INFO-114219]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107197 - Deep Learning and Neural Networks

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

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

Prerequisites
T-INFO-101383 - Neural networks must not be started.

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

T 5.27 Course: Design and Architectures of Embedded Systems (ESII) [T-INFO-114254]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: M-INFO-107230 - Design and Architectures of Embedded Systems (ESII)

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

Events					
WT 24/25	2424106	Design and architectures of embedded systems (ES2)	2 SWS	Lecture	Khdr, Henkel
Exams					
WT 24/25	7500124	VL: Design and architectures of embedded systems (ES2)			Henkel

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Knowledge of computer structures is helpful.

T 5.28 Course: Digital Marketing [T-WIWI-112693]

Responsible: Prof. Dr. Ann-Kristin Kupfer
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2571185	Digital Marketing	2 SWS	Lecture / 🗣	Kupfer
ST 2025	2571186	Digital Marketing Exercise	1 SWS	Practice / 🗣	Kopp
Exams					
ST 2025	7900064	Digital Marketing			Kupfer

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

Competence Certificate
Success is assessed in the form of an examination of another type. The following aspects are included in the assessment:

- Elaboration and presentation of a group task
- Written exam

Further details on the organization of the performance and the points system for the assessment will be announced in the lecture.

Prerequisites
None

Recommendation
Students are highly encouraged to actively participate in class.

Workload
135 hours

T 5.29 Course: Digital Marketing and Sales in B2B [T-WIWI-106981]

Responsible: Prof. Dr. Martin Klarmann
Anja Konhäuser
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	1,5	Grade to a third	Each summer term	1

Events					
ST 2025	2571156	Digital Marketing and Sales in B2B	1 SWS	Others (sons / 🗣	Konhäuser

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

Competence Certificate
Alternative exam assessment according to § 4 paragraph 2 Nr. 3 of the examination regulation. (team presentation of a case study with subsequent discussion totalling 30 minutes).

Prerequisites
None.

Annotation
This course will not take place in the summer term 2023, but is expected to be offered again on a regular basis starting in the summer term 2024.
Participation requires an application. The application period starts at the beginning of the semester. More information can be obtained on the website of the research group Marketing and Sales (marketing.iism.kit.edu). Access to this course is restricted. Typically all students will be granted the attendance of one course with 1.5 ECTS. Nevertheless attendance can not be guaranteed.For further information please contact Marketing and Sales Research Group (marketing.iism.kit.edu).Please note that only one of the 1.5-ECTS courses can be attended in this module.

Workload
45 hours

T 5.30 Course: Distributed Computing [T-INFO-114235]

Responsible: Prof. Dr. Achim Streit
Organisation: KIT Department of Informatics
Part of: M-INFO-107215 - Distributed Computing

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes. Depending on the number of participants it will be announced six weeks before the assessment (§3 Abs. 3 SPO) if the assessment is done
• as an oral examination according to § 4 Abs. 2 No. 2 SPO or
• as a written examination according to § 4 Abs. 2 No. 1 SPO.

Prerequisites
None.

Modeled Conditions
The following conditions have to be fulfilled:
1. The course T-INFO-101298 - Distributed Computing must not have been started.

Recommendation
Knowledge in the area of computer networks helpful.

5.31 Course: Economic Decision Making [T-WIWI-114174]

Responsible:	Prof. Dr. Benjamin Scheibehenne
Organisation:	KIT Department of Economics and Management
Part of:	M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	4,5	Grade to a third	Each winter term	1 terms	1

Competence Certificate
Alternative exam assessment. The grading includes the following aspects:

- a written exam (60 minutes)
- a presentation during the exercise.

The scoring system for the grading will be announced at the beginning of the course.

Prerequisites
Registration via the CAMPUS Portal is required for participation in the Übung. The Übung is a prerequisite for the exam.

Annotation
The judgments and decisions that we make can have long ranging and important consequences for our (financial) well-being and individual health. Hence, the goal of this lecture is to gain a better understanding of how people make judgments and decisions and the factors that influences their behavior. We will look into simple heuristics and mental shortcuts that decision makers use to navigate their environment, in particular so in an economic context. Following this, the lecture will provide an overview into social and emotional influences on decision making. In the second half of the semester we will look into some more specific topics including self-control, nudging, and food choice. The last part of the lecture will focus on risk communication and risk perception. We will address these questions from an interdisciplinary perspective at the intersection of Psychology, Behavioral Economics, Marketing, Cognitive Science, and Biology. Across all topics covered in class, we will engage with basic theoretical work as well as with groundbreaking empirical research and current scientific debates.
The workload of the class is 4.5 ECTS. This consists of 3 ETCS for the lecture and 1.5 ETCS for the Übung. Details about the Übung will be communicated at the first day of the class.

Workload
135 hours

T 5.32 Course: Edge-AI in Software and Sensor Applications [T-INFO-114258]

Responsible: Dr. Victor Pankratius
Organisation: KIT Department of Informatics
Part of: M-INFO-107234 - Edge-AI in Software and Sensor Applications

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

Events					
WT 24/25	2400124	EdgeAI in Software and Sensor Applications	2 SWS	Lecture / 🖥	Pankratius
ST 2025	2400006	EdgeAI in Software and Sensor Applications	2 SWS	Lecture / 🖥	Pankratius
Exams					
WT 24/25	7500303	Edge-AI in Software and Sensor Applications			Pankratius
ST 2025	7500196	Edge-AI in Software and Sensor Applications			Pankratius

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Prerequisites
Basic studies in computer science

Recommendation
Knowledge of e.g. cognitive systems, software engineering, algorithms, computer networks & structures, low-power design is helpful.

T 5.33 Course: Embedded Machine Learning Lab [T-INFO-111549]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: M-INFO-105775 - Embedded Machine Learning Lab

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	1

Events					
WT 24/25	2400295	Embedded Machine Learning Lab	4 SWS	Practical course / 🗣	Henkel, Ahmed, Pfeiffer
Exams					
WT 24/25	7500295	Embedded Machine Learning Lab			Henkel

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO), in the form of a practical assignment, presentations and, if applicable, a written paper. The written paper, presentations and practical work are weighted according to the course.

Prerequisites
None.

Recommendation
This lab requires a basic (theoretic) knowledge about neural networks and training. Further knowledge of Linux environments and Python is strongly advised since they will be intensively used in the lab and are the de-facto industry standard for machine learning research.

T 5.34 Course: Engineering Self-Adaptive Systems [T-INFO-113349]

Responsible: Prof. Dr. Raffaela Mirandola
Organisation: KIT Department of Informatics
Part of: M-INFO-106626 - Engineering Self-Adaptive Systems

Type	Credits	Grading scale	Version
Oral examination	3	Grade to a third	1

Events					
WT 24/25	2400186	Engineering Self-Adaptive Systems		Lecture	Mirandola
Exams					
WT 24/25	7500381	Engineering Self-Adaptive Systems			Mirandola

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

T 5.35 Course: Entrepreneurship [T-WIWI-102864]

Responsible: Prof. Dr. Orestis Terzidis
Organisation: KIT Department of Economics and Management
Part of: M-ETIT-105073 - Student Innovation Lab

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

Events					
WT 24/25	2545001	Entrepreneurship	2 SWS	Lecture /	Terzidis, Dang
ST 2025	2545001	Entrepreneurship	2 SWS	Lecture /	Terzidis, Dang
Exams					
WT 24/25	7900045	Entrepreneurship			Terzidis
WT 24/25	7900229	Entrepreneurship			Terzidis
ST 2025	7900002	Entrepreneurship			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

5.36 Course: EU Data Protection Law [T-INFO-113887]

Responsible: Gustavo Gil Gasiola
Organisation: KIT Department of Informatics
Part of: M-INFO-107030 - EU Data Protection Law

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

Events					
WT 24/25	2424019	EU Data Protection Law	2 SWS	Lecture / 🗣	Gil Gasiola
Exams					
WT 24/25	7500378	EU Data Protection Law			Zufall

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

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

Prerequisites
None

Annotation
Competency Goals:

Students are able to comprehend the EU data protection regulation, including the General Data Protection Regulation and related EU data regulations.

They know the foundations of data protection rules, including fundamental concepts (e.g., “personal data”, “processing”, “data subject”). They are also familiar with the principles of personal data processing (lawfulness, limited purpose, transparency, accountability) as well as the rights of the data subject.

They can identify the main obligations of the controller and the processor.

Students understand the conditions for the transfer of personal data to third countries.

They can identify the other regulations that govern data in the European Union.

Students are able to read and understand legal text related to data regulation.

They can understand and solve simple data protection cases.

Content:

The General Data Protection Regulation (GDPR) of the European Union is a milestone in protecting individuals from the unlawful use of their data. In a data-driven society, economy, and government, this protection has become essential to guarantee fundamental rights. In addition to its direct impact on the legal systems of all Member States, the GDPR has a major influence on third countries that have adopted similar regulations (e.g. Switzerland, Argentina, Brazil, South Africa, and many others). In this way, the EU Data Protection Regulation has established itself as the “gold standard” of data protection, providing guidance to address the challenges posed by new technologies and new ways of creating, using and sharing personal data. Understanding the structure of data protection in the EU is therefore essential to grasp its impact on individual rights, public administration, business models, and even technological development.
This lecture aims to provide a structured overview of the EU Data Protection Regulation, and to offer tools to understand the regulatory structure of the EU Data Regulation. The lecture will cover the following topics:

- Introduction to EU law
- Development of the EU data protection regulation
- Legal structure of data protection in the EU
- Role of national and sectoral laws
- Data protection as fundamental right
- Principles of data protection
- Lawfulness of personal data processing
- Anonymization and pseudonymization of personal data
- Special categories of personal data
- Rights of the data subject
- Transfer of personal data to third countries
- Responsibility of the controller and the processor
- Security of personal data and personal data breach
- Open Data Directive
- Data Governance Act
- Data Act

Workload

- Attendance time to the lectures = 15 x 90 min = 22 h 30 min
- Self-study during the semester = 47 h 30 min
- Preparation for the exam = 20 h
- Total = 90 h

5.37 Course: Explainable Artificial Intelligence [T-INFO-112774]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Organisation: KIT Department of Informatics
Part of: M-INFO-106302 - Explainable Artificial Intelligence

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

Events					
ST 2025	2400128	Explainable Artificial Intelligence	2 SWS	Lecture / 🗣	Lioutikov
Exams					
WT 24/25	7500370	Explainable Artificial Intelligence			Lioutikov
ST 2025	7500359	Explainable Artificial Intelligence			Lioutikov

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

A bonus can be acquired through successful participation in the exercise as a success control of a different kind (§4(2), 3 SPO 2008) or study performance (§4(3) SPO 2015). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4). The bonus is only valid for the main and post exams of the semester in which it was earned. After that, the grade bonus expires.

Prerequisites
None.

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

T 5.38 Course: Fine-Grained Complexity Theory & Algorithms [T-INFO-113391]

Responsible: Prof. Dr.-Ing. Marvin Künnemann
Organisation: KIT Department of Informatics
Part of: M-INFO-106644 - Fine-Grained Complexity Theory & Algorithms

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

Events					
ST 2025	2400152	Fine-Grained Complexity Theory & Algorithms	4 SWS	Lecture / Practice (/ 🗣	Künnemann
Exams					
WT 24/25	7500042	Fine-Grained Complexity Theory & Algorithms			Künnemann

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20-30 minutes.

Prerequisites
None.

Recommendation
Basic knowledge of theoretical computer science and algorithm design is recommended.

T 5.39 Course: Geometric Deep Learning [T-INFO-112662]

Responsible: Jun.-Prof. Dr. Jan Stühmer
Organisation: KIT Department of Informatics
Part of: M-INFO-106237 - Geometric Deep Learning

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

Events					
WT 24/25	2400179	Geometric Deep Learning	2 SWS	Lecture / 🗣	Stühmer
Exams					
WT 24/25	7500338	Geometric Deep Learning			Stühmer

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Knowledge about the foundations of machine learning, group theory and linear algebra useful but not required.

T 5.40 Course: Graph Partitioning and Graph Clustering in Theory and Practice [T-INFO-114232]

Responsible: Prof. Dr. Peter Sanders
Dr. rer. nat. Torsten Ueckerdt

Organisation: KIT Department of Informatics

Part of: M-INFO-107211 - Graph Partitioning and Graph Clustering in Theory and Practice

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

The module grade is made up of the graded and weighted performance assessments (usually 80% of the oral examination and 20% of the other performance).

Prerequisites
None.

Recommendation
Knowledge of graph theory and algorithm technology is helpful.

T 5.41 Course: Graph Partitioning and Graph Clustering in Theory and Practice - Practical [T-INFO-114233]

Responsible: Prof. Dr. Peter Sanders
Dr. rer. nat. Torsten Ueckerdt

Organisation: KIT Department of Informatics

Part of: M-INFO-107211 - Graph Partitioning and Graph Clustering in Theory and Practice

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). (seminar paper/presentation/programming task or similar).

The module grade is made up of the graded and weighted performance assessments (usually 80% of the oral examination and 20% of the other performance). An overall grade is awarded.

Prerequisites
None.

Recommendation
Knowledge of graph theory and algorithm technology is helpful.

T 5.42 Course: Graph Theory [T-MATH-102273]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-101336 - Graph Theory

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	2

Prerequisites
None

T 5.43 Course: Hands-on Bioinformatics Practical [T-INFO-103009]

Responsible: Prof. Dr. Alexandros Stamatakis
Organisation: KIT Department of Informatics
Part of: M-INFO-101573 - Hands-on Bioinformatics Practical

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Practical tasks in the field of bioinformatics must be completed. The results must be presented in writing or orally.

Prerequisites
The exam in Introduction to Bioinformatics for Computer Scientists must have been passed in one of the preceding semesters.

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-INFO-100749 - Introduction to Bioinformatics for Computer Scientists must have been passed.

T 5.44 Course: Hardware Modeling and Simulation [T-ETIT-100672]

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

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-100449 - Hardware Modeling and Simulation

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

Events					
WT 24/25	2311608	Hardware Modeling and Simulation	2 SWS	Lecture / 🗣	Becker, Becker
WT 24/25	2311610	Tutorial for 2311608 Hardware Modeling and Simulation	1 SWS	Practice / 🗣	Unger
Exams					
WT 24/25	7311608	Hardware Modeling and Simulation			Becker, Becker
ST 2025	7311608	Hardware Modeling and Simulation			Becker, Becker

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

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

Prerequisites
none

T 5.45 Course: Hardware Synthesis and Optimization [T-ETIT-113922]

Responsible: Prof. Dr.-Ing. Jürgen Becker
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106963 - Hardware Synthesis and Optimization

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

Events					
ST 2025	2311619	Hardware Synthesis and Optimization	3 SWS	Lecture / 🗣	Becker
ST 2025	2311621	Tutorial for 2311619 Hardware Synthesis and Optimization	1 SWS	Practice / 🗣	Schmidt

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

Competence Certificate
The examination takes place within the framework of an oral overall examination (approx. 30 minutes).
The module grade is the grade of the oral exam.

Prerequisites
none

T 5.46 Course: HRI and Social Robotics [T-INFO-113396]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: M-INFO-106650 - HRI and Social Robotics

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

Events					
ST 2025	2400159	HRI and Social Robotics	4 SWS	Lecture / Practice (/ 🗣	Bruno, Maure
Exams					
WT 24/25	7500390	HRI and Social Robotics - Nachklausur			Bruno
ST 2025	7500101	HRI and Social Robotics			Bruno

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Prerequisites
None.

Recommendation
Knowledge of the content of modules Robotics I - Introduction to Robotics is helpful.

T 5.47 Course: HRI and Social Robotics - Pass [T-INFO-113397]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: M-INFO-106650 - HRI and Social Robotics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	2	Grade to a third	Each summer term	1

Events					
ST 2025	2400159	HRI and Social Robotics	4 SWS	Lecture / Practice (/ 🗣	Bruno, Maure
Exams					
WT 24/25	7500390	HRI and Social Robotics - Nachklausur			Bruno
ST 2025	7500101	HRI and Social Robotics			Bruno
ST 2025	7500358	HRI and Social Robotics - Exercises			Bruno

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Students must regularly submit exercise sheets. The number of exercise sheets and the scale for passing will be announced at the beginning of the course. The assessment can only be repeated once.

Recommendation
Knowledge of the content of modules Robotics I - Introduction to Robotics is helpful.

T 5.48 Course: Human-Machine-Interaction [T-INFO-114192]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-107166 - Human Computer Interaction

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

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

Prerequisites
Participation in the exercise is compulsory and the contents of the exercise are relevant for the examination.

Modeled Conditions
The following conditions have to be fulfilled:
1. The course T-INFO-114193 - Human-Machine-Interaction Pass must have been passed.

T 5.49 Course: Human-Machine-Interaction Pass [T-INFO-114193]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-107166 - Human Computer Interaction

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Exercise sheets must be handed in regularly to pass the course. The specific details will be announced in the lecture.

Prerequisites
None.

Annotation
Participation in the exercise is compulsory and the contents of the exercise are relevant for the examination.

T 5.50 Course: Humanoid Robots - Locomotion and Whole-Body Control [T-INFO-113395]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106649 - Humanoid Robots - Locomotion and Whole-Body Control

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

Events					
ST 2025	2400135	Humanoid Robots – Locomotion and Whole-Body Control	4 SWS	Lecture / 🗣	Mombaur, Ackermann

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

The grade of the course is given based on the performance in in an individual programming project on the topic of humanoid robots, which consists of the definition and solution of the project itself as well as a subsequent oral presentation in a block event and the submission of a written report. Project work starts in the exercise slots during the second half of the term and ends during the lecture free time.

As a prerequisite for the enrollment in the project, the students must regularly and successfully participate in the exercises and present their results for the exercise sheets during the first part of the term, according to the modalities announced at the beginning of the course.
Both components can be completed in the same group of two students. Withdrawal is possible until 2 weeks after enrollment in the project.
Active participation in the class is expected from all students and is a necessary requirement for the course.

Prerequisites
- Completion of module Robotics 1 or corresponding knowledge required.
- Programing skills

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

Annotation
Limitation to 30 participants

T 5.51 Course: Humanoid Robots - Locomotion and Whole-Body Control -Pass [T-INFO-114282]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106649 - Humanoid Robots - Locomotion and Whole-Body Control

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

Events					
ST 2025	2400135	Humanoid Robots – Locomotion and Whole-Body Control	4 SWS	Lecture / 🗣	Mombaur, Ackermann

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

Competence Certificate
The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO).

The grade of the course is given based on the performance in in an individual programming project on the topic of humanoid robots, which consists of the definition and solution of the project itself as well as a subsequent oral presentation in a block event and the submission of a written report. Project work starts in the exercise slots during the second half of the term and ends during the lecture free time.

As a prerequisite for the enrollment in the project, the students must regularly and successfully participate in the exercises and present their results for the exercise sheets during the first part of the term, according to the modalities announced at the beginning of the course.
Both components can be completed in the same group of two students. Withdrawal is possible until 2 weeks after enrollment in the project.
Active participation in the class is expected from all students and is a necessary requirement for the course.

Prerequisites
- Completion of module Robotics 1 or corresponding knowledge required.
- Programing skills

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

Annotation
Limitation to 30 participants

T 5.52 Course: Humanoid Robots - Seminar [T-INFO-114170]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-107152 - Humanoid Robots - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). It includes a presentation at the end of the term and a term paper.

Prerequisites
None.

Recommendation
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III – Sensors and Perception in Robotics, Mechano-Informatics and Robotics and Wearable Robotic Technologies is recommended.

T 5.53 Course: Information, Science and Responsibility - Current Ethical Challenges of IT [T-INFO-111839]

Responsible: Angelika Kaplan
Organisation: KIT Department of Informatics
Part of: M-INFO-107254 - Interdisciplinary Qualifications

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

Events					
ST 2025	2400094	Ethik der IT	2 SWS	Lecture / 🖥	Reussner, Bagattini

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

T 5.54 Course: Information, Wissenschaft und Verantwortung – aktuelle ethische Herausforderungen der IT [T-INFO-112148]

Responsible: Angelika Kaplan
Organisation: KIT Department of Informatics
Part of: M-INFO-107254 - Interdisciplinary Qualifications

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

Events					
ST 2025	2400094	Ethik der IT	2 SWS	Lecture / 🖥	Reussner, Bagattini

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

T 5.55 Course: Innovation Lab [T-ETIT-110291]

Responsible: Prof. Dr.-Ing. Sören Hohmann
Prof. Dr. Werner Nahm
Prof. Dr.-Ing. Eric Sax
Prof. Dr. Wilhelm Stork
Prof. Dr.-Ing. Thomas Zwick

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105073 - Student Innovation Lab

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	9	Grade to a third	Each term	2 terms	1

Events					
WT 24/25	2303192	Innovation Lab	2 SWS	Project (P / 🗣	Hohmann, Zwick, Sax, Stork, Nahm, Schmalen, Rost
ST 2025	2303192	Innovation Lab	2 SWS	Project (P / 🗣	Hohmann, Zwick, Sax, Stork, Terzidis
Exams					
WT 24/25	7303192	Innovation Lab			Hohmann, Zwick, Stork, Sax, Nahm

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

Competence Certificate
see module description

T 5.56 Course: Internet of Everything [T-INFO-101337]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: M-INFO-100800 - Internet of Everything

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

Events					
WT 24/25	2424104	Internet of Everything	2 SWS	Lecture / 🗣	Zitterbart, Mahrt, Neumeister, Hildenbrand
Exams					
WT 24/25	7500009	Internet of Everything			Zitterbart
ST 2025	7500071	Internet of Everything			Zitterbart

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.

- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO or

- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO

takes place.

Prerequisites
None.

Recommendation
The contents of the lecture Introduction to Computer Networks are assumed to be known. Attendance of the lecture Telematics is strongly recommended, as the contents are an important basis for understanding and classifying the material.

T 5.57 Course: Introduction to Bioinformatics for Computer Scientists [T-INFO-101286]

Responsible: Prof. Dr. Alexandros Stamatakis
Organisation: KIT Department of Informatics
Part of: M-INFO-100749 - Introduction to Bioinformatics for Computer Scientists

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

Events					
WT 24/25	2400055	Introduction to Bioinformatics for Computer Scientists	2 SWS	Lecture /	Stamatakis
Exams					
WT 24/25	7500057	Introduction to Bioinformatics for Computer Scientists			Stamatakis

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Basic knowledge in the areas of theoretical computer science (algorithms, data structures) and technical computer science (sequential optimisation in C or C++, computer architectures, parallel programming, vector processors) will be beneficial.

T 5.58 Course: IT Security [T-INFO-113960]

Responsible: Prof. Dr. Jörn Müller-Quade
TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: M-INFO-106998 - IT Security

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	2

Events					
WT 24/25	2400010	IT Security	4 SWS	Lecture / Practice (/	Müller-Quade, Wressnegger, Martin, Tiepelt

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 90 minutes.

Prerequisites
None.

Recommendation
Students should be familiar with the content of the compulsory lecture "Informationssicherheit".

T 5.59 Course: Lab Project: Speech Translation [T-INFO-114205]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107176 - Lab Project: Speech Translation

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Prerequisites
None.

Recommendation
Students should have understood the theoretical principles as introduced in the lectures Deep Learning or Machine Translation.

T 5.60 Course: Logical Foundations of Cyber-Physical Systems [T-INFO-112360]

Responsible: Prof. Dr. André Platzer
Organisation: KIT Department of Informatics
Part of: M-INFO-106102 - Logical Foundations of Cyber-Physical Systems

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	3

Events					
WT 24/25	2400161	Logical Foundations of Cyber-Physical Systems	4 SWS	Lecture / 🗣	Platzer
Exams					
WT 24/25	7500252	Logical Foundations of Cyber-Physical Systems			Platzer

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

Competence Certificate
The assessment is usually carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.
- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO or
- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO
takes place.

In order to receive a bonus, you must earn at least 50% of the points for solving the exercises. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4).

Prerequisites
None.

Recommendation
The course assumes prior exposure to basic computer programming and mathematical reasoning. This course covers the basic required mathematical and logical background of cyber-physical systems. You will be expected to follow the textbook as needed: André Platzer. Logical Foundations of Cyber-Physical Systems. Springer 2018. DOI:10.1007/978-3-319-63588-0

Annotation
Course web page: https://lfcps.org/course/lfcps.html

T 5.61 Course: Low Power Design [T-INFO-101344]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: M-INFO-100807 - Low Power Design

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

Events					
ST 2025	2424672	Low Power Design	2 SWS	Lecture / 🗣	Henkel, Khdr, Siddhu, Pfeiffer
Exams					
WT 24/25	7500139	VL: Low Power Design			Henkel

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

Competence Certificate
The assessment is carried out as an oral examination lasting 25-30 minutes, in accordance with Section 4 (2) No. 2 SPO.

Prerequisites
None.

Recommendation
- Basic knowledge from the modules “Design and Architectures of Embedded Systems (ESII)” and “Optimization and Synthesis of Embedded Systems (ESI)” are helpful but not essential for understanding of this lecture.
- The lecture is equally suitable for students from both computer science as well as electrical engineering department.
- The Lab of “Low Power Design and Embedded Systems” enables students to apply some of the theoretical knowledge gained from the lecture in practice.

T 5.62 Course: Machine Learning - Foundations and Algorithms [T-INFO-111558]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-107169 - Machine Learning - Foundations and Algorithms

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

Events					
ST 2025	2400018	Machine Learning – Foundations and Algorithms	4 SWS	Lecture / Practice (/ 🗣	Neumann
Exams					
WT 24/25	7500292	Machine Learning - Foundations and Algorithms			Neumann
ST 2025	7500215	Machine Learning - Foundations and Algorithms			Neumann

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

Competence Certificate
The success control takes place in the form of a written exam, usually 90 minutes in length, according to § 4 Abs. 2 Nr. 1 SPO.

A bonus can be acquired through successful participation in the exercise as a success control of a different kind (§4(2), 3 SPO 2008) or study performance (§4(3) SPO 2015). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4). The bonus is only valid for the main and post exams of the semester in which it was earned. After that, the grade bonus expires.

Prerequisites
None.

Recommendation
- Attendance of the lecture “Foundations of Artificial Intelligence” (“Grundlagen der Künstlichen Intelligence”)
- Knowledge in python
- Mathematics-heavy lecture. The basics will be reviewed, but mathematical proficiency is helpful

T 5.63 Course: Machine Learning for Natural Sciences [T-INFO-113916]

Responsible: TT-Prof. Dr. Pascal Friederich
Organisation: KIT Department of Informatics
Part of: M-INFO-106959 - Machine Learning for Natural Sciences

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

Events					
ST 2025	2400008	Machine Learning for the Natural Sciences	2 SWS	Lecture /	Friederich
Exams					
ST 2025	7500211	Machine Learning for Natural Sciences			Friederich

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

Competence Certificate
Lecture: The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 90 minutes.

Exercise: The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO). Students must regularly submit exercise sheets. The number of exercise sheets and the scale for passing will be announced at the beginning of the course. The assessment an only be repeated once.

Prerequisites
None.

Recommendation
- Knowledge of the basics of machine learning is helpful but not required
- Interest in natural science topics is required
- Basic knowledge of python is recommended. It has to be acquired during the semester through self-study

T 5.64 Course: Machine Learning for Natural Sciences - Pass [T-INFO-113917]

Responsible: TT-Prof. Dr. Pascal Friederich
Organisation: KIT Department of Informatics
Part of: M-INFO-106959 - Machine Learning for Natural Sciences

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	1

Events					
ST 2025	2400034	Übung zu Maschinelles Lernen für die Naturwissenschaften	2 SWS	Lecture / Practice (/	Friederich, Reiser, Zhou, Torresi, Neubert, Eberhard, Schlöder
Exams					
ST 2025	7500149	Exercise for Machine Learning for the Natural Sciences			Friederich

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

Competence Certificate
Lecture: The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 90 minutes.

Exercise: The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO). Students must regularly submit exercise sheets. The number of exercise sheets and the scale for passing will be announced at the beginning of the course. The assessment an only be repeated once.

Prerequisites
None.

Recommendation
- Knowledge of the basics of machine learning is helpful but not required
- Interest in natural science topics is required
- Basic knowledge of python is recommended. It has to be acquired during the semester through self-study

T 5.65 Course: Machine Learning in Climate and Environmental Sciences [T-INFO-113083]

Responsible: TT-Prof. Dr. Peer Nowack
Organisation: KIT Department of Informatics
Part of: M-INFO-106470 - Machine Learning in Climate and Environmental Sciences

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	2

Events					
WT 24/25	2400151	Machine Learning in Climate and Environmental Sciences	4 SWS	Lecture / Practice (/ 🗣	Nowack
Exams					
WT 24/25	7500363	Machine Learning in Climate and Environmental Sciences			Nowack

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

Competence Certificate
The assessment of the lectures is likely carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60-120 minutes (exact duration to be confirmed).

Depending on the class size, this might be changed to an oral examination (lasting around 20 minutes, § 4 Abs. 2 No. 2 SPO). The exact type of assessment will be confirmed at least six weeks prior to the assessment.

Prerequisites
No strict prerequisites but several strong recommendations (see below).

Modeled Conditions
The following conditions have to be fulfilled:
1. The course T-INFO-113085 - Machine Learning in Climate and Environmental Sciences - Pass must have been started.

Recommendation
• Previous programming experience, e.g. in scientific contexts or in computer science, is required.
• Knowledge of fundamentals about machine learning is an advantage.
• Knowledge of the Python programming language is an advantage.
• Good knowledge of mathematical concepts such as linear algebra is an advantage.
• An interest in scientific questions important for the climate- and environmental sciences.

T 5.66 Course: Machine Learning in Climate and Environmental Sciences - Pass [T-INFO-113085]

Responsible: TT-Prof. Dr. Peer Nowack
Organisation: KIT Department of Informatics
Part of: M-INFO-106470 - Machine Learning in Climate and Environmental Sciences

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	0	pass/fail	Each winter term	2

Events					
WT 24/25	2400151	Machine Learning in Climate and Environmental Sciences	4 SWS	Lecture / Practice (/ 🗣	Nowack
Exams					
WT 24/25	7500380	Machine Learning in Climate and Environmental Sciences - Pass			Nowack

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

Competence Certificate
The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO). Students must regularly submit exercise sheets. The number of exercise sheets and the scale for passing will be announced at the beginning of the course. The assessment an only be repeated once.

Prerequisites
No strict prerequisites but several strong recommendations (see below).

Recommendation
• Previous programming experience, e.g. in scientific contexts or in computer science, is required.
• Knowledge of fundamentals about machine learning is an advantage.
• Knowledge of the Python programming language is an advantage.
• Good knowledge of mathematical concepts such as linear algebra is an advantage.
• An interest in scientific questions important for the climate- and environmental sciences.

T 5.67 Course: Market Research [T-WIWI-107720]

Responsible: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2025	2571150	Market Research	2 SWS	Lecture / 🗣	Klarmann
ST 2025	2571151	Market Research Tutorial	1 SWS	Practice / 🗣	Klarmann
Exams					
WT 24/25	7900053	Market Research			Klarmann
ST 2025	7900015	Market Research			Klarmann

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

Competence Certificate
The assessment of success takes place through a written exam (70 minutes) with additional aids in the sense of an open book exam. Further details will be announced during the lecture.

Prerequisites
None

Recommendation
None

Annotation
Please note that this course has to be completed successfully by students interested in master thesis positions at the Marketing & Sales Research Group.

T 5.68 Course: Master's Thesis [T-INFO-113697]

Responsible:	Prof. Dr. Bernhard Beckert
Organisation:	KIT Department of Informatics
Part of:	M-INFO-106828 - Module Master's Thesis

Type	Credits	Grading scale	Recurrence	Version
Final Thesis	30	Grade to a third	Each term	1

Competence Certificate
The Master's thesis is reglenented in § 14 and § 19 of the SPO23 Master of Computer Science. The presentation should take place no later than four weeks after submission of the Master's thesis.

The Master's thesis is assessed in the form of a report. An overall assessment (including the presentation) must be written.

The presentation should take place no later than four weeks after submission of the Master's thesis. The presentation may also take place before submission.

Prerequisites
A prerequisite for admission to the Master's thesis is that students have generally already acquired 60 credit points, of which at least 15 credit points must come from one of the two specialization subjects. The application for admission to the Master's thesis must be submitted no later than three months after taking the last module examination.

Final Thesis
This course represents a final thesis. The following periods have been supplied:

Submission deadline	6 months
Maximum extension period	3 months
Correction period	8 weeks

This thesis requires confirmation by the examination office.

T 5.69 Course: Media Management [T-WIWI-112711]

Responsible: Prof. Dr. Ann-Kristin Kupfer
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2572192	Media Management	2 SWS	Lecture / 🗣	Kupfer
WT 24/25	2572193	Media Management Exercise	1 SWS	Practice / 🗣	Kopp
Exams					
WT 24/25	7900135	Media Management			Kupfer
ST 2025	7900004	Media Management			Kupfer

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

Competence Certificate
Success is assessed in the form of an examination of another type. The following aspects are included in the assessment:

- Elaboration and presentation of a group task
- Written exam

Further details on the organization of the performance and the points system for the assessment will be announced in the lecture.

Prerequisites
None

Recommendation
Students are highly encouraged to actively participate in class.

Workload
135 hours

T 5.70 Course: Mobile Communication [T-INFO-114271]

Responsible: Prof. Dr. Oliver Waldhorst
Prof. Dr. Martina Zitterbart

Organisation: KIT Department of Informatics

Part of: M-INFO-107245 - Mobile Communication

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

Events					
WT 24/25	2424643	Mobile Communications	2 SWS	Lecture	Waldhorst, Mahrt
Exams					
ST 2025	7500073	Mobile Communication			Waldhorst, Zitterbart

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.

- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO ***or***

- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO

takes place.

Prerequisites
None.

Recommendation
The contents of the lecture Introduction to Computer Networks are assumed to be known. Attendance of the lecture Telematics is strongly recommended, as the contents are an important basis for understanding and classifying the material.

T 5.71 Course: Mobile Communications [T-ETIT-112127]

Responsible: Prof. Dr.-Ing. Peter Rost
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105971 - Mobile Communications

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

Events					
WT 24/25	2310523	Mobile Communications	2 SWS	Lecture /	Rost
WT 24/25	2310524	Tutorial for 2310523 Mobile Communications	1 SWS	Practice /	Rost
Exams					
WT 24/25	7310524-1	Mobile Communications			Rost
ST 2025	7310524-1	Mobile Communications			Rost

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

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

Prerequisites
none

T 5.72 Course: Model-Driven Software Development [T-INFO-113896]

Responsible: Dr.-Ing. Erik Burger
Prof. Dr. Ralf Reussner

Organisation: KIT Department of Informatics

Part of: M-INFO-106931 - Model-Driven Software Development

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

Events					
WT 24/25	2424657	Model-Driven Software Development	2 SWS	Lecture / 🗣	Burger
Exams					
WT 24/25	7500086	Model Driven Software Development			Reussner, Burger

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 25 minutes.

Prerequisites
None.

Recommendation
Basic knowledge from the lecture Software Engineering II is helpful.

T 5.73 Course: Modern Methods in Combinatorics [T-MATH-113911]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-106957 - Modern Methods in Combinatorics

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

Competence Certificate
Oral examination (approx. 30 min)

Prerequisites
None

Workload
180 hours

T 5.74 Course: Motion in Human and Machine - Seminar [T-INFO-105140]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-102555 - Motion in Human and Machine - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	3

Events					
ST 2025	2400063	Motion in Human and Machine	3 SWS	Seminar / 🗣	Asfour
Exams					
ST 2025	7500289	Motion in Man and Machine - Seminar			Asfour

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). It includes a term paper and a final presentation.

Prerequisites
None.

Recommendation
Programming experience in C++, Python or Matlab is recommended.
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics, Mechano-Informatics and Robotics and Wearable Robotic Technologies is recommended.

Annotation
The block internship is an interdisciplinary event in co-operation with the University of Stuttgart and the University of Heidelberg.

T 5.75 Course: Nano- and Quantum Electronics [T-ETIT-111232]

Responsible: Prof. Dr. Sebastian Kempf
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105604 - Nano- and Quantum Electronics

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

Events					
ST 2025	2312668	Nano- and Quantum Electronics	3 SWS	Lecture / 🗣	Kempf
ST 2025	2312670	Tutorial for 2312668 Nano- and Quantum Electronics	1 SWS	Practice / 🗣	Wünsch
Exams					
WT 24/25	7312668	Nano- and Quantum Electronics			Kempf
ST 2025	7312668	Nano- and Quantum Electronics			Kempf

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

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

Prerequisites
none

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

T 5.76 Course: Natural Language Processing [T-INFO-114207]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107178 - Natural Language Processing

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

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

Prerequisites
None.

T 5.77 Course: Natural Language Processing and Software Engineering [T-INFO-114257]

Responsible: Prof. Dr.-Ing. Anne Koziolek
Organisation: KIT Department of Informatics
Part of: M-INFO-107233 - Natural Language Processing and Software Engineering

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

Events					
WT 24/25	2424187	Natural Language Processing and Software Engineering	2 SWS	Lecture / 🗣	Hey, Koziolek
Exams					
ST 2025	7500185	Natural Language Processing and Software Engineering			Koziolek, Hey

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 25 minutes.

Prerequisites
None.

T 5.78 Course: Network Security: Architectures and Protocols [T-INFO-114238]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: M-INFO-107218 - Network Security: Architectures and Protocols

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.

- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO or

- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO

takes place.

Prerequisites
None.

Recommendation
The contents of the lecture Introduction to Computer Networks are assumed to be known. Attendance of the lecture Telematics is strongly recommended, as the contents are an important basis for understanding and classifying the material.

T 5.79 Course: Next Generation Internet [T-INFO-101321]

Responsible: Dr.-Ing. Roland Bless
Prof. Dr. Martina Zitterbart

Organisation: KIT Department of Informatics

Part of: M-INFO-100784 - Next Generation Internet

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

Events					
ST 2025	24674	Next Generation Internet	2 SWS	Lecture / 🗣	Bless
Exams					
WT 24/25	7500016	Next Generation Internet			Bless, Zitterbart
ST 2025	7500074	Next Generation Internet			Bless, Zitterbart

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

Competence Certificate

The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.
- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO **or**
- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO
takes place.

Prerequisites

None.

Recommendation

The contents of the lecture Introduction to Computer Networks are assumed to be known. Attendance of the lecture Telematics is strongly recommended, as the contents are an important basis for understanding and classifying the material.

T 5.80 Course: Online Concepts for Karlsruhe City Retailers [T-WIWI-111848]

Responsible: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	2

Events					
ST 2025	2571184	Online concepts for Karlsruhe city retailers	2 SWS	Others (sons / 🗣	Kupfer

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

Competence Certificate
Alternative exam assessment:

- presentations in teams (in each case to the extent of approx. 15 minutes per team with subsequent discussio)
- delivery of a written elaboration per team.

Annotation
Please note that an application is required to participate in this workshop. The application phase usually takes place at the beginning of the lecture period in the summer semester. More information on the application process is usually available on the Marketing and Sales Research Group website (marketing.iism.kit.edu) shortly before the start of the lecture period in the summer semester.

Workload
90 hours

T 5.81 Course: Optical Engineering [T-ETIT-100676]

Responsible: Prof. Dr. Wilhelm Stork
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100456 - Optical Engineering

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

Events					
WT 24/25	2311629	Optical Engineering	2 SWS	Lecture /	Stork
WT 24/25	2311631	Tutorial for 2311629 Optical Engineering	1 SWS	Practice /	Fan
Exams					
WT 24/25	7311629	Optical Engineering			Stork
ST 2025	7311730	Optical Engineering			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 5.82 Course: Optimization and Synthesis of Embedded Systems (ESI) [T-INFO-114253]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: M-INFO-107229 - Optimization and Synthesis of Embedded Systems (ESI)

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Knowledge of computer structures is helpful.

The prerequisites, if any, are explained in more detail in the module description.

T 5.83 Course: Optimization Methods for Machine Learning and Engineering [T-INFO-110809]

Responsible: Prof. Dr.-Ing. Jürgen Beyerer
Dr.-Ing. Julius Pfrommer

Organisation: KIT Department of Informatics

Part of: M-INFO-105329 - Optimization Methods for Machine Learning and Engineering

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

Events					
WT 24/25	2400280	Optimization Methods for Machine Learning and Engineering	2 SWS	Lecture /	Pfrommer, Beyerer
WT 24/25	2400281	Optimization Methods for Machine Learning and Engineering	1 SWS	Practice /	Pfrommer, Beyerer
Exams					
WT 24/25	7500279	Optimization Methods for Machine Learning and Engineering			Beyerer
ST 2025	7500329	Optimization Methods for Machine Learning and Engineering			Beyerer

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

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

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.

- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO **or**

- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO

takes place.

Prerequisites
None.

T 5.84 Course: Parallel Algorithms [T-INFO-114221]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-107199 - Parallel Algorithms

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Final grade: 80% oral examination, 20% exercise

Prerequisites
None.

Modeled Conditions
The following conditions have to be fulfilled:
1. The course T-INFO-101333 - Parallel Algorithms must not have been started.
2. The course T-INFO-114222 - Parallel Algorithms Pass must have been started.

Recommendation
Knowledge from lectures such as Algorithms I/II is recommended.

T 5.85 Course: Parallel Algorithms Pass [T-INFO-114222]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-107199 - Parallel Algorithms

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

The exercise can be proven via various performance records (usually exercise sheets). This will be determined individually during the lecture.

Final grade: 80% oral examination, 20% exercise

Prerequisites
None.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-111857 - Parallel Algorithms Pass must not have been started.

Recommendation
Knowledge from lectures such as Algorithms I/II is recommended.

T 5.86 Course: Parameterized Algorithms [T-INFO-114194]

Responsible: TT-Prof. Dr. Thomas Bläsius
Organisation: KIT Department of Informatics
Part of: M-INFO-107167 - Parameterized Algorithms

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Basic knowledge of algorithms and data structures (e.g. from the lectures Algorithms 1 + 2) is helpful.

T 5.87 Course: Parameterized Algorithms - Pass [T-INFO-114195]

Responsible: TT-Prof. Dr. Thomas Bläsius
Organisation: KIT Department of Informatics
Part of: M-INFO-107167 - Parameterized Algorithms

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A total of two repetitions are possible.

Prerequisites
None.

Recommendation
Basic knowledge of algorithms and data structures (e.g. from the lectures Algorithms 1 + 2) is helpful.

T 5.88 Course: Participatory Technology Design [T-INFO-114199]

Responsible: Prof. Dr. Kathrin Gerling
Organisation: KIT Department of Informatics
Part of: M-INFO-107170 - Participatory Technology Design

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 90 minutes.

Prerequisites
None.

Recommendation
Knowledge of the basics of human-machine interaction is helpful.

T 5.89 Course: Participatory Technology Design - Pass [T-INFO-114200]

Responsible: Prof. Dr. Kathrin Gerling
Organisation: KIT Department of Informatics
Part of: M-INFO-107170 - Participatory Technology Design

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). A total of two repetitions are possible.

Prerequisites
None.

Recommendation
Knowledge of the basics of human-machine interaction is helpful.

T 5.90 Course: Practical Course on Network Security Research [T-INFO-114270]

Responsible: Mario Hock
Prof. Dr. Martina Zitterbart

Organisation: KIT Department of Informatics

Part of: M-INFO-107244 - Practical Course on Network Security Research

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

Events					
ST 2025	2400130	Practical Course on Network Security Research		Practical course / 🗣	Zitterbart

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Among other things, implementation, documentation, presentation in the colloquium and the research report to be prepared are included in the assessment of success.

Withdrawal is possible up to two weeks after the first (online) presentation event.

Prerequisites
None.

Recommendation
The module Network Security: Architectures and Protocols [M-INFO-100782] should have been started or completed.

T 5.91 Course: Practical Course on Telematics Research [T-INFO-114239]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: M-INFO-107220 - Practical Course on Telematics Research

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Among other things, implementation, documentation, presentation in the colloquium and the research report to be prepared are included in the assessment of success.

Prerequisites
None.

Recommendation
A pronounced scientific interest in the topics of network security is a prerequisite: no prefabricated exercises are worked on, instead the internship requires a high degree of personal initiative.

T 5.92 Course: Practical Course: Advanced Topics in High Performance Computing, Data Management and Analytics [T-INFO-111803]

Responsible: Prof. Dr. Achim Streit
Organisation: KIT Department of Informatics
Part of: M-INFO-105870 - Practical Course: Advanced Topics in High Performance Computing, Data Management and Analytics

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

Events					
WT 24/25	2400043	Advanced Topics in High Performance Computing, Data Management and Analytics	3 SWS	Practical course	Farhadi, Streit
Exams					
WT 24/25	7500345	Practical Course: Advanced Topics in High Performance Computing, Data Management and Analytics			Streit

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). The examination can consist of experiments or projects, each with a concluding presentation. Students may redraw from the assigned topic during the first two weeks after the topic has been communicated.

Prerequisites
None.

Recommendation
Knowledge in the area of databases, data management, data analytics, parallel computing is helpful.

T 5.93 Course: Practical Course: AI for Climate and Weather Predictions [T-INFO-113659]

Responsible: TT-Prof. Dr. Peer Nowack
Organisation: KIT Department of Informatics
Part of: M-INFO-106800 - Practical Course: AI for Climate and Weather Predictions

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

Events					
WT 24/25	2400064	AI for climate and weather predictions	2 SWS	Practical course / 🗣	Nowack
ST 2025	2400082	AI for climate and weather predictions	3 SWS	Practical course / 🗣	Nowack
Exams					
WT 24/25	7500394	Practical Course: AI for Climate and Weather Predictions			Nowack
ST 2025	7500036	Practical Course: AI for Climate and Weather Predictions			Nowack

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
- Previous programming experience, e.g., in scientific contexts or in computer science, is required.
- Students should have previous experience in the theory and implementation of machine learning models.

Recommendation
- Knowledge of the Python programming language.
- Good knowledge of mathematical concepts such as linear algebra is an advantage.
- An interest in scientific questions around climate science and weather forecasting.

5.94 Course: Practical Course: Application Security [T-INFO-113958]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: M-INFO-106996 - Practical Course: Application Security

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each winter term	1

Events					
ST 2025	2400114	Application security lab	4 SWS	Practical course / 🗣	Müller-Quade, Mechler, Dörre, Wressnegger, Noppel
ST 2025	2400117	Application Security Lab	4 SWS	Practical course / 🗣	Müller-Quade, Mechler, Dörre, Wressnegger, Noppel
Exams					
WT 24/25	7500188	Application Security Lab			Geiselmann, Müller-Quade, Wressnegger

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). Students have to solve different tasks. An overall grade is awarded.

Prerequisites
None.

Recommendation
The basics of IT security are assumed.

The content of the lectures "Computer Organization" and "Operating Systems" should be known.

T 5.95 Course: Practical Course: Artificial Intelligence & Security Lab (AISEC-Lab) [T-INFO-113760]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: M-INFO-106867 - Practical Course: Artificial Intelligence & Security Lab (AISEC-Lab)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each summer term	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

At least one assignment from each unit must be successfully completed (comparable results to other students).

Prerequisites
None.

Recommendation
The basics of IT security and artificial intelligence are a prerequisite.

T 5.96 Course: Practical Course: Chip Design I [T-INFO-114298]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-107265 - Practical Course: Chip Design I

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

Events					
ST 2025	2400104	Practical Course: Chip Design I	4 SWS	Practical course / 🗣	Tahoori

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs.
2 No. 3 SPO).

The overall impression is evaluated. The grading is based on the results of the practical work (80 %) and the final presentation(20%). An overall grade is awarded.

Students may redraw from the examination during the first two weeks after the topic has been communicated. The assessment can be repeated once.

Prerequisites
None.

Recommendation
The requirements are individual to each of the offered projects.
Knowledge of HDL is helpful.

T 5.97 Course: Practical Course: Chip Design II [T-INFO-114299]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-107266 - Practical Course: Chip Design II

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

Events					
ST 2025	2400107	Practical Course: Chip Design II	4 SWS	Practical course / 🗣	Tahoori

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

Competence Certificate

The assessment is carried out as an examination of another type (§ 4 Abs.
2 No. 3 SPO).

The overall impression is evaluated. The grading is based on the results of the practical work (80 %) and the final presentation(20%). An overall grade is awarded.

Students may redraw from the examination during the first two weeks after the topic has been communicated. The assessment can be repeated once.

Prerequisites

None.

Recommendation

The requirements are individual to each of the offered projects.
Knowledge of HDL is helpful.

T 5.98 Course: Practical Course: Digital Design & Test Automation Flow [T-INFO-105565]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-102570 - Practical Course: Digital Design & Test Automation Flow

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

Events					
WT 24/25	2424318	Digital Design & Test Automation Flow	4 SWS	Practical course / 🗣	Tahoori
Exams					
WT 24/25	7500084	Practical Course Digital Design & Test Automation Flow			Tahoori

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

Competence Certificate
The assessment is carried out in form of an examination of another type (§ 4 Abs. 2 No. 3 SPO). Students must give a presentation.

The module grade is made up of 80% of the work completed in the practical course and 20% of the presentation.

An overall grade is awarded.

Prerequisites
None.

Recommendation
Knowledge of “Dependable Computing” and “Fault Tolerant Computing” and Computer Architecture is helpful.

T 5.99 Course: Practical Course: Efficient Parallel C++ [T-INFO-114228]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-107203 - Practical Course: Efficient Parallel C++

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).Students have to solve multiple programming tasks in C++. An overall grade is awarded.

Prerequisites
None.

Modeled Conditions
The following conditions have to be fulfilled:
1. The course T-INFO-106992 - Lab: Efficient Parallel C++ must not have been started.

Recommendation
At least basic knowledge of the C++ language is necessary for participation in the course. Students should be able to implement given algorithms.

T 5.100 Course: Practical Course: Fine-grained Algorithm Design and Engineering [T-INFO-113635]

Responsible: Prof. Dr.-Ing. Marvin Künnemann
Organisation: KIT Department of Informatics
Part of: M-INFO-106784 - Practical Course: Fine-grained Algorithm Design and Engineering

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

Events					
WT 24/25	2400104	Fine-grained Algorithm Design and Engineering	4 SWS	Practical course / 🗣	Künnemann

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). The overall performance is evaluated, which includes the quality of the produced results, the project report and the presentation.

Prerequisites
None.

Recommendation
- Basic knowledge of algorithms and data structures is assumed.
- Knowledge of fine-grained complexity is helpful, but not required.

T 5.101 Course: Practical Course: FPGA Programming [T-INFO-105576]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-102661 - Practical Course: FPGA Programming

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

Events					
WT 24/25	2400106	FPGA Programming	4 SWS	Practical course / 🗣	Tahoori
ST 2025	2400106	FPGA Programming	4 SWS	Practical course / 🗣	Tahoori
Exams					
WT 24/25	7500083	Practical Course FPGA Programming			Tahoori
ST 2025	7500087	Practical Course FPGA Programming			Tahoori

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

Competence Certificate
The assessment is carried out in form of an examination of another type (§ 4 Abs. 2 No. 3 SPO). Students must give a presentation.

The module grade is made up of 80% of the work completed in the practical course and 20% of the presentation.

An overall grade is awarded.

Prerequisites
None.

Recommendation
Knowledge of “Dependable Computing” and “Fault Tolerant Computing” and Computer Architecture is helpful.

T 5.102 Course: Practical Course: General-Purpose Computation on Graphics Processing Units [T-INFO-109914]

Responsible: Prof. Dr.-Ing. Carsten Dachsbacher
Organisation: KIT Department of Informatics
Part of: M-INFO-100724 - Practical Course: General-Purpose Computation on Graphics Processing Units

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

Events					
WT 24/25	2424297	Praktikum General-Purpose Computation on Graphics Processing Units	2 SWS	Practical course / 🗣	Dereviannykh, Klepikov, Dittebrandt, Dachsbacher
ST 2025	24911	General-Purpose Computation on Graphics Processing Units	2 SWS	Practical course / 🗣	Lerzer, Dereviannykh, Klepikov, Dachsbacher
Exams					
WT 24/25	7500470	Practical Course: General-Purpose Computation on Graphics Processing Units			Dachsbacher

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Performance is assessed continuously for the individual projects and in a final presentation.

Prerequisites
None.

Recommendation
It is recommended to have attended relevant lectures in the specialisation area of computer graphics.

T 5.103 Course: Practical Course: Internet of Things (IoT) [T-INFO-107493]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: M-INFO-103706 - Practical Course: Internet of Things (IoT)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	1

Events					
WT 24/25	2424304	Internet of Things (IoT) Lab	4 SWS	Practical course / 🗣	Siddhu, Mentzos, Henkel
Exams					
WT 24/25	7500183	Lab: Internet of Things (IoT)			Henkel

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO), in the form of a practical assignment, presentations and, if necessary, a written report. Written reports, presentations and practical work are weighted depending on the event.

Prerequisites
Basic skills in **C** or **C++** programming.

Recommendation
- Familiarity with other (than C) languages like Python could be helpful as well.
- Basic knowledge from the modules "Design and Architectures of Embedded Systems (ESII)" and "Optimization and Synthesis of Embedded Systems (ESI)" are helpful but not essential for understanding the lab.

5.104 Course: Practical Course: Low Power Design and Embedded Systems [T-INFO-108323]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: M-INFO-104031 - Practical Course: Low Power Design and Embedded Systems

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).
The overall impression is evaluated.
The grading will be based on multiple exercises and a final report.
Details of the grading scale will be announced during the course.

Prerequisites
None.

Recommendation
Students should be familiar with software development practices under Linux-based systems. Practical knowledge in C/C++ as well as Python is required.

T 5.105 Course: Practical Course: Model-Driven Software Development [T-INFO-113897]

Responsible: Dr.-Ing. Erik Burger
Prof. Dr. Ralf Reussner

Organisation: KIT Department of Informatics

Part of: M-INFO-106932 - Practical Course: Model-Driven Software Development

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

Events					
ST 2025	2400091	Practical Course Model-Driven Software Development	4 SWS	Practical course / 🗣	Burger

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO), in the form of predominantly practical tasks.

Prerequisites
None.

Recommendation
Attending the lectures Software Engineering II and Model-Driven Software Development is helpful.

T 5.106 Course: Practical Course: Movement and Technology [T-INFO-113394]

Responsible: Prof. Dr. Katja Mombaur
Organisation: KIT Department of Informatics
Part of: M-INFO-106648 - Practical Course: Movement and Technology

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

Events					
ST 2025	2400151	Practical Course: Movement and Technology	4 SWS	Practical course / 🗣	Mombaur, Lau

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

This includes the preparation of a project report (ca. 10 pages and an oral presentation of the project topics and results with slides. Students may withdraw from the examination during the first two weeks after the topic has been communicated.

Prerequisites
Programming skills are required.

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

Programming skills.

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

T 5.107 Course: Practical Course: Natural Language Dialog Systems [T-INFO-114206]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107177 - Practical Course: Natural Language Dialog Systems

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Prerequisites
None.

T 5.108 Course: Practical Course: Real-world Vulnerability Discovery and Exploits [T-INFO-113350]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: M-INFO-106627 - Practical Course: Real-world Vulnerability Discovery and Exploits

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each term	1

Events					
WT 24/25	24241337	Real-world Vulnerability Discovery and Exploits		Practical course / 🗣	Wressnegger

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Prerequisites
None.

Recommendation
Application security internship

5.109 Course: Practical Course: Robotics [T-INFO-114172]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-107155 - Robotics - Practical Course

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

Events					
ST 2025	24870	Robotics - Practical Course	4 SWS	Practical course / 🗣	Asfour

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). It is composed of several sub-tasks.

Prerequisites
Knowledge of the programming language C++ is required.

Recommendation
Attending the lectures Robotics I – Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics and Mechano-Informatics and Robotics is recommended.

T 5.110 Course: Practical Course: Security, Usability and Society [T-INFO-110990]

Responsible: Dr. Willi Geiselmann
Prof. Dr. Thorsten Strufe

Organisation: KIT Department of Informatics

Part of: M-INFO-105453 - Practical Course: Security, Usability and Society

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Exams			
WT 24/25	7900116	Advanced Lab Security, Usability and Society (Bachelor)	Volkamer
WT 24/25	7900307	Advanced Lab Security, Usability and Society (Master)	Volkamer

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Prerequisites
None.

T 5.111 Course: Practical Course: Smart Energy System [T-INFO-112030]

Responsible: Dr.-Ing. Simon Waczowicz
Organisation: KIT Department of Informatics
Part of: M-INFO-105955 - Practical Course: Smart Energy System

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

Events					
WT 24/25	2400159	Lab Course: Smart Energy System Lab	4 SWS	Practical course / 🗣	Hagenmeyer, Waczowicz, Jumar, Fernengel
ST 2025	2400170	Laboratory: Smart Energy System Lab	4 SWS	Practical course / 🗣	Hagenmeyer, Waczowicz, Jumar, Fernengel

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). A written paper must be prepared and a presentation given.

Prerequisites
None.

Recommendation
- Knowledge of the fundamentals of energy informatics is a prerequisite.
- Knowledge of the fundamentals of electrical engineering and energy technology is required.
- Knowledge of the basics of mechatronics, data analysis and signal processing is helpful.
- Knowledge of power systems or power electronics is helpful.

T 5.112 Course: Practical Course: Software Defined Networking [T-INFO-114240]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: M-INFO-107221 - Practical Course: Software Defined Networking

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Prerequisites
None.

Recommendation
Knowledge of a programming language (Java, C++, Python, ...) and the contents of the telematics lectures are assumed. Previous knowledge of SDN is not mandatory: the topic will be introduced in an introductory task at the beginning of the practical course. Note: Successful participation in the introductory assignment is a prerequisite for further participation in the practical course.

T 5.113 Course: Practical Course: Visual Computing [T-INFO-103000]

Responsible: Prof. Dr.-Ing. Carsten Dachsbacher
Organisation: KIT Department of Informatics
Part of: M-INFO-101567 - Practical Course: Visual Computing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each term	4

Events					
WT 24/25	2424283	Praktikum GPU-Computing	4 SWS	Practical course / 🗣	Dereviannykh, Klepikov, Dittebrandt, Dachsbacher
ST 2025	24909	GPU-Computing	4 SWS	Practical course / 🗣	Lerzer, Dereviannykh, Klepikov, Dachsbacher
Exams					
WT 24/25	7500110	Practical Course GPU-Computing			Dachsbacher

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO) in the form of practical work, presentations and, if applicable, a written paper

Written papers, presentations and practical work are weighted according to the course.

Prerequisites
None.

Recommendation
Programming skills in C/C++ are recommended.

T 5.114 Course: Practical Introduction to Hardware Security [T-INFO-114267]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-107241 - Practical Introduction to Hardware Security

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

Events					
ST 2025	2400009	Practical Introduction in Hardware Security	4 SWS	Lecture / Practice (/ 🗣	Tahoori, Gnad
Exams					
ST 2025	7500224	Practical Introduction to Hardware Security			Tahoori

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). 4 topics will be covered in this lecture. After each topic the student will receive an assignment. The quality of his tasks will be evaluated afterwards of its correctness.

Prerequisites
None.

Recommendation
Knowledge of Digital Design (lecture TI)

Practical Course “FPGA Programming”

T 5.115 Course: Practical SAT Solving [T-INFO-114262]

Responsible: Dr. Tomas Balyo
Dr. Markus Iser
Prof. Dr. Peter Sanders
Dr. Dominik Schreiber

Organisation: KIT Department of Informatics

Part of: M-INFO-107238 - Practical SAT Solving

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

Events					
ST 2025	2400115	Practical SAT Solving	3 SWS	Lecture / Practice (	Sanders, Iser, Schreiber

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) usually lasting 30 minutes.

Prerequisites
None.

Recommendation
Relevant literature will be announced in the lecture.

T 5.116 Course: Privacy Enhancing Technologies [T-INFO-110989]

Responsible: Dr. Willi Geiselmann
Prof. Dr. Thorsten Strufe

Organisation: KIT Department of Informatics

Part of: M-INFO-105452 - Privacy Enhancing Technologies

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

Events					
ST 2025	2400088	Privacy Enhancing Technologies	3 SWS	Lecture / 🗣	Strufe
Exams					
WT 24/25	7500308	Privacy Enhancing Technologies			Strufe

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

T 5.117 Course: Probability and Computing [T-INFO-114196]

Responsible: TT-Prof. Dr. Thomas Bläsius
Dr. Maximilian Katzmann
Prof. Dr. Peter Sanders

Organisation: KIT Department of Informatics

Part of: M-INFO-107168 - Probability and Computing

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	1

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Basic knowledge of algorithms and data structures (e.g. from the lectures Algorithms 1 + 2) as well as basic knowledge of probability theory (e.g. from the lecture Introduction to Stochastics) are helpful.

5.118 Course: Public International Law [T-INFO-113381]

Responsible: TT-Prof. Dr. Frederike Zufall
Organisation: KIT Department of Informatics
Part of: M-INFO-107029 - Public International Law with an Economic Law Focus

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

Events					
ST 2025	2400172	Public International Law with an Economic Law Focus	2 SWS	Lecture / 🗣	Kasper
Exams					
WT 24/25	7500066	Public International Law			Zufall
ST 2025	7500182	Public International Law with an Economic Law Focus			Zufall

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

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

Depending on the number of participants, it will be announced six weeks before the examination (§ 6 (3) SPO) whether the performance assessment is carried out
- as an oral examination (duration approx. 20 mins.) (§ 4 Abs. 2 Nr. 2 SPO) or
- as a written examination (lasting 60 mins.) (§ 4 Abs. 2 No. 1 SPO).

Prerequisites
None.

Recommendation
- General knowledge of (public) law (eg, through participating in public law or EU law modules) is helpful but not necessary.
- Interest in international affairs and politics is welcomed.

Annotation
Competency Goals:
- Participating students will be able to navigate the plethora of multilateral treaties to detect relevant international law for specific cases.
- They can develop solutions for legal problems based on case law of international courts and tribunals.
- Students will be able to read and comprehend international treaties and case law.
- They will have a fundamental understand of the interplay between various subfields of public international law.
- Students can identify and explain current issues in public international law.

Content:
The lecture is designed to provide participating students with a general understanding of the foundations, subjects, and sources of public international law, its interplay with national legal regimes, and more detailed knowledge of particular subfields of public international law.

Since the lecture targets students of information systems, particular focus will be given to economic topics in international law, such as investment and trade law aspects. Due to the general importance of climate change for todays (economic) law, international climate change law and environmental law will form further focus areas.

In addition, a concise overview on human rights law, the law on State responsibility, and the peaceful settlement of disputes will be provided.

Throughout the lecture, important case law will be referenced and students are expected to read relevant cases in part to facilitate a discussion of such cases and their relevance for a subject field. Although the United Nations, including its principal judicial organ, the International Court of Justice, is one of the, if not the, key international organization in public international law, further international organizations (eg, Council of Europe, World Trade Organization) and their respective law(s) will also be touched.

Students are advised to have a statute book at hand that includes the most important international treaties and conventions (eg, Evans, Blackstone's International Law Documents, currently 15th ed 2021).

Conducting the lecture in English intends to facilitate students to link their ideas and arguments to current debates in international law.

T 5.119 Course: Python for Computational Risk and Asset Management [T-WIWI-110213]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105032 - Data Science for Finance

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	3

Competence Certificate
The examination takes the form of an alternative exam assessment.
The alternative exam assessment consists of a Python-based "Takehome Exam". At the end of the third week of January, the student is given a "Takehome Exam" which he processes and sends back independently within 4 hours using Python. Precise instructions will be announced at the beginning of the course. The alternative exam assessment can be repeated a maximum of once. A timely repeat option takes place at the end of the third week in March of the same year. More detailed instructions will be given at the beginning of the course.

Prerequisites
None.

Recommendation
Good knowledge of statistics and basic programming skills

Workload
135 hours

T 5.120 Course: Reading Group [T-INFO-102051]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: M-INFO-107254 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (oral)	1	pass/fail	Each term	1

T 5.121 Course: Reinforcement Learning [T-INFO-111255]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-105623 - Reinforcement Learning

Type	Credits	Grading scale	Recurrence	Version
Written examination	6	Grade to a third	Each winter term	2

Events					
WT 24/25	2400163	Reinforcement Learning		Lecture / Practice (/ 🗣	Neumann, Lioutikov, Zhou
Exams					
WT 24/25	7500293	Reinforcement Learning			Neumann
ST 2025	7500221	Reinforcement Learning			Neumann

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

Competence Certificate
The success control takes place in the form of a written exam, usually 90 minutes in length, according to § 4 Abs. 2 Nr. 1 SPO.

A bonus can be acquired through successful participation in the exercise as a success control of a different kind (§4(2), 3 SPO 2008) or study performance (§4(3) SPO 2015). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4). The bonus is only valid for the main and post exams of the semester in which it was earned. After that, the grade bonus expires.

Prerequisites
None.

Recommendation
• Students should be familiar with the content of the "Foundations of Artificial Intelligence" lecture.
• Good Python knowledge is required.
• Good mathematical background knowledge is required.

T 5.122 Course: Reliable Computing I [T-INFO-101387]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-100850 - Reliable Computing I

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

Events					
WT 24/25	2424071	Reliable Computing I	2 SWS	Lecture / 🗣	Tahoori
Exams					
WT 24/25	7500167	Reliable Computing I			Tahoori
ST 2025	7500027	Reliable Computing I			Tahoori

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Knowledge of Digital Design and Computer Architecture is helpful.

T 5.123 Course: Research Focus Class: Blockchain & Cryptocurrencies [T-INFO-113400]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: M-INFO-106654 - Research Focus Class: Blockchain & Cryptocurrencies

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

Events					
ST 2025	2400184	Research Focus Class: Blockchain & Cryptocurrencies Seminar	2 SWS	Seminar / 🗣	Hartenstein, Droll
ST 2025	2400185	Research Focus Class: Blockchain & Cryptocurrencies	1 SWS	Lecture / 🗣	Hartenstein, Droll

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

Competence Certificate
The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO). A presentation must be given.

Prerequisites
None.

T 5.124 Course: Research Focus Class: Blockchain & Cryptocurrencies - Seminar [T-INFO-113401]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: M-INFO-106654 - Research Focus Class: Blockchain & Cryptocurrencies

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

Events					
ST 2025	2400184	Research Focus Class: Blockchain & Cryptocurrencies Seminar	2 SWS	Seminar / 🗣	Hartenstein, Droll
ST 2025	2400185	Research Focus Class: Blockchain & Cryptocurrencies	1 SWS	Lecture / 🗣	Hartenstein, Droll

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

T 5.125 Course: Research Practical Course: Artificial Intelligence & Security [T-INFO-113759]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: M-INFO-106866 - Research Practical Course: Artificial Intelligence & Security

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

Events					
WT 24/25	2424042	Research Lab: Artificial Intelligence & Security	4 SWS	Practical course / Blended	Wressnegger
Exams					
WT 24/25	7500400	Research Practical Course: Artificial Intelligence & Security			Wressnegger

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Prerequisites
None.

Recommendation
The basics of IT security and artificial intelligence are a prerequisite.

T 5.126 Course: Research Practical Course: Interactive Learning [T-INFO-112772]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Organisation: KIT Department of Informatics
Part of: M-INFO-106300 - Research Practical Course: Interactive Learning

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	Each summer term	3

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).
Presentation on the chosen topic at the end of the semester and written elaboration.

Prerequisites
None.

Recommendation
We highly recommend to take this research project in combination with the “Interactive Learning” seminar.

It is highly recommended to attend the “Explainable Artificial Intelligence” lecture in parallel or prior to this project.

• Experience in Machine Learning is recommended, e.g. through prior coursework.
◦ The Computer Science Department offers several great lectures e.g., “Maschinelles Lernen - Grundlagen und Algorithmen” and “Deep Learning ”
• A good mathematical background will be beneficial
• Python experience is recommended
• We might use the PyTorch deep learning library In the exercises. Some prior knowledge in this is helpful but not necessary.

T 5.127 Course: Research Project Deep Learning for Robotics [T-INFO-114203]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-107174 - Research Project Deep Learning for Robotics

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

It is only possible to resign within two weeks after assignment of the topic.

Es müssen eine schriftliche Ausarbeitung erstellt und eine Präsentation gehalten werden.

- The discussed algorithms have to be implemented successfully.
- The experiments need to be conducted scientifically and need to be well documented.
- The final report is well written and well structured
- The final presentation is well prepared

Prerequisites
None.

Recommendation
- Experience in Machine Learning is recommended.
- Python experience is recommended
- We will use the PyTorch deep learning library. Some prior knowledge in this is helpful but not necessary.

T 5.128 Course: Research Project: Generative AI for Autonomous Agents [T-INFO-114189]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-107163 - Research Project: Generative AI for Autonomous Agents

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

Events					
ST 2025	2400049	Research Project: Generative AI for Autonomous Agents	4 SWS	Practical course / 🗣	Neumann, Hoang

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

- The discussed algorithms have to be implemented successfully.
- The experiments need to be conducted scientifically and need to be well documented.
- The final report is well written and well structured
- The final presentation is well prepared

Prerequisites
None.

Recommendation
- Experience in Machine Learning is recommended.
- Python experience is recommended
- We will use the PyTorch deep learning library. Some prior knowledge in this is helpful but not necessary.

T 5.129 Course: Resilient Networking [T-INFO-111209]

Responsible: Prof. Dr. Thorsten Strufe
Organisation: KIT Department of Informatics
Part of: M-INFO-105591 - Resilient Networking

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

Events					
WT 24/25	2400134	Resilient Networking	3 SWS	Lecture / 🞵	Strufe
WT 24/25	2400136	Resilient Networking	1 SWS	Practice / 🞵	Strufe
Exams					
WT 24/25	7500302	Resilient Networking			Strufe

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Basics from cryptography and computer networks are helpful.

T 5.130 Course: Robotics I - Introduction to Robotics [T-INFO-114190]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-107162 - Robotics I - Introduction to Robotics

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Prerequisites
none.

T 5.131 Course: Robotics II - Humanoid Robotics [T-INFO-114152]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-107123 - Robotics II - Humanoid Robotics

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

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

Prerequisites
- M-INFO-100816 - Robotics II - Learning and planning robots Module must not have been started.
- T-INFO-101391 - Anthropomatics: Humanoid RoboticsPartial work must not have been started.

Recommendation
Having visited the lectures on Robotics I - Introduction to Robotics and Mechano-Informatics and Robotics is recommended.

T 5.132 Course: Robotics III - Sensors and Perception in Robotics [T-INFO-114155]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Organisation: KIT Department of Informatics
Part of: M-INFO-107130 - Robotics III - Sensors and Perception in Robotics

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

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

Prerequisites
none.

Recommendation
Attending the lecture Robotics I – Introduction to Robotics is recommended.

T 5.133 Course: Sampling Methods for Machine Learning [T-INFO-114133]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: M-INFO-107090 - Sampling Methods for Machine Learning

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

Events					
ST 2025	2400194	Sampling Methods for Machine Learning	3 SWS	Lecture / 🗣	Hanebeck
Exams					
ST 2025	7500391	Sampling Methods for Machine Learning			Hanebeck

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

Competence Certificate
The assessment is carried out as an oral examination, lasting 20 minutes in accordance with Section 4 (2) No. 2 SPO.

Prerequisites
Additional certificate for digital exercise (Übungsschein)

Modeled Conditions
The following conditions have to be fulfilled:
1. The course T-INFO-114134 - Sampling Methods for Machine Learning - Pass must have been started.

Recommendation
Knowledge of a higher programming language with sophisticated libraries for scientific-numerical computing (e.g. Julia, Matlab, Python) is advantageous.

T 5.134 Course: Sampling Methods for Machine Learning - Pass [T-INFO-114134]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: M-INFO-107090 - Sampling Methods for Machine Learning

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

Events					
ST 2025	2400194	Sampling Methods for Machine Learning	3 SWS	Lecture / 🗣	Hanebeck
Exams					
ST 2025	7500391	Sampling Methods for Machine Learning			Hanebeck
ST 2025	7500392	Sampling Methods for Machine Learning - Pass			Hanebeck

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

Competence Certificate
Digital exercise:

The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Recommendation
Knowledge of a higher programming language with sophisticated libraries for scientific-numerical computing (e.g. Julia, Matlab, Python) is advantageous

T 5.135 Course: Scientific Methods to Design and Analyze Secure Decentralized Systems [T-INFO-111568]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: M-INFO-105780 - Scientific Methods to Design and Analyze Secure Decentralized Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	1

Events					
WT 24/25	2400009	Scientific Methods to Design and Analyze Secure Decentralized Systems	3 SWS	Lecture / Practice (/ 🗣	Hartenstein, Jacob
Exams					
WT 24/25	7500050	Scientific Methods to Design and Analyze Secure Decentralized Systems			Hartenstein

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

Competence Certificate

The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.

- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO
or
- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO

takes place.

Prerequisites

None.

Recommendation

Prior knowledge on the abstract concepts as well as concrete use cases of decentralized systems is strongly recommended. The “Decentralized Systems: Fundamentals, Modeling, and Applications” lecture covers all necessary aspects, but equivalent lectures and / or self-study can also be sufficient.

T 5.136 Course: Self-Booking-HOC-SPZ-FORUM-Graded [T-INFO-111475]

Responsible: Lena Coerdt
Organisation: KIT Department of Informatics
Part of: M-INFO-107254 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	2	Grade to a third	Each term	1

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

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Annotation
Interdisciplinary qualifications (IQ) completed at the House-of-Competence (HoC),
at the Zentrum für Angewandte Kulturwissenschaften (ZAK) or at the Sprachenzentrum (SpZ)
can be assigned in self-service.

First, select a partial accomplishment named "self-assignment" in your study schedule
and second, assign an IQ-achievement via the tab "IQ achievements".

T 5.137 Course: Self-Booking-HOC-SPZ-FORUM-Graded [T-INFO-111474]

Responsible: Lena Coerdt
Organisation: KIT Department of Informatics
Part of: M-INFO-107254 - Interdisciplinary Qualifications

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

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

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Annotation
Interdisciplinary qualifications (IQ) completed at the House-of-Competence (HoC),
at the Zentrum für Angewandte Kulturwissenschaften (ZAK) or at the Sprachenzentrum (SpZ)
can be assigned in self-service.

First, select a partial accomplishment named "self-assignment" in your study schedule
and second, assign an IQ-achievement via the tab "IQ achievements".

T 5.138 Course: Self-Booking-HOC-SPZ-FORUM-Graded [T-INFO-111476]

Responsible: Lena Coerdt
Organisation: KIT Department of Informatics
Part of: M-INFO-107254 - Interdisciplinary Qualifications

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

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

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Annotation
Interdisciplinary qualifications (IQ) completed at the House-of-Competence (HoC),
at the Zentrum für Angewandte Kulturwissenschaften (ZAK) or at the Sprachenzentrum (SpZ)
can be assigned in self-service.

First, select a partial accomplishment named "self-assignment" in your study schedule
and second, assign an IQ-achievement via the tab "IQ achievements".

T 5.139 Course: Self-Booking-HOC-SPZ-FORUM-ungraded [T-INFO-111479]

Responsible: Lena Coerdt
Organisation: KIT Department of Informatics
Part of: M-INFO-107254 - Interdisciplinary Qualifications

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

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

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Annotation
Interdisciplinary qualifications (IQ) completed at the House-of-Competence (HoC),
at the Zentrum für Angewandte Kulturwissenschaften (ZAK) or at the Sprachenzentrum (SpZ)
can be assigned in self-service.

First, select a partial accomplishment named "self-assignment" in your study schedule
and second, assign an IQ-achievement via the tab "IQ achievements".

T 5.140 Course: Self-Booking-HOC-SPZ-FORUM-Ungraded [T-INFO-111478]

Responsible: Lena Coerdt
Organisation: KIT Department of Informatics
Part of: M-INFO-107254 - Interdisciplinary Qualifications

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

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

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Annotation
Interdisciplinary qualifications (IQ) completed at the House-of-Competence (HoC), at the Zentrum für Angewandte Kulturwissenschaften (ZAK) or at the Sprachenzentrum (SpZ) can be assigned in self-service.

First, select a partial accomplishment named "self-assignment" in your study schedule and second, assign an IQ-achievement via the tab "IQ achievements".

T 5.141 Course: Self-Booking-HOC-SPZ-FORUM-Ungraded [T-INFO-111477]

Responsible: Lena Coerdt
Organisation: KIT Department of Informatics
Part of: M-INFO-107254 - Interdisciplinary Qualifications

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

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

- House of Competence
- Sprachenzentrum
- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)

Annotation
Interdisciplinary qualifications (IQ) completed at the House-of-Competence (HoC), at the Zentrum für Angewandte Kulturwissenschaften (ZAK) or at the Sprachenzentrum (SpZ) can be assigned in self-service.

First, select a partial accomplishment named "self-assignment" in your study schedule and second, assign an IQ-achievement via the tab "IQ achievements".

T 5.142 Course: Seminar Advanced Topics in Machine Translation [T-INFO-105653]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-102725 - Seminar Advanced Topics in Machine Translation

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

Events					
WT 24/25	2400074	Advanced Topics in Machine Translation	2 SWS	Seminar	Waibel, Niehues, Li
Exams					
WT 24/25	7500267	Seminar Advanced Topics in Machine Translation			Niehues

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Knowledge from the lecture Machine Translation
Knowledge from the lecture Cognitive Systems

T 5.143 Course: Seminar Dependable Computing [T-INFO-105577]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-102662 - Seminar Dependable Computing

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

Events					
WT 24/25	2400030	Dependable Computing	2 SWS	Seminar / 🗣	Tahoori
ST 2025	2400030	Dependable Computing	2 SWS	Seminar / 🧩	Tahoori
Exams					
WT 24/25	7500152	Seminar Dependable Computing			Tahoori
ST 2025	7500118	Seminar Dependable Computing			Tahoori

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.
The module grade is made up of 50% of the presentation and 50% of the written paper.

Prerequisites
None.

Recommendation
Knowledge of "Dependable Computing" and "Fault Tolerant Computing" and computer architecture is helpful.

T 5.144 Course: Seminar in Privacy [T-INFO-114268]

Responsible: Prof. Dr. Thorsten Strufe
Organisation: KIT Department of Informatics
Part of: M-INFO-107242 - Seminar in Privacy

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each summer term	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given; in addition, preliminary papers must be submitted and commented on in a peer review between fellow students. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Fundamentals of IT security, computer networks and distributed systems are required

T 5.145 Course: Seminar Near Threshold Computing [T-INFO-105579]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-102663 - Seminar Near Threshold Computing

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Knowledge of "Dependable Computing" and "Fault Tolerant Computing" and computer architecture is helpful.

T 5.146 Course: Seminar Non-volatile Memory Technologies [T-INFO-105935]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-102961 - Seminar Non-volatile Memory Technologies

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Knowledge of "Dependable Computing" and "Fault Tolerant Computing" and computer architecture is helpful.

5.147 Course: Seminar: Advanced Topics on SAT Solving [T-INFO-114231]

Responsible: Dr. Markus Iser
Prof. Dr. Peter Sanders

Organisation: KIT Department of Informatics

Part of: M-INFO-107209 - Seminar: Advanced Topics on SAT Solving

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2400020	Advanced Topics in SAT Solving	2 SWS	Seminar / 🗣	Sanders, Iser, Schreiber

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A presentation must be given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Knowledge of the basics from "SAT Solving in Practice" is helpful.

T 5.148 Course: Seminar: Algorithm Engineering [T-INFO-112312]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-106086 - Seminar: Algorithm Engineering

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Knowledge of algorithms is an advantage. Exemplary lectures are Algorithms I, Algorithms II, Algorithm Engineering and Parallel Algorithms.

T 5.149 Course: Seminar: Applications and Extensions of Timed Systems [T-INFO-113132]

Responsible: Jun.-Prof. Dr. Maike Schwammberger
Organisation: KIT Department of Informatics
Part of: M-INFO-106512 - Seminar: Applications and Extensions of Timed Systems

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Events					
WT 24/25	2400196	Seminar: Applications and Extensions of Timed Systems	2 SWS	Seminar / 🗣	Schwammberger
Exams					
WT 24/25	7500374	Seminar: Applications and Extensions of Timed Systems			Schwammberger

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Paper and presentation. The main language of the seminar will be English, but it is possible to write the paper either in German or English. The same holds for the presetation.

Prerequisites
None.

Recommendation
Knowledge in areas of theoretical computer science and modeling of (embedded) software systems is helpful (e.g. CTL, finite automata, first order logic). It is also helpful, but not at all necessary, to have knowledge of the topics of the summer term lecture „Timed Systems“. Necessary topics from that lecture will also be introduced in the beginning of the winter term, if necessary.

T 5.150 Course: Seminar: Artificial Intelligence for Energy Systems [T-INFO-113110]

Responsible: TT-Prof. Dr. Benjamin Schäfer
Organisation: KIT Department of Informatics
Part of: M-INFO-106490 - Seminar: Artificial Intelligence for Energy Systems

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2400175	Seminar: Artificial Intelligence for Energy Systems		Seminar / 🗣	Schäfer
Exams					
WT 24/25	7500354	Seminar: Artificial Intelligence for Energy Systems			Schäfer

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO), consisting of a Term paper (max. 15 pages) and a Presentation (duration approx. 30 min.)
The grading scale will be announced in the course.

Students may redraw from the examination during the first two weeks after the topic has been communicated. The assessment can be repeated once.

Prerequisites
None.

Recommendation
Previous participation in “Energieinformatik 1” and/or “Energieinformatik 2” is beneficiary but not mandatory.

T 5.151 Course: Seminar: Continuous Software Engineering [T-INFO-110794]

Responsible: Prof. Dr.-Ing. Anne Koziolek
Organisation: KIT Department of Informatics
Part of: M-INFO-105309 - Seminar: Continuous Software Engineering

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

Events					
WT 24/25	2400108	Continuous Software Engineering	2 SWS	Seminar	Koziolek
Exams					
WT 24/25	7500243	Seminar: Continuous Software Engineering			Koziolek

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

- the preparation of a written paper (50%)
- the assessment of two seminar papers as part of a peer review (10%)
- the preparation of presentation slides and giving a presentation (20%)
- punctuality of submissions (20%)

Prerequisites
None.

T 5.152 Course: Seminar: Critical Topics in AI [T-INFO-113915]

Responsible: TT-Prof. Dr. Pascal Friederich
Organisation: KIT Department of Informatics
Part of: M-INFO-106958 - Seminar: Critical Topics in AI

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). The following partial aspects are included in the grading: Term paper (approx. 10-15 pages), presentation (duration 30+15 min.). The grading scale will be announced in the course. Students may redraw from the examination during the first two weeks after the topic has been communicated. The assessment can be repeated once.

Prerequisites
Basic knowledge in AI and Machine Learning, e.g.
• BA Informatics: Introduction to artificial intelligence

Recommendation
Interest in social topics and research questions is required

T 5.153 Course: Seminar: Current Trends in Theoretical Computer Science [T-INFO-114091]

Responsible: Prof. Dr.-Ing. Marvin Künnemann
Organisation: KIT Department of Informatics
Part of: M-INFO-107027 - Seminar: Current Trends in Theoretical Computer Science

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Events					
ST 2025	2400101	Current Trends in Theoretical Computer Science		Seminar / 🗣	Künnemann

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO) and consists of the overall impression during the seminar, including the presentation as session leader and a scientific report at the end of the seminar.

Prerequisites
None.

Recommendation
Basic knowledge of theoretical computer science and algorithm design is recommended.

T 5.154 Course: Seminar: Deep Learning for Robotics [T-INFO-114204]

Responsible: Prof. Dr. Gerhard Neumann
Organisation: KIT Department of Informatics
Part of: M-INFO-107175 - Seminar: Deep Learning for Robotics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2400099	Deep Learning for Robotics	2 SWS	Seminar / 🗣	Neumann
Exams					
WT 24/25	7500306	Seminar: Deep Learning for Robotics			Neumann

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Presentation on the chosen topic at the end of the semester and written elaboration
Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Attendance of the lecture "Machine Learning - Fundamentals and Algorithms" is recommended.

T 5.155 Course: Seminar: Embedded Systems I [T-INFO-114255]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: M-INFO-107231 - Seminar: Embedded Systems I

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Knowledge of IoT and embedded systems

T 5.156 Course: Seminar: Embedded Systems II [T-INFO-114256]

Responsible: Prof. Dr.-Ing. Jörg Henkel
Organisation: KIT Department of Informatics
Part of: M-INFO-107232 - Seminar: Embedded Systems II

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-INFO-114256 - Seminar: Embedded Systems II must not have been started.

Recommendation
Knowledge of IoT and embedded systems

Annotation
This is identical to the module 'Seminars: Embedded Systems I' and enables participation in a second seminar at the CES Chair.

T 5.157 Course: Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society [T-INFO-113398]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: M-INFO-106651 - Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	1

Events					
ST 2025	2400161	Exploring Robotics: Insights from Science Fiction, Research and Society	2 SWS	Seminar / 🗣	Bruno, Maure
Exams					
ST 2025	7500110	Seminar: Exploring Robotics - Insights from Science Fiction, Research and Society			Bruno

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

The overall impression is evaluated. The following partial aspects are included in the grading: Term paper (approx. 6 pages in double-column format), Presentation (duration approx. 10+10 min.).

Prerequisites
None.

Recommendation
Knowledge of the content of modules Robotics I - Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics is helpful.

T 5.158 Course: Seminar: Fine-Grained Complexity Theory & Algorithms [T-INFO-113392]

Responsible: Prof. Dr.-Ing. Marvin Künnemann
Organisation: KIT Department of Informatics
Part of: M-INFO-106645 - Seminar: Fine-Grained Complexity Theory & Algorithms

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Events					
ST 2025	2400153	Fine-Grained Complexity Theory & Algorithms	2 SWS	Seminar / 🗣	Künnemann

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO) and consists of a presentation and a scientific report.

Prerequisites
None.

Recommendation
Basic knowledge of theoretical computer science and algorithm design is recommended.

Concurrent or previous attendance of the lecture “Fine-Grained Complexity Theory & Algorithms” is helpful, but not required. This seminar can be attended independently.

T 5.159 Course: Seminar: Hot Topics in Artificial Intelligence & Security 1 [T-INFO-113761]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: M-INFO-106868 - Seminar: Hot Topics in Artificial Intelligence & Security 1

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2424007	Seminar: Hot Topics in Cyber-Physical Systems Security	2 SWS	Seminar / 🗣	Wressnegger
WT 24/25	2424008	Seminar: Hot Topics in Security of Machine Learning	2 SWS	Seminar / 🗣	Wressnegger, Zhao
Exams					
WT 24/25	7500359	Seminar: Hot Topics in Security of Machine Learning			Wressnegger

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given. One repetition is possible.

Prerequisites
None.

Recommendation
The basics of IT security and artificial intelligence are a prerequisite.

T 5.160 Course: Seminar: Hot Topics in Artificial Intelligence & Security 2 [T-INFO-113762]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: M-INFO-106869 - Seminar: Hot Topics in Artificial Intelligence & Security 2

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each summer term	1

Events					
WT 24/25	2424007	Seminar: Hot Topics in Cyber-Physical Systems Security	2 SWS	Seminar / 🗣	Wressnegger
WT 24/25	2424008	Seminar: Hot Topics in Security of Machine Learning	2 SWS	Seminar / 🗣	Wressnegger, Zhao
Exams					
WT 24/25	7500361	Seminar: Hot Topics in Cyber-Physical Systems Security			Wressnegger

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written elaboration must be prepared and a presentation must be given. Withdrawal is possible within two weeks after assignment of the topic. One repetition is possible.

Prerequisites
None.

Annotation
The basics of IT security and artificial intelligence are a prerequisite.

T 5.161 Course: Seminar: Hot Topics in Bioinformatics [T-INFO-101287]

Responsible: Prof. Dr. Alexandros Stamatakis
Organisation: KIT Department of Informatics
Part of: M-INFO-100750 - Seminar: Hot Topics in Bioinformatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	2

Events					
ST 2025	2400011	Hot Topics in Bioinformatics	2 SWS	Seminar / 🗣	Stamatakis
Exams					
ST 2025	7500014	Seminar: Hot Topics in Bioinformatics			Stamatakis

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). (Weighting of presentation and written report: 50% each)

Prerequisites
The exam in Introduction to Bioinformatics for Computer Scientists must have been passed in one of the preceding semesters.

Modeled Conditions
The following conditions have to be fulfilled:
1. The module M-INFO-100749 - Introduction to Bioinformatics for Computer Scientists must have been passed.

Recommendation
Basic knowledge in the areas of theoretical computer science (algorithms, data structures) and technical computer science (sequential optimisation in C or C++, computer architectures, parallel programming, vector processors) will be beneficial.

T 5.162 Course: Seminar: Hot Topics in Decentralized Systems [T-INFO-109922]

Responsible: Prof. Dr. Hannes Hartenstein
Organisation: KIT Department of Informatics
Part of: M-INFO-104891 - Seminar: Hot Topics in Decentralized Systems

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

Events					
ST 2025	2400029	Hot Topics in Decentralized Systems	2 SWS	Seminar / 🗣	Hartenstein, Grundmann

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Knowledge of the basics of IT security management for networked systems and the basic security module is helpful.

T 5.163 Course: Seminar: Hot Topics in Explainable Artificial Intelligence (XAI) [T-INFO-112917]

Responsible: TT-Prof. Dr. Christian Wressnegger
Organisation: KIT Department of Informatics
Part of: M-INFO-106392 - Seminar: Hot Topics in Explainable Artificial Intelligence (XAI)

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper (seminar paper) must be prepared and a presentation must be given.

Prerequisites
None.

T 5.164 Course: Seminar: Human-Robot Interaction [T-INFO-113116]

Responsible: TT-Prof. Dr. Barbara Bruno
Organisation: KIT Department of Informatics
Part of: M-INFO-106498 - Seminar: Human-Robot Interaction

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2400194	Human-Robot Interaction - Seminar	2 SWS	Seminar / 🗣	Bruno, Maure
Exams					
WT 24/25	7500068	Seminar: Human-Robot Interaction			Bruno

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO). The overall impression is evaluated. The following partial aspects are included in the grading: Term paper (approx. 6 pages in double-column format), Presentation (duration approx. 10+10 min.).

Prerequisites
None.

Recommendation
Knowledge of the content of modules Robotics I - Introduction to Robotics, Robotics II: Humanoid Robotics, Robotics III - Sensors and Perception in Robotics is helpful.

T 5.165 Course: Seminar: Interactive Learning [T-INFO-112773]

Responsible: TT-Prof. Dr. Rudolf Lioutikov
Organisation: KIT Department of Informatics
Part of: M-INFO-106301 - Seminar: Interactive Learning

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Presentation on the chosen topic at the end of the semester and written elaboration.

Prerequisites
None.

Recommendation
We highly recommend to take this seminar in combination with the “Interactive Learning” research project (Forschungspraktikum).

It is highly recommended to attend the “Explainable Artificial Intelligence” lecture in parallel or prior to this seminar.

• Experience in Machine Learning is recommended, e.g. through prior coursework.
◦ The Computer Science Department offers several great lectures e.g., “Maschinelles Lernen - Grundlagen und Algorithmen” and “Deep Learning ”
• A good mathematical background will be beneficial
• Python experience is recommended
• We might use the PyTorch deep learning library In the exercises. Some prior knowledge in this is helpful but not necessary.

T 5.166 Course: Seminar: Interpretability and Causality in Machine Learning [T-INFO-114237]

Responsible: Jun.-Prof. Dr. Jan Stühmer
Organisation: KIT Department of Informatics
Part of: M-INFO-107217 - Seminar: Interpretability and Causality in Machine Learning

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written elaboration must be prepared and a presentation must be given. Students may redraw from the examination during the first two weeks after the topic has been communicated. The assessment can be repeated once.

Prerequisites
None.

Recommendation
Attendance of the lecture "Machine Learning - Fundamentals and Algorithms" is recommended.

T 5.167 Course: Seminar: Law and Legal Studies [T-INFO-114094]

Responsible: Gustavo Gil Gasiola
Organisation: KIT Department of Informatics
Part of: M-INFO-107028 - Seminar: Law and Legal Studies

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

Events					
ST 2025	2400171	Regulating AI: from ethics to law	2 SWS	Seminar / 🗣	Gil Gasiola
ST 2025	2400177	Designing Data Governance of Digital Systems (en)	2 SWS	Seminar / 🗣	Pathak
ST 2025	2400190	EU Digital Regulatory Framework	2 SWS	Seminar / 🗣	Zufall
Exams					
ST 2025	7500060	Seminar: Law and Legal Studies			Zufall
ST 2025	7500237	Seminar: Law and Legal Studies			Zufall

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

Competence Certificate
Success is assessed by preparing a written seminar paper and its presentation as a different type of examination in accordance with Section 4 (2) No. 3 SPO.

Prerequisites
None.

T 5.168 Course: Seminar: Machine Learning in Climate and Environmental Sciences [T-INFO-113519]

Responsible: TT-Prof. Dr. Peer Nowack
Organisation: KIT Department of Informatics
Part of: M-INFO-106719 - Seminar: Machine Learning in Climate and Environmental Sciences

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

Events					
ST 2025	2400178	Seminar Machine Learning in Climate and Environmental Sciences	2 SWS	Seminar / 🗣	Nowack, Amiramjadi
Exams					
ST 2025	7500213	Seminar Machine Learning in Climate and Environmental Sciences			Nowack

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

In the form of a written seminar paper and the presentation of the same.

Prerequisites
- Familiarity with machine learning concepts and techniques.
- Basic knowledge of climate and environmental scince is advantageous but not mandatory.

Recommendation
- An interest in climate and environmental sciences topics is a prerequisite.

T 5.169 Course: Seminar: Operating Systems [T-INFO-114230]

Responsible: Prof. Dr.-Ing. Frank Bellosa
Organisation: KIT Department of Informatics
Part of: M-INFO-107205 - Seminar: Operating Systems

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

Events					
WT 24/25	2400017	Hot Topics in Modern Operating Systems	2 SWS	Seminar / 🗣	Bellosa, Khalil
Exams					
WT 24/25	7500223	Seminar: Operating Systems			Bellosa

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO), by preparing a written seminar paper and the presentation of the same.

The overall grade is made up of the graded and weighted performance assessments (usually 50 % seminar paper, 50 % presentation). An overall grade is awarded.

Prerequisites
None.

T 5.170 Course: Seminar: Post-Quantum Cryptography [T-INFO-111200]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: M-INFO-105585 - Seminar: Post-Quantum Cryptography

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

Events					
ST 2025	2400002	Post-Quantum Cryptography	2 SWS	Seminar / 🗣	Ottenhues, Tiepelt, Müller-Quade, Fruböse, Gröll, Beskorovajnov, Benz, Klooß

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned

Prerequisites
None.

Recommendation
Basic knowledge of IT-Security and cryptography are recommended.

T 5.171 Course: Seminar: Practical Graph Algorithms [T-INFO-114297]

Responsible: Prof. Dr. Henning Meyerhenke
Organisation: KIT Department of Informatics
Part of: M-INFO-107264 - Seminar: Practical Graph Algorithms

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Events					
ST 2025	2400196	Practical Graph Algorithms	2 SWS	Seminar	Meyerhenke

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Knowledge of algorithms, in particular graph algorithms, is a clear advantage. Exemplary lectures are Algorithms I and Algorithms II.

T 5.172 Course: Seminar: Privacy and Security [T-INFO-114236]

Responsible: Prof. Dr. Thorsten Strufe
Organisation: KIT Department of Informatics
Part of: M-INFO-107216 - Seminar: Privacy and Security

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Each winter term	1

Events					
WT 24/25	2400118	Seminar Privacy and Security	2 SWS	Seminar	Strufe, Guerra Balboa, Bayreuther
Exams					
WT 24/25	7500127	Seminar Privacy and Security			Strufe

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and a presentation given; in addition, preliminary papers must be submitted and commented on in a peer review between fellow students. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Fundamentals of IT security, computer networks and distributed systems are required

T 5.173 Course: Seminar: Proofs from THE BOOK [T-INFO-106604]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-103306 - Seminar: Proofs from THE BOOK

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

The student must present multiple proofs over the course of the semester and moderate the ensuing discussion about those proofs. No written documents are required. Students may redraw from their participation until the end of the second seminar date.

Prerequisites
None.

Recommendation
The German version “Das Buch der Beweise” is available online at the KIT library within the KIT network. The English version “Proofs from THE BOOK” is available as a physical copy at the KIT library. We recommend having a look inside either version before registering for this seminar.

T 5.174 Course: Seminar: Quantum Information Theory [T-INFO-110904]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: M-INFO-105408 - Seminar: Quantum Information Theory

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

Events					
ST 2025	2400085	Quantum Information Theory	2 SWS	Seminar / 🧩	Müller-Quade, Tiepelt, Ottenhues, Fruböse, Hetzel, Martin

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A presentation must be given and a written elaboration of exercises must be prepared.
Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Basic knowledge of IT-Security and linear algebra are recommended.

T 5.175 Course: Seminar: Recent Highlights in Algorithms [T-INFO-114201]

Responsible: TT-Prof. Dr. Thomas Bläsius
Prof. Dr. Peter Sanders
Dr. rer. nat. Torsten Ueckerdt

Organisation: KIT Department of Informatics

Part of: M-INFO-107172 - Seminar: Recent Highlights in Algorithms

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO), by preparing a written seminar paper and the presentation of the same

Prerequisites
None.

Recommendation
Knowledge of the basics of graph theory and algorithm technology is helpful.

T 5.176 Course: Seminar: Recent Topics of Machine Learning in Materials Science and Chemistry [T-INFO-112740]

Responsible: TT-Prof. Dr. Pascal Friederich
Organisation: KIT Department of Informatics
Part of: M-INFO-106284 - Seminar: Recent Topics of Machine Learning in Materials Science and Chemistry

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

The following partial aspects are included in the grading: Term paper (approx. 10-15 pages), presentation (duration 30+15 min.). The grading scale will be announced in the course. Students may redraw from the examination during the first two weeks after the topic has been communicated. The assessment can be repeated once.

Prerequisites
Basic knowledge in AI and Machine Learning, e.g.

BA Informatics: Introduction to artificial intelligence

Recommendation
Participation in Machine Learning for Natural Sciences (M-INFO-105630) or other advanced machine learning lectures

T 5.177 Course: Seminar: Scalable Parallel Graph Algorithms [T-INFO-110810]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-105330 - Seminar: Scalable Parallel Graph Algorithms

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO) by preparing a written seminar paper and presenting it.

Prerequisites
None.

Recommendation
Knowledge of the basics of graph theory, algorithm technology and parallel algorithms is helpful.

T 5.178 Course: Seminar: Secure Multiparty Computation [T-INFO-111501]

Responsible: Prof. Dr. Jörn Müller-Quade
Organisation: KIT Department of Informatics
Part of: M-INFO-105761 - Seminar: Secure Multiparty Computation

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

Events					
WT 24/25	2400088	Secure Multipary Computation	2 SWS	Seminar / 🗣	Raiber, Müller-Quade, Jiang
Exams					
WT 24/25	7500326	Seminar: Secure Multiparty Computation			Geiselmann, Müller-Quade

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

A written paper must be prepared and/or a presentation must be given. Withdrawal is possible within two weeks of the topic being assigned.

Prerequisites
None.

Recommendation
Knowledge of the content of the lecture Cryptographic Protocols is assumed.

T 5.179 Course: Seminar: Software Architecture, Security and Privacy [T-INFO-114260]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: M-INFO-107236 - Seminar: Software Architecture, Security and Privacy

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4	Grade to a third	Irregular	1

Events					
WT 24/25	2400060	Data in Software-Intensive Technical Systems – Modeling – Analysis – Protection	2 SWS	Seminar / 🗣	Reussner, Raabe, Werner, Müller-Quade
Exams					
WT 24/25	7500232	Seminar Data in Software-Intensive Technical Systems – Modeling – Analysis – Protection			Reussner

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

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

- the preparation of a written paper (50%)
- the assessment of two seminar papers as part of a peer review (10%)
- the preparation of presentation slides and giving a presentation (20%)
- punctuality of submissions (20%)

Prerequisites
None.

T 5.180 Course: Seminar: Speech-to-Speech Translation [T-INFO-114208]

Responsible: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107179 - Seminar: Speech-to-Speech Translation

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	1

Competence Certificate
The assessment is carried out as an examination of another type (§ 4 Abs. 2 No. 3 SPO).

Prerequisites
None.

T 5.181 Course: Service Design Thinking [T-WIWI-102849]

Responsible: Prof. Dr. Gerhard Satzger
Prof. Dr. Orestis Terzidis
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101503 - Service Design Thinking

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	9	Grade to a third	Irregular	5

Events					
WT 24/25	2595600	Service Design Thinking	2 SWS	Lecture / 🗣	Feldmann, Terzidis, Satzger
ST 2025	2595600	Service Design Thinking	2 SWS	Lecture / 🗣	Feldmann, Terzidis, Satzger
Exams					
ST 2025	7900319	Service Design Thinking			Satzger
ST 2025	7900320	Practical Seminar Service Innovation			Satzger

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

Competence Certificate
Success is assessed in the form of an alternative exam assessment which consists of a case study, workshops, and a final presentation. The weighting of these components for the grade will be announced at the beginning of the course.

Prerequisites
None

Recommendation
This course is held in English – proficiency in writing and communication is required.

Our past students recommend to take this course at the beginning of the masters program.

Annotation
Due to practical project work as a component of the program, access is limited. The module (as well as the module component) spans two semesters. It starts in September every year and runs until end of June in the subsequent year. Entering the program is only possible at its beginning - after prior application in May/June. For more information on the application process and the program itself are provided in the module component description and the program's website (https://sdtkarlsruhe.de/). Furthermore, the lecturers provide an information event for applicants every year in May.

5.182 Course: SIL Entrepreneurship Project [T-WIWI-110166]

Responsible: Prof. Dr. Orestis Terzidis
Organisation: KIT Department of Economics and Management
Part of: M-ETIT-105073 - Student Innovation Lab

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2545082	SIL Entrepreneurship Project	4 SWS	Seminar	Terzidis
Exams					
WT 24/25	7900037	SIL Entrepreneurship Project			Terzidis

Competence Certificate
Alternative exam assessment (§4(2), 3 SPO). The final grade is a result from both, the grade of the term paper and its presentation, as well as active participation during the seminar. In addition, smaller, ungraded tasks are provided in the course to monitor progress.

Prerequisites
None

Recommendation
None

Workload
90 hours

T 5.183 Course: Software Architecture and Quality [T-INFO-114261]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: M-INFO-107237 - Software Architecture and Quality

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

Events					
ST 2025	24667	Software Architecture and Quality	2 SWS	Lecture / 🗣	Reussner
Exams					
WT 24/25	7500032	Software Architecture and Quality			Reussner

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 120 minutes.

Prerequisites
This lecture and the lectures *Component-Based Software Development* and *Software Architecture* are mutually exclusive.

T 5.184 Course: Software Engineering II [T-INFO-114259]

Responsible: Prof. Dr.-Ing. Anne Koziolek
Prof. Dr. Raffaela Mirandola
Prof. Dr. Ralf Reussner

Organisation: KIT Department of Informatics

Part of: M-INFO-107235 - Software Engineering II

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

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 90 minutes.

Prerequisites
None.

Recommendation
The course *Software Engineering I* should already have been attended.

T 5.185 Course: Software Product Line Engineering [T-INFO-114234]

Responsible: Prof. Dr.-Ing. Ina Schaefer
Organisation: KIT Department of Informatics
Part of: M-INFO-107212 - Software Product Line Engineering

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

Competence Certificate
The assessment is carried out as an oral examination, usually lasting 25 minutes in accordance with Section 4 (2) No. 2 SPO.

Depending on the number of attending students, it will be announced six weeks before the examination (§ 6 Para. 3 SPO) whether the performance assessment will take place

- in the form of an oral examination in accordance with Section 4 (2) No. 2 SPO (as described above) or
- in the form of a written examination lasting 90 minutes in accordance with Section 4 (2) No. 1 SPO.

Prerequisites
None.

Recommendation
Basic knowledge from the lectures Software Engineering II [T-INFO-101370] and Formal Systems [T-INFO-101336] is helpful.

5.186 Course: Software Security Engineering [T-INFO-112862]

Responsible: Dr. Christopher Gerking
Prof. Dr. Ralf Reussner

Organisation: KIT Department of Informatics

Part of: M-INFO-106344 - Software Security Engineering

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

Events					
ST 2025	2400059	Software Security Engineering	2 SWS	Lecture / 🗣	Gerking
Exams					
WT 24/25	7500040	Software Security Engineering			Gerking
WT 24/25	7500386	Software Security Engineering			Gerking

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 25 minutes.

Prerequisites
None.

Recommendation
Knowledge of Software Engineering I and Software Engineering II is recommended.

T 5.187 Course: Software-Evolution [T-INFO-101256]

Responsible: Prof. Dr. Ralf Reussner
Organisation: KIT Department of Informatics
Part of: M-INFO-100719 - Software-Evolution

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

Events					
WT 24/25	2424164	Software Evolution	2 SWS	Lecture / 🗣	Heinrich
Exams					
WT 24/25	7500004	Software-Evolution			Reussner, Heinrich

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 25 minutes.

Prerequisites
None.

Recommendation
Knowledge of software technology and software architectures is helpful.

T 5.188 Course: Softwaretest and Quality Management (SQM) [T-INFO-114263]

Responsible: Prof. Dr.-Ing. Ina Schaefer
Organisation: KIT Department of Informatics
Part of: M-INFO-107239 - Software Test and Quality Management (SQM)

Type	Credits	Grading scale	Recurrence	Version
Written examination	5	Grade to a third	Each winter term	1

Exams			
ST 2025	7500180	Software Test and Quality Management (SQM)	Schaefer

Competence Certificate
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 90 minutes.

Prerequisites
None.

Annotation
At the end of the course there is also the opportunity to be certified as an "ISTQB - Certified Tester - Foundation Level". A date and the modalities for the exam will be agreed on in the lecture.

5.189 Course: Systems and Software Engineering [T-ETIT-100675]

Responsible: Prof. Dr.-Ing. Eric Sax
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100537 - Systems and Software Engineering

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

Events					
WT 24/25	2311605	Systems and Software Engineering	2 SWS	Lecture /	Sax
WT 24/25	2311607	Tutoral for 2311605 Systems and Software Engineering	1 SWS	Practice /	Nägele
Exams					
WT 24/25	7311605	Systems and Software Engineering			Sax
ST 2025	7311605	Systems and Software Engineering			Sax

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

Competence Certificate
Written exam, approximately 90 minutes.

Students are given the opportunity to earn a grade bonus through separate task assignments. If the grade of the written exam is between 4.0 and 1.3, the bonus improves the grade by a maximum of one grade level (0.3 or 0.4). The exact criteria for awarding a bonus will be announced at the beginning of the lecture. Bonus points do not expire and remain valid for exams taken at a later date:

The grade is determined by the written exam and the bonus points.

Prerequisites
none

T 5.190 Course: Systems Engineering for Automotive Electronics [T-ETIT-100677]

Responsible: Hon.-Prof. Dr. Jürgen Bortolazzi
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-100462 - Systems Engineering for Automotive Electronics

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

Events					
ST 2025	2311642	Systems Engineering for Automotive Electronics	2 SWS	Lecture / 🖥	Bortolazzi
ST 2025	2311644	Tutorial for 2311642 Systems Engineering for Automotive Electronics	1 SWS	Practice / 🖥	Beck
Exams					
ST 2025	7311642	Systems Engineering for Automotive Electronics			Bortolazzi

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

Prerequisites
none

T 5.191 Course: Telematics [T-INFO-114269]

Responsible: Prof. Dr. Martina Zitterbart
Organisation: KIT Department of Informatics
Part of: M-INFO-107243 - Telematics

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

Exams			
ST 2025	7500115	Telematics	Zitterbart

Competence Certificate

The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 90 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.

- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO ***or***

- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO

takes place.

Prerequisites

None.

Recommendation

- Contents of the lecture ***Introduction to computer networks***or comparable lectures are a prerequisite.
- Attendance of the module-accompanying ***basic practical course Protocol Engineering*** is recommended.

T 5.192 Course: Testing Digital Systems I [T-INFO-101388]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-100851 - Testing Digital Systems I

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Knowledge of Digital Design and Computer Architecture is helpful.

5.193 Course: Testing Digital Systems II [T-INFO-105936]

Responsible: Prof. Dr. Mehdi Baradaran Tahoori
Organisation: KIT Department of Informatics
Part of: M-INFO-102962 - Testing Digital Systems II

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

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

Recommendation
Knowledge of Digital Design and Computer Architecture is helpful.

T 5.194 Course: Text-Indexing [T-INFO-114226]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-107202 - Text Indexing

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 (generally 15 minutes) according to § 4 Abs. 2 Nr. 2 SPO.

The examination takes place in the form of an oral examination and a project/experiment as an examination of success of a different kind.

Weighting: 80% oral examination, 20% project/experiment. An overall grade is awarded.

Prerequisites
None.

Recommendation
The lecture builds on parts of the contents of the lectures Algorithms I and Algorithms II. Corresponding knowledge is therefore helpful.

T 5.195 Course: Text-Indexing Project/Experiment [T-INFO-114227]

Responsible: Prof. Dr. Peter Sanders
Organisation: KIT Department of Informatics
Part of: M-INFO-107202 - Text Indexing

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

Competence Certificate
The assessment is carried out in form of course work (German Studienleistung, § 4 Abs. 3 SPO). Students must regularly submit exercise sheets. The number of exercise sheets and the scale for passing will be announced at the beginning of the course. The assessment an only be repeated once.

The examination takes place in the form of an oral examination and a project/experiment as an examination of success of another type.

Weighting: 80% oral examination, 20% project/experiment. An overall grade is awarded.

Prerequisites
None.

Recommendation
The lecture builds on parts of the contents of the lectures Algorithms I and Algorithms II. Corresponding knowledge is therefore helpful.

T 5.196 Course: Timed Systems [T-INFO-112754]

Responsible: Jun.-Prof. Dr. Maike Schwammberger
Organisation: KIT Department of Informatics
Part of: M-INFO-106293 - Timed Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Each summer term	4

Events					
ST 2025	2400146	Timed Systems	4 SWS	Lecture	Schwammberger, Hamarneh

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Depending on the number of participants, it will be announced six weeks before the examination (Section 6 (3) SPO) whether the assessment will take the form of an oral examination of approx.

- in the form of an oral examination of approx. 30 minutes in accordance with § 4 Para. 2 No. 2 SPO or

- in the form of a written examination in accordance with § 4 Para. 2 No. 1 SPO

takes place.

Prerequisites
None.

Recommendation
Basic knowledge in areas of theoretical computer science and modeling of (embedded) software systems is helpful (e.g. temporal logics, finite automata, predicate logic), but is not required.

Annotation
The book "E.-R. Olderog, H. Dierks: Real-Time Systems" is used as reading material for some of the lecture contents (https://doi.org/10.1017/CBO9780511619953).

T 5.197 Course: Ubiquitous Computing [T-INFO-114188]

Responsible: Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-107161 - Ubiquitous Computing

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	1

Competence Certificate
The assessment is carried out as an oral examination (§ 4 Abs. 2 Nr. 2 SPO) lasting 20 minutes.

Prerequisites
None.

T 5.198 Course: Wearable Robotic Technologies [T-INFO-114145]

Responsible: Prof. Dr.-Ing. Tamim Asfour
Prof. Dr.-Ing. Michael Beigl
Organisation: KIT Department of Informatics
Part of: M-INFO-107113 - Wearable Robotic Technologies

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

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

Prerequisites
Attending the lecture Mechano-Informatics and Robotics is recommended.

Recommendation
Attending the lecture Mechano-Informatics and Robotics is recommended.