Hochschule Karlsruhe

Faculty for Computer Science and Business Information Systems

Module manual

Course of studies Computer Science (Bachelor), ER 8

Summer semester 2025

Module Computer Science (Bachelor), ER 8

Module Computer Science 1	
Internal number	INFB110
Coordinator	Prof. Dr. Carsten Sinz
Scope	12.0 ECTS points, 10.0 Contact hours
Placement	1st Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	none
Competences	The courses in this module provide fundamental knowledge of programming and theoretical computer science, which are essential skills for every computer scientist. Students acquire basic concepts of object-oriented programming, such as modeling, selecting and creating data structures, implementation, and quality assurance. They also develop essential problem-solving skills by analyzing problems and solving them using programs. In theoretical computer science, fundamental concepts such as formal languages, propositional logic, and formal mathematical automaton models are introduced. They are motivated by their relevance to practical applications in computer science.
Exams	Written Exam 120 Min. (graded)

Lecture Computer Science 1	
Internal number	INFB111.a
Lecturer	Prof. Dr. Carsten Sinz
Scope	4.5 ECTS points, 4.0 Contact hours 135 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	Students in this course will learn the fundamentals of object-oriented programming using the Java programming language. They will become familiar with basic programming constructs such as variables, types, expressions, control structures, and arrays, enabling them to solve simple problems. Additionally, participants will acquire initial knowledge of object-oriented design and will be introduced to fundamental concepts of object-oriented programming, such as methods, classes, objects, and fields, which they will apply in small programs. Problem-solving paradigms such as divide-and-conquer will be introduced, along with their practical implementation using recursive programs. Besides arrays, students will also become familiar with fundamental data structures such as lists and their implementation, enabling them to use these structures for problem-solving. Furthermore, participants will be introduced to more advanced object-oriented programming concepts, including inheritance, interfaces, information hiding, generic programming, and polymorphism.
Recommended reading	1. Board notes, slides 2. Exercises with solutions 3. Collection of past exams and their solutions 4. Java programs and their documentation as Javadoc 5. Additional Java exercises with solutions for further practice 6. Peter Pepper, "Learning to Program: A Fundamental Introduction with Java", Springer Verlag, 3rd edition, 2007.
Exams	Module exam
Comments	

Lecture Theoretical Computer Science 1

Internal number	INFB111.b
Lecturer	Prof. Dr. Heiko Körner
Scope	4.5 ECTS points, 4.0 Contact hours 135 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	This course gives an introduction to the theory of formal languages. The Chomsky hierarchy will serve as a model to classify these languages by their computational complexity. Modern computers are represented by finite state automatons, showing theier principal limits. The students also learn how to apply several proof techniques. The lecture include the following areas of theoretical computer science: mathematical logic, formal languages, proof techniques, the O-calculus, finite automata, regular languages and expressions, the Chomsky hierarchy, the pumping lemma for regular and context-free languages and the minimization of finite automata by the theorem of Myhill-Nerode. Furthermore, the course covers pushdown automata, the CYK algorithm and closure properties of regular and context-free languages.

Recommended reading	- Discussion at the blackboard - Lecture notes - Sample solutions for all exercises - D. W. Hoffmann: Theoretical Computer Science, 5th edition. Hanser, 2022 - M. Sipser: Introduction to the Theory of Computation, 3rd edition. Cengage Learning, Inc, 2012
Exams	Module exam
Comments	This course will take place as a pure lecture. Numerous exercises deepen selected areas and will be discussed in tutorials.
Lecture Computer Science 1 Laboratory	
Internal number	INFB112
Lecturer	Prof. Dr. Carsten Sinz
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	In weekly exercises, students deepen their understanding of the practical content covered in the lectures. Initially, they use terminal commands, but later transition to a professional, integrated Java development environment to create, debug, test, and modify programs. Starting with simple calculations in Java using variables, expressions, and control structures, the assignments gradually become more complex, incorporating basic data modeling tasks. By the end, students will have programmed simple games and implemented solutions of mathematical problems, e.g., using approximation methods. In addition to ensuring the correctness and functionality of their programs, students also learn to follow good programming practices and adhere to coding conventions — an essential skill for future work in teams.
Recommended reading	
Exams	Exercise 1 Semester (not graded)
Comments	

Module Computer Engineering 1	
Internal number	INFB120
Coordinator	Prof. Dr. Dirk Hoffmann
Scope	6.0 ECTS points, 4.0 Contact hours
Placement	1st Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	none
Competences	Students learn the basic concepts of computer engineering. They acquire the mathematical concepts of number representation and Boolean algebra, which are necessary for the analysis and design of hardware circuits. They learn how the common basic elements of digital technology are constructed and how these can be combined into complex combinational and sequential circuits. Furthermore, students will be able to explain the structure and functioning of common standard circuits, such as adders or shift registers. They will understand the basic concepts of the instruction set architecture of a processor and will be able to create simple assembly programs for a rudimentary model processor.
Exams	Individual exams
Lecture Computer Engineering 1	
Internal number	INFB121
Lecturer	Prof. Dr. Dirk Hoffmann
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Students acquire basic knowledge in the field of logic and circuit design. They learn how the functionality of a computer can be broken down into elementary operations, which are then physically realized in the form of logic gates. Students recognize how the desired functional components are designed from these, which require a minimum number of gates. This lays the foundation for corresponding CAE systems. The following topics are covered in detail: basic functioning of a computer; knowledge of the basic logical circuit blocks; technologies for realizing the basic components; knowledge of the most important electrical parameters; number and character representation in different codes; basics of Boolean algebra; methods of simplifying Boolean expressions; use of CAE software; designing combinational circuits; designing sequential circuits; designing synchronous circuits; flip-flops; counters and registers.
Recommended reading	Slides, blackboard, exercise sheets
Exams	Written Exam 90 Min. (graded)

Comments	Lecture
Lecture Computer Engineering 1 Laboratory	
Internal number	INFB122
Lecturer	Dipl.-Inform. (FH) Rolf Betz
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	Alongside the lecture, students work through several exercises. The tasks come from the areas of number representation, Boolean algebra, circuit design and minimization, standard circuits and microcomputer architecture.
Recommended reading	Exercise sheets, blackbord
Exams	Exercise 1 Semester (not graded)
Comments	In-class exercises

Module Mathematics 1	
Internal number	INFB130
Coordinator	Prof. Dr.-Ing. Astrid Laubenheimer
Scope	8.0 ECTS points, 6.0 Contact hours
Placement	1st Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	none
Competences	Participants learn the mathematical basics from linear algebra, which are often used in computer science. These basics are specifially needed in computer graphics, robotic, cryptography.
Exams	Individual exams
Lecture Mathematics 1	
Internal number	INFB131
Lecturer	M.Sc. Martin Redlof
Scope	5.0 ECTS points, 4.0 Contact hours 150 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	he participants should learn basic knowledge of mathematics and especially of linear algebra and acquire the methods to solve smaller mathematical tasks by themselves. In the part on linear algebra we will focus on knowledge needed in computer grafic and 3D simulations. Content of the lectures: Proof methods, relations, euqivalence relations, modulo-calculation, Euklid's algorithm, functions, operations, groups, rings, fields, polynomial rings, finite fields, interpolation, vector spaces, basis, dimension, linear equations, rank, Gauß-Jordan-algorithm, determinant, matrices, linear map, inverse matrices, rotation, translation, scaling, scalarproduct, norm, vectorproduct, orthogonal matrizen, eigenvalues, eigenvectors, homogeneous coordinates.
Recommended reading	Own writings from the blackboard, Exercises and summaries from the internet, Tutorials given by students, Textbook: Peter Stingl: Mathematik für Fachhochschulen, Hanser Verlag, 8. Auflage, 2009, ISBN-10: 3-446-42065-7
Exams	Written Exam 90 Min. (graded)
Comments	Lecture, Exercises, Summary of the solutions in the lecture, Tutorials for further assistance
Lecture Mathematics 1 Laboratory	
Internal number	INFB132
Lecturer	M.Sc. Martin Redlof

Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German
Content	Improving the knowledge of the related lectures, basics in computer-algebra systems, mathematical problem solving with computer assistance. With the help of the computer algebra system Maple different, applied mathematical questions from the fields of geometry, curves, interpolation and linear equations will be solved. Additionally we will look at functions, which can be represented by matrices.
Recommended reading	Short introduction will be given. Exercises distributed in the classes and also available on the internet.
Exams	Exercise 1 Semester (not graded)
Comments	Exercises in the labs with Maple (instructor will be present).

Module Language Competence	
Internal number	INFB140
Coordinator	Prof. Dr.-Ing. Holger Vogelsang
Scope	4.0 ECTS points, 4.0 Contact hours
Placement	1st Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	none
Competences	The learning of a foreign language is an integral component of the in the course of studies communicated key qualification.
Exams	Individual exams
Lecture English	
Internal number	INFB141
Lecturer	Mehrere Dozenten
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	English
Content	After a grading test students can deepen their English skills to three grades. The entry level requires the competence grade A2 (basic user) in the six-stage common European reference framework. The first two grades (English for advanced learners 1 and 2) engage besides a recapitulation of grammar mainly in issues of job-oriented common language and cultural studies, e.g. job application letters, descriptions of products and services, business telephone calls, progress of formal and informal conferences, presentations etc. The thus achieved grade complies with 173 points in the TOEFL (computer-based) or the competence grade B2 (independent user) of the European reference framework. In the following grade special language skills (English for science and technics) are leant: In business English the priority is on spoken language and small study groups. At the beginning of the semester each group founds its own company which advances dynamically during the course of the semester. At the same time vocabulary and phrasing in respect of topics like company structures, meetings, negotiation, marketing, production and sale, finances, comprehending of reports and presentations are gone through in order to make the attendees handle the language instruments to cope with each step of the simulation in English. The highlights of the course are a simulated exhibition, a hiring procedure and the group presentation. In technical English the priority is on the learning and practice of a technical basis vocabulary and typical expressions of technical communication.
Recommended reading	Literature depends on grade, PowerPoint presentations, execises, Videos, DVDs

Exams	Written Exam 90 Min. (graded)
Comments	Lecture participation, short talks, discussions

Module Computer Science 2	
Internal number	INFB210
Coordinator	Prof. Dr. Christian Pape
Scope	10.0 ECTS points, 8.0 Contact hours
Placement	2nd Semester
Pre-requisites with regard to content	Computer Science 1
Pre-requisites according to the examination regulations	none
Competences	The students learn about basic algorithms and data structures. They can estimate in which situations specific and complex data types are used, how they work and how much time they take. They are able to prove the correctness of algorithms. In practical assignments the students are enabled to implement various algorithms and data structures.
Exams	Written Exam 90 Min. (graded)

Lecture Computer Science 2	
Internal number	INFB211
Lecturer	Prof. Dr. Christian Pape
Scope	5.0 ECTS points, 4.0 Contact hours 150 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The lecture is divided into several parts building on one another: 1. In the first part, students learn to precisely define algorithmic problems, writing algorithms for in pseudocode, estimating the resource consumption of an algorithm and proving its correctness. 2. Building on this, students learn search and sorting methods, apply the skills acquired in the first part to them and are able to select a suitable method for a problem.They learn the lower bound of this problem and how to prove it. 3. In the third part, they acquire detailed knowledge of the structure and implementation of operations of elementary data structures such as queues, lists and binary trees. The students learn typical application examples for these data structures. 4. The fourth part of the lecture focuses on advanced data structures and the associated algorithms, such as hash tables and binary search trees. They learn how search trees can be balanced. 5. In the final part, the lecture deals with the basics of graphs. The students can apply different representations, such as adjacency matrices and adjacency lists. They learn basic algorithms, such as shortest path search, union find and the calculation of minimum spanning trees to real problems.

Recommended reading	- Lecture notes. - Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein: Introduction to Algorithms. Third Edition. MIT Press. - Robert Sedgewick: Algorithms in Java. Addison Wesley. Third Edition.
Exams	Module exam
Comments	Weekly exercises for reviewing lecture content and for exam preparation. Simple tasks in the lecture.

Lecture Theoretical Computer Science 2

Internal number	INFB212
Lecturer	Prof. Dr. Heiko Körner
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The course deals with the computational limits of modern computer systems, showing the undecidability and intractability of important problems. Several computational conceps like Turing machines and WHILE-programs are presented. Other topics include the Church-Turing thesis, the theory of NP-completeness and zero-knowledge-proofs. For this course some basics concerning theoretical computer science are required (regular languages, finite automata, O-calculus, etc.). This knowledge can be purchased in the lecture Theoretical Computer Science I.
Recommended reading	- Discussion at the blackboard - Lecture notes - Sample solutions for all exercises - D. W. Hoffmann: Theoretical Computer Science, 5th edition. Hanser, 2022 - M. Sipser: Introduction to the Theory of Computation, 3rd edition. Cengage Learning, Inc, 2012
Exams	Module exam
Comments	This course will take place as a pure lecture. Numerous exercises deepen selected areas and will be discussed in tutorials.

Lecture Computer Science 2 Laboratory

Internal number	INFB213
Lecturer	Prof. Dr. Christian Pape
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	The students deepen the knowledge acquired in the lecture by implementing and testing selected algorithms in Java. They use standard development environments. The algorithms and data structures to be implemented are used culminating in a final task.

Recommended reading	Assignements and basic source code.
Exams	Exercise 1 Semester (not graded)
Comments	Practical exercise with discussion of solutions

Module Software Laboratory	
Internal number	INFB220
Coordinator	Prof. Dr. Martin Sulzmann
Scope	6.0 ECTS points, 4.0 Contact hours
Placement	2nd Semester
Pre-requisites with regard to content	Computer Science 1
Pre-requisites according to the examination regulations	none
Competences	This course covers programming languages that belong to the C/C++ family of languages including new forms such as Go and Rust. After this course, students will be able to code in C/C++, are able to understand the commonalities and differences to Java and have an understanding of the latest developments such as C++20 plus new forms such as Go and Rust. Lectures introduce concepts via some live coding followed by some lab sessions where students work on smaller practical exercises. Several (online) quizzes allow students to test their knowledge. Content. C/C++ basics. - Functions and basic data types - Pointers and the pitfalls of manual memory management - IO streams and overloading - Subclassing and virtual methods - Templates - C++11 copy/move semantics. Recent extensions and new directions. - C++20 - Go - Rust Written final exam, closed book. Exam questions refer to practical exercises that are covered in the lab.
Exams	Individual exams

Lecture Software Project	
Internal number	INFB221
Lecturer	Prof. Dr. Martin Sulzmann
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.

Type/mode	Lecture
Language of instruction	German
Content	The students implement projects with an increasing complexity in C++. They have to use generic classes, inheritance, polymorphism, abstract classes and interfaces and concepts for error handling and detection like exceptions and assertions. Additionally they will learn to use elements of the STL and to model the classes and their relationships with UML.
Recommended reading	On the homepage: Project description with a step-by-step instruction, Java script, optional exercise with solutions, books: - Ulrich Breymann, C++ - Einführung und professionelle Programmierung, Hanser-Verlag
Exams	Written Exam 90 Min. (graded)
Comments	Laboratory work in small groups
Lecture Software Project Laboratory	
Internal number	INFB222
Lecturers	Dipl. Inf. (FH) Oktavian Gniot Prof. Dr. Martin Sulzmann
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	
Recommended reading	
Exams	Exercise 1 Semester (not graded)
Comments	

Module Computer Engineering 2	
Internal number	INFB230
Coordinator	Prof. Dr. Christian Langen
Scope	6.0 ECTS points, 4.0 Contact hours
Placement	2nd Semester
Pre-requisites with regard to content	Computer Engineering 1
Pre-requisites according to the examination regulations	none
Competences	The students are familiar with the foundations required for design of embedded systems. This includes computer aided hardware design techniques and an introduction into the hardware design lanquage VHDL. Additionally, students are familiarized with internal functions of various processors and peripherals. All knowledge gained will be reinforced by practical work in the laboratory.
Exams	Individual exams
Lecture Computer Engineering 2	
Internal number	INFB231
Lecturer	Prof. Dr. Christian Langen
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The lecture will provide an overview of programmable logic. This will be followed by a description of the basic modular devices that comprise programmable logic. The students will particapate in an exercise which exposes them to the CAD for programmable logic. An introduction to the design language VHDL will be given. This will be expanded to provide background in parallel and sequential description modes used in VHDL. The remaining description modes (processes and structures) will also be discussed. On the processor side, the lecture will cover the following, basic processor hardware, processor architecture, addressing modes, instructions, memory mapping, peripherals and bit processing.
Recommended reading	Powerpoint slide, personal notes, web based exercises and the suggested solution (provided upon request).
Exams	Written Exam 90 Min. (graded)
Comments	The student will be required to come prepared to participate in the lecture and will be expected to be able to develop a summary upon completion of the lecture, all exercises provided for reinforcement will be required to be individual work.
Lecture Computer Engineering 2 Laboratory	
Internal number	INFB232

Lecturer	Prof. Dr. Christian Langen
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German
Content	Lab experiments will be conducted using: - Digital Circuits - Microcontrollers - Peripherals - Timers and Counters
Recommended reading	Exercises, equipment provided and various manuals and other support material.
Exams	Exercise 1 Semester (not graded)
Comments	All laboratory work will be group work. It will include the conduct of the experiment, demonstration of the required result and be prepared to answer questions on the work and the results. Groups are on their own and are required to come to the laboratory prepared to conduct the exercise. Each group will prepare a final documentation of the exercise.

Module Mathematics 2	
Internal number	INFB240
Coordinator	Prof. Dr.-Ing. Astrid Laubenheimer
Scope	8.0 ECTS points, 6.0 Contact hours
Placement	2nd Semester
Pre-requisites with regard to content	Mathematics 1
Pre-requisites according to the examination regulations	none
Competences	
Exams	Written Exam 90 Min. (graded)
Lecture Analysis	
Internal number	INFB241.a
Lecturer	Prof. Dr.-Ing. Astrid Laubenheimer
Scope	5.0 ECTS points, 4.0 Contact hours 150 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Module exam
Comments	
Lecture Statistics	
Internal number	INFB241.b
Lecturer	Prof. Dr. Patrick Baier
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The statistics lecture teaches skills in handling and analyzing empirical data, as well as an introduction to probability theory. Students learn to analyze and model data by seeing common statistical methods and models in action, which will enable them to apply static methods to evaluate data themselves. The contents of the lecture include: - Basic concepts of probability calculation - Probability distributions - Independence from random variables conditional probabilities - Excerpts from descriptive and inferential statistics.
Recommended reading	Teschl G. und Teschl S. Mathematik für Informatiker. Band 1 und Band 2. Springer Verlag. Zum Beispiel 3. Auflage 2010.
Exams	Module exam
Comments	

Module System Software	
Internal number	INFB310
Coordinator	Prof. Dr. Thomas Fuchß
Scope	8.0 ECTS points, 6.0 Contact hours
Placement	3rd Semester
Pre-requisites with regard to content	Computer Science 2, Software Laboratory
Pre-requisites according to the examination regulations	none
Competences	Having successfully completed the module, students will be able to understand and explain the functions and structures of modern operating systems and how they are embedded in various computer architectures. They will be able to use system-related knowledge to design, develop and implement performant software solutions. In addition, they are able to organize, collaborate on and successfully complete complex programming tasks in a team. They have further developed their technical, social and personal skills as well as their communication skills and self-management.
Exams	Individual exams
Lecture System Software	
Internal number	INFB311
Lecturer	Prof. Dr. Thomas Fuchß
Scope	5.0 ECTS points, 4.0 Contact hours 150 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The course "System Software" covers the fundamental tasks and functionalities of modern operating systems and enables students to apply these techniques independently and systematically in teams to solve system-level development tasks. The course is divided into four main thematic areas: Fundamentals, Process Management, and Scheduling: - Understanding the relationship between computer architecture and operating systems. - Principles of processor virtualization and limited direct execution. - Scheduling algorithms (e.g., Round-Robin, Shortes-Job-First). File Systems and Persistence: - Requirements and differences in HDDs and SSDs. - Structure and implementation of file systems. - Concepts of free-space management and crash consistency. Memory Virtualization: - Principles of memory segmentation and paging. - Management of page frames and allocation strategies. - Mechanisms for isolation and memory management. Concurrency: Processes and Threads: - Introduction to threads. - Synchronization mechanisms: Mutexes, semaphores, condition variables, monitors. - Patterns for parallel and concurrent programming. In addition, the specific challenges of each topic are discussed, along with common strategies for addressing them. Practical exercises complement the lectures to facilitate the application of theoretical concepts to realistic scenarios.
Recommended reading	Slides, videos, textbooks, and other literature: - Arpaci-Dusseau, Remzi H.; Arpaci-Dusseau, Andrea C. Operating Systems: Three Easy Pieces, (V. 1.10) Arpaci-Dusseau Books, 2023 - Tanenbaum, Andrew S.; Bos, H. Modern Operating Systems (4th Edition) – Pearson, 2014 - Stallings, W. Operating Systems: Internals and Design Principles (8th Edition) – Pearson, 2014
Exams	Written Exam 90 Min. (graded)
Comments	The lecture will take the form of seminars with exercises.

Lecture System Software Laboratory

Internal number	INFB312
Lecturer	Prof. Dr. Carsten Sinz
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German

Content	In the lab, small groups (typically three people) work on multiple tasks related to system-level programming in C and C++. The goal is to familiarize students with the interfaces to the Linux operating system and learn how to practically utilize the functionalities they provide. Topics covered include file systems, processes, communication, memory management, linked data structures, and bit manipulation. The specific tasks for each exercise vary, encompassing, e.g., accelerating (parallelizing) an existing ray tracer using multiple processes, processing image files to produce mosaics, developing a broadcast server for song lyrics, or compressing image data using run-length encoding. The implementations in C and C++ deepen students' skills in working with system libraries, dynamic data structures, bit operations, memory management, and pointers. In addition to the main problem, each task includes several preliminary smaller exercises that guide students toward the final solution.
Recommended reading	Introductory slides on the topic of each exercise. In-depth information on the exercise sheets.
Exams	Laboratory Work 1 Semester (not graded)
Comments	

Module Databases and Communication Networks 1	
Internal number	INFB320
Coordinator	Prof. Dr. Oliver Waldhorst
Scope	8.0 ECTS points, 7.0 Contact hours
Placement	3rd Semester
Pre-requisites with regard to content	Computer Science 1, Computer Science 2
Pre-requisites according to the examination regulations	none
Competences	The module teaches the basics and practical skills in database systems and communication networks. Competence objectives in the field of databases: - Students can model, normalize and implement relational databases. - They are proficient in SQL (DDL, DML, DCL), transaction management, JDBC and OR mapping (Hibernate). - They develop database applications independently and integrate them into programming languages such as Java. - Teamwork and problem-solving skills are encouraged through practice-oriented projects. Competence goals in the area of communication networks: - Students understand the architecture and functionality of networks and analyze protocols such as HTTP, TCP, UDP, IPv4/IPv6. - They plan, configure and evaluate networks, including routing and subnetting. - They implement protocol functions and use tools for network analysis and fault diagnosis. - They are able to analyze and evaluate network performance indicators. The module promotes analytical thinking, practical problem-solving skills and teamwork and provides a foundation for topics such as network security and distributed systems.
Exams	Written Exam 120 Min. (graded)
Lecture Databases 1	
Internal number	INFB321.a
Lecturer	Prof. Dr.-Ing. Holger Vogelsang
Scope	2.5 ECTS points, 2.0 Contact hours 75 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The lecture covers the following topics: - Introduction to information systems - Basics of database systems - Database organization - Data models - Database schema - Architecture: 3-tier model, client-server architecture - Current SQL standard (queries, DDL, DML, in particular SQL:2003 with object-oriented extensions, NF2, window functions) - Transactions - JDBC - ER modeling - Mapping entities and relationships to relational data models - Normalization - OR mapping
Recommended reading	- Script - Example databases of the lecture for the common database systems - Exercises - Sample programs - Collection of old exams and their solutions - Edwin Schicker, "Datenbanken und SQL", Springer Vieweg, 2017, ISBN: 978-3834817327 - Gunter Saake, Kai-Uwe Sattler, "Datenbanken - Konzepte und Sprachen", mitp, 2013, ISBN: 978-3286694530
Exams	Module exam
Comments	

Lecture Communication Networks 1

Internal number	INFB321.b
Lecturer	Prof. Dr. Oliver Waldhorst
Scope	2.5 ECTS points, 2.0 Contact hours 75 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	In this course, students expand their knowledge of communication networks, in particular by taking an in-depth look at the functionalities and challenges of the layers of the Internet protocol stack. After completing the course, they will be able to analyze, evaluate and practically apply advanced mechanisms and protocols in the application layer, transport layer, network layer and security layer. They will be able to identify complex network problems, combine specific solution modules and develop innovative solutions. The lecture covers the following topics: - Transmission of multimedia content in the application layer, e.g. Netflix and Skype, as well as the basics of secure communication such as TLS and secure email. - Transport layer mechanisms, including extensions to TCP such as SACK and CUBIC, as well as new protocols such as QUIC. - Network layer with addressing and routing concepts, including IPv6, Software Defined Networking (SDN) and IPsec. - Data link layer with a focus on VLANs, MPLS and data center networks. The lecture is taught in a flipped classroom format. Students prepare for the classroom sessions independently using lecture slides and explanatory videos. In these sessions, the topics are explored in greater depth through case studies and exercises. Online tests offer students the opportunity for self-assessment and to collect bonus points for the exam. The examination consists of a 60-minute written exam, which is part of the module exam "Databases and Communication Networks 2". The total workload is 75 hours, divided into 25 hours of attendance time, 25 hours of asynchronous learning and 25 hours for exam preparation and follow-up.
Recommended reading	- Slide collection and explanatory videos in the ILIAS system - James Kurose, Keith Ross: Computer Networking - A Top-Down Approach, 8th edition, Pearson, 2021 - Various Internet standards, see https://www.rfc-editor.org - Further information in the lecture
Exams	Module exam
Comments	

Lecture Databases 1 Laboratory

Internal number	INFB322
Lecturers	Prof. Dr.-Ing. Holger Vogelsang M.Sc. Amir Bukhari
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German

Content	The knowledge learned in "Databases 1" is deepened and practiced in group work. The interaction of a database with a higher programming language (Java) is understood. The use of SQL (DCL; DML; DDL), transactions and isolation levels and the avoidance of deadlocks is mastered. A database application for warehouse management will be designed and prototypically implemented. This includes the setup of a DB schema, the design and testing of SQL queries, the use of transactions and transaction levels as well as the programming of queries and transactions with Java using JDBC based on Oracle (the preparation for the laboratory should be done in PostgreSQL or MySQL). Finally, several given verbal facts are analyzed, transferred to an Entity Relationship model, normalized, transferred to a physical schema and finally created in SQL. Finally, the handling of the OR mapper Hibernate is practiced.
Recommended reading	- Script - Sample databases - Programming framework - Edwin Schicker, "Datenbanken und SQL", Springer Vieweg, 2017, ISBN: 978-3834817327 - Gunter Saake, Kai-Uwe Sattler, "Datenbanken - Konzepte und Sprachen", mitp, 2013, ISBN: 978-3286694530
Exams	Exercise 1 Semester (not graded)
Comments	Supervised laboratory with final presentation on the computer, independent work, preparation for follow-up, writing a laboratory report on the tasks.
Lecture Communication Networks 1 Laboratory	
Internal number	INFB323
Lecturer	Prof. Dr. Oliver Waldhorst
Scope	1.0 ECTS points, 1.0 Contact hours 30 Stunden gesamt, davon 15 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German

Content	In the lab, students apply practical knowledge and skills to consolidate the content of the lecture of the same name. After completing the lab, they will be able to analyze, configure and programmatically implement network protocols in various layers and measure and evaluate the performance of network applications. After successful participation, students will be able to: - explain the functionality of application layer protocols (e.g. SMTP, POP3) and implement them through programming. - implement and evaluate transport layer mechanisms (e.g. stop-and-wait protocol) in unreliable networks. - Plan, configure and analyze networks and subnets, including addressing and routing. - use tools for network analysis and diagnostics (e.g. iperf3, cpunetlog) to measure performance and interpret the results. The laboratory includes the following experiments, which are carried out in teams of 2-4 people: - Experiment 1: Application layer: Configuration and programming of e-mail services (SMTP, POP3) with tools such as Postfix, Dovecot and Java Mail API. - Experiment 2: Transport layer: Implementation of a reliable data transmission protocol based on UDP. Simulation of a faulty communication medium and use of the stop-and-wait protocol. - Experiment 3: Network layer: Network planning and configuration with Mininet, including routing, subnetting and the use of tools such as ping, traceroute and ifconfig. - Experiment 4: Performance measurement: Analysis of network performance in simulated environments with iperf3 and cpunetlog. Investigation of data streams and CPU utilization. The experiments are carried out in a virtual environment as group work. The students document their results and present them at the end. The examination consists of the successful completion of the four laboratory experiments and the presentation of the results. The workload is 30 hours, including 15 hours of attendance time and 15 hours of independent preparation and follow-up work.
Recommended reading	- Collection of slides and explanatory videos on the experiments in the ILIAS system - Documents for the lecture "Communication Networks 1"
Exams	Laboratory Work 1 Semester (not graded)
Comments	

Module Man-Machine-Communication	
Internal number	INFB330
Coordinator	Prof. Dr. Christian Zirpins
Scope	8.0 ECTS points, 6.0 Contact hours
Placement	3rd Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	none
Competences	Students acquire comprehensive knowledge of techniques and concepts in distributed systems, particularly in the context of web applications. They understand the general architecture of the Internet and the Web and are able to analyze the requirements of web applications accurately. They can develop interactive web applications using HTML, CSS, and client-side JavaScript, as well as implement server-side code for application services, including authentication, cookies, and session management. In addition, they are able to identify potential security issues such as cross-site scripting and SQL injection and implement appropriate protective measures. These skills enable students to design, develop, and operate complex and secure web applications effectively. Furthermore, students acquire competencies in designing user-friendly interfaces. They are familiar with the requirements of software ergonomics and the principles of usability in context, as well as with a user-centered design process. This process is reinforced through practical exercises and project work. They are capable of evaluating the usability of a product through tests and surveys, critically analyzing the results, and implementing targeted improvements. They understand the relevance and content of style guides and typographic design principles and apply them systematically in their design processes. Through teamwork in project groups, students also develop discursive skills that foster effective collaboration and professional communication throughout the development process.
Exams	Individual exams
Lecture Distributed Systems 1	
Internal number	INFB331
Lecturer	Prof. Dr. Christian Zirpins
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The course provides a practical introduction to the concepts and paradigms of distributed systems using the example of web technologies and application development on the web. This initially involves an introduction of the world wide web with basic protocols such as HTTP and other standards in the context of the Internet. After that an introduction to the design and construction of web applications is provided. This includes firstly the frontend development with HTML5, CSS3 as well as client-side JavaScript and secondly the backend development with server-side JavaScript on the Node.js platform. Interactions between frontend and backend follow modern REST/HTTP and AJAX techniques. In addition, mechanisms for personalization with cookies and sessions as well as to authenticate users are presented. The course closes with a detailed discussion of web application security. Upon completing this lecture class, students will acquire practical skills in the development and deployment of web applications, grounded in an understanding of distributed systems and web technologies. They will learn to proficiently use HTML5, CSS3, and JavaScript for frontend development, alongside server-side development with Node.js, enhancing their ability to create dynamic, full-stack web applications. Additionally, students will gain knowledge in implementing modern REST/HTTP and AJAX techniques for efficient frontend-backend communication, as well as in employing cookies, sessions, and authentication strategies for personalizing user experiences and ensuring application security. This comprehensive skill set will prepare students for a wide range of roles in web development and application design, equipping them with the necessary tools to address current and future challenges in the field.
Recommended reading	- Semmy Purewal, "Learning Web App Development", O'Reilly, 1. Auflage, 2014 - David Gourley, Brian Totty, "HTTP: The Definite Guide", O'Reilly, 2002 - Mark Pilgrim, "HTML5 Up and Running", O'Reilly, 2010 (Online: http://diveintohtml5.info) - Marijn Haverbeke, "Eloquent JavaScrip", No Starch Press, 2014 (Online: http://eloquentjavascript.net) - Peter Gasston, "The Book of CSS3 - A Developer's Guide to the Future of Web Design", 2nd Edition, No Starch Press, 2014 - Andy Budd, Emil Björklund, "CSS Mastery", Third Edition, Apress, 2016 (Online verfügbar im Hochschulnetz) - Ethan Brown, "Web development with Node and Express", O'Reilly, 2014 - Robert Prediger ; Ralph Winzinger, "Node.js : Professionell hochperformante Software entwickeln", Hanser, 2015 (Online verfügbar im Hochschulnetz) - Additional literature will be announced during the lecture
Exams	Written Exam 60 Min. (graded)
Comments	In preparation for individual lecture units, the self-study of basic content is required by means of the accompanying literature (relevant chapters will be announced in the event). Further independent work concerns the follow-up of the lecture contents and the exam preparation.
Lecture Distributed Systems 1 Laboratory	
Internal number	INFB332

Lecturer	Prof. Dr. Christian Zirpins
Scope	2.0 ECTS points, 1.0 Contact hours 60 Stunden gesamt, davon 15 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German
Content	
Recommended reading	
Exams	Laboratory Work 1 Semester (not graded)
Comments	

Lecture Man-Machine-Communication Design

Internal number	INFB333
Lecturer	M.A. Daniel Hepperle
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	- "GUI Design Essentials " von Susan Weinschenk, Pamela Jamar, Sarah C. Yeo, Verlag John Wiley & Sons, 1997, ISBN: 0471175498
Exams	Written/verbal Exam 90/20 Min. (graded)
Comments	

Lecture Man-Machine-Communication Design Laboratory

Internal number	INFB334
Lecturer	B.Sc. Valeria Zitz
Scope	2.0 ECTS points, 1.0 Contact hours 60 Stunden gesamt, davon 15 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	An MMC-task which is standard practice is designed starting from task analysis up to the paper prototype. This prototype is subject - possibly over several iterations - of a usability test until the specified quality targets are reached.
Recommended reading	Script, eye-tracker and user monitoring space in the Usability Lab Textbooks: - "GUI Design Essentials " von Susan Weinschenk, Pamela Jamar, Sarah C. Yeo, Verlag John Wiley & Sons, 1997, ISBN: 0471175498
Exams	Homework 1 Semester (not graded)
Comments	Supervised group work with presentation and discussion; test the usability of the prototype, prepare a test report with proposals for improvements.

Module Business Administration and Service Management	
Internal number	INFB340
Coordinator	Prof. Dr. Uwe Haneke
Scope	6.0 ECTS points, 6.0 Contact hours
Placement	3rd Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	none
Competences	Students are introduced to the fundamental concepts of general business administration and service management. They learn about economic processes and interrelationships and are able to identify and outline the various areas of business administration and service management. Using different tools and concepts, students can describe and analyze a company's situation. In addition, students are equipped to independently calculate and analyze key performance indicators that provide insights into a company's efficiency and performance. This module serves as a foundation for the subjects ERP systems, project management, business process management, and business intelligence.
Exams	Written Exam 120 Min. (graded)

Lecture Business Administration	
Internal number	INFB341
Lecturer	Prof. Dr. Uwe Haneke
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Students are introduced to the fundamental concepts of general business administration. They learn about economic processes and interrelationships and become familiar with typical processes and requirements within companies. They are able to identify and outline the various areas of business administration. Using diferent tools and concepts, students can describe and analyze a company's situation. In addition, students are equipped to independently calculate and analyze key performance indicators that provide insights into a company's efficiency and effectiveness. In the Business Administration lecture, topics such as the economic environment (economics), business structures, organization, investment and financing, marketing, and accounting are covered in depth. This enables students to gain a comprehensive understanding of how a company operates and the resulting requirements.

Recommended reading	- Slides - Case studies - Exercises
Exams	Module exam
Comments	
Lecture IT Service Management	
Internal number	INFB342
Lecturer	Prof. Dr. rer. pol. Mathias Philipp
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The lecture covers the core processes of IT service management as well as methods for systematic planning, provision and support of IT services. For each process, the objectives, tasks, demarcation, mode of operation and the dependencies on the other processes are worked out. The students thus acquire the competence to know the relevant technical terms and to apply them in practical situations. The necessary roles and responsibilities are learned. The students understand how IT processes are represented in reference models. The lecture is based on the IT Infrastructure Library (ITIL), which is a generally accepted standard for the structure and operation of IT organizations.
Recommended reading	Lecture material as PowerPoint slides Blackboard notes for interactive development of core problems Numerous multiple-choice questions on each process in ILIAS
Exams	Module exam
Comments	

Module Internship Preparation and Roundup	
Internal number	INFB4P0
Coordinator	Prof. Dr. Heiko Körner
Scope	6.0 ECTS points, 4.0 Contact hours
Placement	4th Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	Vorstudium
Competences	After completing this module, students will be able to handle important work-related skills that are also relevant for the practical semester. They can use the Scrum process model to manage projects and work in corresponding Scrum teams. They master techniques for the professional creation of scientific documents, can prepare data in a targeted manner and visualise their findings in an appealing way using modern presentation tools.
Exams	Individual exams

Lecture Internship Preparation	
Internal number	INFB4P1
Lecturers	Dr. Martin Holzer B.Sc. Veit Richter
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The process of academic writing is presented in its entirety. Individual phases are examined step by step and guidelines for successful implementation are developed. Another focus of the course is a thorough introduction to the use of the LaTeX typesetting system, which is widely used in the academic environment. The students create documents while observing correct citation practices. The second block of the course introduces the Scrum process model using practical examples.
Recommended reading	- Set of lecture slides - Accompanying script for reference - Exercises
Exams	Exercise 1 Week (not graded)
Comments	

Lecture Internship Roundup	
Internal number	INFB4P2
Lecturers	Dipl. WiInf. Lars Thoralf Thielemann Prof. Dr. Heiko Körner

Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	This lecture deals with the general handling of MS Office products and specifically provides an introduction to the most important functionalities of MS Excel. Students learn, for example, how to use input methods, formulae, diagrams and search functions. Basic knowledge of programming under VBA is also taught. These are then used to create macro scripts in MS Word. The focus is on the efficient use of MS Office products. Participating students are then able to quickly solve typical tasks.
Recommended reading	Lecture notes
Exams	Exercise 1 Week (not graded)
Comments	The course consists of a lecture (50%) and supervised practical exercises (50%).

Module Internship	
Internal number	INFB4PX
Coordinator	Prof. Dr. Patrick Baier
Scope	24.0 ECTS points, 0.0 Contact hours
Placement	4th Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	Vorstudium
Competences	The internship is designed to deepen the previously acquired knowledge and skills by qualified collaboration in a larger project. The focus is on improving the technical competence and the development of social and personal skills. The student needs to assert himself as an independent member of the team. He becomes acquainted with new fields of duty and will become familiar with new tools. He learns to evolve himself and to assess his skills. The internship may be pursued in a company, in a research facility or an authority.
Exams	Individual exams
Lecture Internship	
Internal number	INFB4PX
Lecturer	Dr. Patrick Baier
Scope	24.0 ECTS points, 0.0 Contact hours 720 Stunden gesamt, davon 0 Stunden Kontaktstudium.
Type/mode	On-the-job Training
Language of instruction	German
Content	
Recommended reading	
Exams	Hands-on Work 95 Days (not graded)
Comments	

Module Software Engineering and Distributed Systems 2	
Internal number	INFB510
Coordinator	Prof. Dr. Thomas Fuchß
Scope	8.0 ECTS points, 7.0 Contact hours
Placement	5th Semester
Pre-requisites with regard to content	System Software, Databases and Communication Networks 1, Computer Science 2, Man-Machine-Communication
Pre-requisites according to the examination regulations	none
Competences	Having successfully completed the module, students are able to work productively and independently on software projects of various sizes. They will be able to analyze and structure tasks as well as develop solutions independently, justify their decisions and document them in a comprehensible manner. They also explain general concepts of architectures, especially for distributed software systems, and apply them constructively. Students recognize the central requirements and challenges of such systems and develop suitable solutions. They will be able to explain concepts such as modularity, communication, fault tolerance and security and incorporate them constructively into the development of comprehensive software systems. They have further developed their technical, social and personal skills as well as their communication skills and self-management. They have learned to apply these new skills in the context of software projects.
Exams	Written Exam 120 Min. (graded)
Lecture Software Engineering	
Internal number	INFB511.a
Lecturer	Prof. Dr. Thomas Fuchß
Scope	2.5 ECTS points, 2.0 Contact hours 75 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The course "Software Engineering" builds on the practical experience students have gained during their internships and introduces techniques and methods for structured large-scale software development. The lecture begins with a review and consolidation of fundamental concepts such as objects, classes, associations, methods, inheritance, and polymorphism to ensure a solid understanding of the basics. It then focuses on the challenges of modern software development processes and structured approaches to address them effectively. Students learn how to integrate agile methodologies, such as Scrum, with established process models like the Unified Software Development Process to manage complex software projects. UML is introduced as a core modeling language to document development decisions and facilitate clear communication. Particular emphasis is placed on understanding the complexities of large-scale systems and applying structured methods and processes to address these challenges. Throughout the course, students develop the ability to work independently in agile environments, make informed development decisions, and document these decisions methodically. Theoretical concepts are complemented by practical examples that help bridge the gap between theory and real-world applications. In the associated lab, students apply the knowledge gained in the lecture to various example projects. They conduct the first iteration of a software development process, practicing teamwork, the use of agile methods, and professional documentation with UML.

Recommended reading	Slides, videos, textbooks, and other literature: - Arlow, J.; Neustadt, I.: UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design, 2. ed. - Addison-Wesley Professional, 2005. - Shimp, D. and Rawsthorne, D. Exploring Scrum: The Fundamentals – CreateSpace, 2011. - Jacobson, I.; Booch, G. and Rumbaugh, J.: The unified software development process - Reading, Mass.: Addison-Wesley, 1999. - Kim, G.; Humble, J.; Debois, P. und Willis, J.: Das DevOps-Handbuch: Teams, Tools und Infrastrukturen erfolgreich umgestalten - Heidelberg: O'Reilly; Heidelberg: dpunkt.verlag, 2017. - Larman, C.: Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, 3. ed. - Upper Saddle River, NJ : Prentice Hall, 2004. - Larman, C. und Vodde, B.: Large-Scale Scrum: Scrum erfolgreich skalieren mit LeSS - Heidelberg: dpunkt.verlag, 2017. - Oestereich, B.: Developing Software with UML: Object-Oriented Analysis and Design in Practice 2. ed. - Addison-Wesley Professional, 2003. - Oestereich, B.: Analyse und Design mit UML 2.1: Objektorientierte Softwareentwicklung, 8. ed. - München; Wien : Oldenbourg, 2006 - OMG Object Management Group. Unified Modeling Language (OMG UML) Version 2.5.1 – OMG, 2017. - Seidl, M.; Scholz, M. and Huemer, C.: UML @ Classroom: An Introduction to Object-Oriented Modeling, Springer, 2015. - Schwaber, K. and Sutherland, J. The Scrum Guide: The Definitive Guide to Scrum – Scrumguides.org, 2020. - Sommerville, I.: Software Engineering, 10. Auflage - Pearson, 2018. - Wintersteiger, A.: Scrum: Schnelleinstieg, 4. Auflage - Frankfurt am Main: entwickler.press, 2018.
Exams	Module exam
Comments	The lecture will take the form of seminars with exercises.

Lecture Distributed Systems 2

Internal number	INFB511.b
Lecturer	Prof. Dr. Christian Zirpins
Scope	2.5 ECTS points, 2.0 Contact hours 75 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The lecture conveys both fundamental and extended principles of distributed systems and illustrates these in practical form on the basis of concrete paradigms and technologies. The spectrum of principles covered includes fundamental aspects of the objectives and classes of distributed systems, as well as their architectures, processes, communications, and naming. Advanced principles include coordination, consistency and replication, fault tolerance and security. The covered principles are exemplified by various paradigms. Here, exemplary implementations of individual principles are presented. In addition, an introduction to the development of corresponding systems based on concrete software technologies is given. Upon completing this lecture class, students will achieve a comprehensive understanding of the principles underlying distributed systems, ranging from their fundamental objectives and architectures to advanced concepts such as coordination, consistency, replication, fault tolerance, and security. They will gain insights into the practical application of these principles through the examination of specific paradigms and technologies, enhancing their ability to analyze and design distributed systems. Moreover, the introduction to developing these systems using concrete software technologies will equip students with the practical skills necessary for implementing robust, efficient, and secure distributed systems in various computing environments.
Recommended reading	- Andrew S. Tannenbaum, Marten van Steen, "Verteilte Systeme, Prinzipien und Paradigmen", 2. aktualisierte Auflage, Pearson Studium, 2008, ISBN 978-3-8273-7293-2 - George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, "Distributed Systems, Concepts and Design", Fifth Edition, Addison-Wesley, 2012, ISBN 978-0-13-214301-1 - Additional literature will be announced during the lecture
Exams	Module exam
Comments	Autonomous work includes pre- and post processing of lectures, exercises and exam preparation.
Lecture Softwareengineering Laboratory	
Internal number	INFB512
Lecturer	Prof. Dr. Thomas Fuchß
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German

Content	In the Software Engineering Lab, students complete a full iterative software development process within a team. Starting with requirements analysis, they develop an analysis and design model and implement it in Java. Along the way, they actively engage with concepts such as use-case-driven development, architecture orientation, iterative and incremental approaches, and component-based software design. Through a concrete example project, students experience the practical application of these methods and learn to make independent design decisions while adhering to given requirements. The lab emphasizes teamwork and independent problem-solving, preparing participants to work effectively in agile development teams and address the challenges of complex software projects.
Recommended reading	Slides, videos, textbooks, and other literature: - Arlow, J.; Neustadt, I.: UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design, 2. ed. - Addison-Wesley Professional, 2005. - Shimp, D. and Rawsthorne, D. Exploring Scrum: The Fundamentals – CreateSpace, 2011. - Jacobson, I.; Booch, G. and Rumbaugh, J.: The unified software development process - Reading, Mass.: Addison-Wesley, 1999. - Kim, G.; Humble, J.; Debois, P. und Willis, J.: Das DevOps-Handbuch: Teams, Tools und Infrastrukturen erfolgreich umgestalten - Heidelberg: O'Reilly; Heidelberg: dpunkt.verlag, 2017. - Larman, C.: Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, 3. ed. - Upper Saddle River, NJ : Prentice Hall, 2004. - Larman, C. und Vodde, B.: Large-Scale Scrum: Scrum erfolgreich skalieren mit LeSS - Heidelberg: dpunkt.verlag, 2017. - Oestereich, B.: Developing Software with UML: Object-Oriented Analysis and Design in Practice 2. ed. - Addison-Wesley Professional, 2003. - Oestereich, B.: Analyse und Design mit UML 2.1: Objektorientierte Softwareentwicklung, 8. ed. - München; Wien : Oldenbourg, 2006 - OMG Object Management Group. Unified Modeling Language (OMG UML) Version 2.5.1 – OMG, 2017. - Seidl, M.; Scholz, M. and Huemer, C.: UML @ Classroom: An Introduction to Object-Oriented Modeling, Springer, 2015. - Schwaber, K. and Sutherland, J. The Scrum Guide: The Definitive Guide to Scrum – Scrumguides.org, 2020. - Sommerville, I.: Software Engineering, 10. Auflage - Pearson, 2018. - Wintersteiger, A.: Scrum: Schnelleinstieg, 4. Auflage - Frankfurt am Main: entwickler.press, 2018.
Exams	Laboratory Work 1 Semester (not graded)
Comments	Attended teamwork

Lecture Distributed Systems 2 Laboratory

Internal number	INFB513
Lecturer	Prof. Dr. Christian Zirpins
Scope	1.0 ECTS points, 1.0 Contact hours 30 Stunden gesamt, davon 15 Stunden Kontaktstudium.

Type/mode	Laboratory Course
Language of instruction	German
Content	
Recommended reading	
Exams	Laboratory Work 1 Semester (not graded)
Comments	

Module Databases and Communication Networks 2	
Internal number	INFB520
Coordinator	Prof. Dr. Zoltán Nochta
Scope	5.0 ECTS points, 4.0 Contact hours
Placement	5th Semester
Pre-requisites with regard to content	Databases and Communication Networks 1
Pre-requisites according to the examination regulations	none
Competences	
Exams	Written Exam 120 Min. (graded)
Lecture Databases 2	
Internal number	INFB521.a
Lecturer	Prof. Dr. Zoltán Nochta
Scope	2.5 ECTS points, 2.0 Contact hours 75 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	- "Datenbanksysteme" von Alfons Kemper, Andre Eickler - "Database Solutions" von Thomas Connolly, Carolyn Begg
Exams	Module exam
Comments	
Lecture Communication Networks 2	
Internal number	INFB521.b
Lecturer	Prof. Dr. Oliver Waldhorst
Scope	2.5 ECTS points, 2.0 Contact hours 75 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	In this course, students expand their knowledge of communication networks, in particular by taking an in-depth look at the functionalities and challenges of the layers of the Internet protocol stack. After completing the course, they will be able to analyze, evaluate and practically apply advanced mechanisms and protocols in the application layer, transport layer, network layer and security layer. They will be able to identify complex network problems, combine specific solution modules and develop innovative solutions. The lecture covers the following topics: - Transmission of multimedia content in the application layer, e.g. Netflix and Skype, as well as the basics of secure communication such as TLS and secure email. - Transport layer mechanisms, including extensions to TCP such as SACK and CUBIC, as well as new protocols such as QUIC. - Network layer with addressing and routing concepts, including IPv6, Software Defined Networking (SDN) and IPsec. - Data link layer with a focus on VLANs, MPLS and data center networks. The lecture is taught in a flipped classroom format. Students prepare for the classroom sessions independently using lecture slides and explanatory videos. In these sessions, the topics are explored in greater depth through case studies and exercises. Online tests offer students the opportunity for self-assessment and to collect bonus points for the exam. The examination consists of a 60-minute written exam, which is part of the module exam "Databases and Communication Networks 2". The total workload is 75 hours, divided into 25 hours of attendance time, 25 hours of asynchronous learning and 25 hours for exam preparation and follow-up.
Recommended reading	- Slide collection and explanatory videos in the ILIAS system - James Kurose, Keith Ross: Computer Networking - A Top-Down Approach, 8th edition, Pearson, 2021 - Various Internet standards, see https://www.rfc-editor.org - Further information in the lecture
Exams	Module exam
Comments	

Module Antomation and Declarative Programming	
Internal number	INFB530
Coordinator	Prof. Dr. Patrick Baier
Scope	5.0 ECTS points, 4.0 Contact hours
Placement	5th Semester
Pre-requisites with regard to content	Computer Science 1
Pre-requisites according to the examination regulations	none
Competences	The students learn the basics of machine learning in theory and practice. They will learn all the necessary steps to implement their own applications in the area of machine learning and to analyze and prepare the data required for this. The module also teaches the necessary basics for further courses in the areas of machine learning and artificial intelligence.
Exams	Individual exams
Lecture Machine Learning	
Internal number	INFB530
Lecturer	Prof. Dr. Patrick Baier
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The lecture gives students a general introduction to the topic of machine learning as a branch of artificial intelligence. Starting with classic methods, an overview of the most important topics in this area is given, which ends with a brief insight into the current developments surrounding “deep learning”. In addition to the theoretical basics, the practical use of the methods learned is demonstrated with the help of the Python programming language and the use of Jupyter Notebooks. The contents of the lecture include: - Introduction and overview of the subject area - Introduction to the Python programming language and Jupyter Notebooks - Linear regression - Logistic regression - ML workflow - Overfitting and underfitting - Decision trees - Ensemble learning (random forest, gradient boosting) - Unsupervised learning - Neural networks and deep learning

Recommended reading	- A. Géron, "Hands-on Machine Learning with Scikit-Learn, Keras & TensorFlow", O'Reilly Media, 2nd Edition, 2019. - J. Frochte, "Maschinelles Lernen - Grundlagen und Algorithmen in Python", Carl Hanser Verlag, 2. Auflage, 2019.
Exams	Written Exam 90 Min. (graded)
Comments	Seminar
Lecture Machine Learning Laboratory	
Internal number	INFB532
Lecturer	Prof. Dr. Patrick Baier
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	The knowledge learned in the “Machine Learning” lecture will be deepened and practiced in the exercise. The exercise includes a practical programming part in the Python programming language, which is introduced at the beginning of the semester as part of the exercise.
Recommended reading	- A. Géron, "Hands-on Machine Learning with Scikit-Learn, Keras & TensorFlow", O'Reilly Media, 2nd Edition, 2019. - J. Frochte, "Maschinelles Lernen - Grundlagen und Algorithmen in Python", Carl Hanser Verlag, 2. Auflage, 2019.
Exams	Exercise 1 Semester (not graded)
Comments	Seminar-style teaching, practice, reporting

Module IT Security	
Internal number	INFB540
Coordinator	nn1
Scope	5.0 ECTS points, 4.0 Contact hours
Placement	5th Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	Modul Internship
Competences	
Exams	Individual exams
Lecture IT Security	
Internal number	INFB541
Lecturer	nn1
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Seminar
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture IT Security Laboratory	
Internal number	INFB542
Lecturer	Alle Dozenten
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	
Recommended reading	
Exams	Exercise 1 Semester (not graded)
Comments	

Module ERP Systems	
Internal number	INFB550
Coordinator	Prof. Dr. rer. pol. Mathias Philipp
Scope	5.0 ECTS points, 4.0 Contact hours
Placement	5th Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	none
Competences	The students shall learn to think in business processes on the basis of integrated ERP systems. They should recognize the interdependence of operational functions, and thus deepen their basic economical knowledge about processes (horizontal integration). Further, the students recognize the need for vertical integration as a prerequisite for the development of ERP systems for management information systems. In addition the students learn architecture, design and development of ERP systems.
Exams	Individual exams
Lecture ERP Systems	
Internal number	INFB551
Lecturer	Prof. Dr. rer. pol. Mathias Philipp
Scope	3.0 ECTS points, 3.0 Contact hours 90 Stunden gesamt, davon 45 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	ERP basics, introduction of integrated business processes, process automation using the example of the sales process, introduction of standard software: company modeling and customizing, architecture of ERP systems, SAP programming.
Recommended reading	- Vorlesungsmaterial vollständig in Powerpoint-Folien - Tafelaufschrieb bei interaktiver Erarbeitung von Kernproblemstellungen - Umfangreiches Material zu jeder Fallstudie.
Exams	Written Exam 90 Min. (graded)
Comments	Vorlesung, Gruppenworkshop, Labor: Fallstudienbasierte Teilnahme an gruppenorientierten Workshops zur Unternehmensanalyse, Präsentation der Gruppenergebnisse, selbstständige Umsetzung der Analyseergebnisse auf SAP R/3 durch entsprechendes System-Customizing im Labor. Selbstständige Bearbeitung einer weiteren Laboraufgabe (z.B. ABAP-Kurs, Fallstudie Projektoffice)
Lecture ERP Laboratory	
Internal number	INFB552
Lecturer	Prof. Dr. rer. pol. Mathias Philipp

Scope	2.0 ECTS points, 1.0 Contact hours 60 Stunden gesamt, davon 15 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German
Content	The laboratory is linked to the lecture and serves to apply and deepen the lecture material. The following laboratory exercises are carried out: - SAP ERP navigation, case study to get to know the user interface and operation of the SAP system - Case study on order processing (SD module) to understand the implementation of business processes in complex ERP systems - Customizing case study on reorder point-oriented procurement planning to independently (under supervision) configure a procurement process in the system (company and process customizing) - Short programming task in ABAP to get to know the programming language. Independent processing of the case studies in an SAP ERP system individually or in a group of a maximum of two people. Software: SAP ECC 6.04, data basis: Global Bike Inc. Alternative to the laboratory: Introduction to the ABAP programming language. See I W918.
Recommended reading	Recommended reading: Extensive material for introduction to the topic as well as on each case study. Provisioning is about the blended learning and e-learning platform ILIAS.
Exams	Exercise 1 Semester (not graded)
Comments	Kind of work: Labor participation and preparation of laboratory results. Exercises and case studies from the curriculum GBI powered by t he SAP University Alliances community. Some case studies have been extended to more detailed tasks.

Module Elective courses 1	
Internal number	INFB560
Coordinator	Prof. Dr.-Ing. Holger Vogelsang
Scope	4.0 ECTS points, 4.0 Contact hours
Placement	5th Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	none
Competences	The compulsory elective subjects enable students to set specialisations according to their own interests and thus apply further specialist areas of computer science or media informatics. The courses belonging to the module are announced on the intranet at the beginning of each semester.
Exams	Individual exams
Lecture Advanced Topics in Computer Science	
Internal number	I W156
Lecturer	Prof. Dr. Martin Sulzmann
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	English
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Malware development and malware analysis	
Internal number	I W164
Lecturer	B.Sc. Florian Dalwigk
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The students - learn about the history of malware. - can identify and categorise malware by the way it works. - understand how malware is recognised under Windows. - learn about the process of malware development. - can develop functional malware such as ransomware and Trojans. - learn which distribution techniques exist for malware. - are able to analyse malware with the help of Ghidra. Contents: - History of malware - Malware taxonomy - Malware architectures - Malware as a Service (MaaS) - Importance of malware in the field of cybercrime - AV detection techniques - WinAPIs, PE format - Payload encryption, payload obfuscation, payload staging - Malware binary signing - Fully Undetectable Malware (FUD) - Project: Ransomware - Project: Trojans - Project: Analysing WannaCry with Ghidra - Malware delivery techniques - Protection against malware Basic knowledge of "ethical hacking" advantageous, initial experience with Assembler and/or Python, access to a Windows system.
Recommended reading	Zhassulan Zhussupov. (2024). Malware Development for Ethical Hackers: Learn how to develop various types of malware to strengthen cybersecurity (English Edition). <packt>
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture Business Intelligence

Internal number	I W179
Lecturer	Prof. Dr. Uwe Haneke
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	- Introduction and business-management background - The concept of data warehousing - Business Analytics and Balanced Scorecard (BSC) - CRM and Data Mining - Trends in Business Intelligence-Case studies
Recommended reading	
Exams	Written Exam 90 Min. (graded)

Comments	
Lecture Parallel Systems	
Internal number	I W391
Lecturer	Prof. Dr. Christian Langen
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Verbal Exam 20 Min. (graded)
Comments	
Lecture IT-Security Management	
Internal number	I W394
Lecturer	Prof. Dr. rer. pol. Mathias Philipp
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The focus of the event is the construction and operation of an IT security management system. This is done in accordance with the standards of the BSI and ISO. Structure Chapter 1: Basics and motivation Chapter 2: Organizational basics of security management (“Institutionalization”) Chapter 3: Structural analysis and modeling of IT network (“Inventory of relative objects”) Chapter 4: Determination of protection requirements in the IT network (“Protection requirements of objects”) Chapter 5: Construction of the IT basic protection model using the IT basic protection compendium (“Target security concept”) Chapter 6: IT basic protection check (target-actual comparison, “Are there gaps?”) Chapter 7: Risk analysis for objects with increased protection requirements Chapter 8: Implementation planning (“Closing the gaps”) Chapter 9: Maintenance and improvement (“ongoing operation”)
Recommended reading	Lecture material completely as pdf documents, blackboard notes for interactive development of central problem positions, instructions for interactive role play and case study material BSI-Standards 200-x ISO-Reihe 27000 Thomas W. Harich: IT-Sicherheitsmanagement: Praxiswissen für IT Security Manager, mitp Professional

Exams	Written Exam 90 Min. (graded)
Comments	Participation lecture, development of an interactive role play in the group, individual execution of a short case study.
Lecture Projective geometry	
Internal number	I W501
Lecturer	Prof. Dr. Frank Schaefer
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written/verbal Exam 90/20 Min. (graded)
Comments	
Lecture Philosophy and theory of computer science	
Internal number	I W502
Lecturer	Prof. Dr. Thomas Morgenstern
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Presentation 20 Min. (graded)
Comments	
Lecture Introduction to applied cryptography	
Internal number	I W505
Lecturer	Dr. Carmen Kempka
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Mathematics for Machine Learning	
Internal number	I W610

Lecturers	Prof. Dr.-Ing. Astrid Laubenheimer M.Sc. Ahmad Assani
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written/verbal Exam 90/20 Min. (graded)
Comments	
Lecture Game Programming	
Internal number	I W620
Lecturer	M.Sc. Raphael Hettich
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	English
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Computer Vision	
Internal number	I W772
Lecturer	Prof. Dr.-Ing. Astrid Laubenheimer
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 60 Min. (graded)
Comments	
Lecture Computer Vision Laboratory	
Internal number	I W773
Lecturer	Prof. Dr.-Ing. Astrid Laubenheimer
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German

Content	
Recommended reading	
Exams	Laboratory Work 1 Semester (graded)
Comments	

Lecture App Programming

Internal number	I W912
Lecturer	M.Sc. Adrian Wörle
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The lecture teaches the construction of mobile media applications. The main concepts are discussed using the Android platform. In a first partt, the basic technologies and limitations of mobile devices are shown. The second part examins different development strategies like native applications, device independend abstractions and web applications. A main part of the lecture is the integration of different media types into mobile applications and the constraints the developer has to keep in mind.
Recommended reading	will be announced
Exams	Written Exam 90 Min. (graded)
Comments	Leacture with exercise

Lecture Cloud Computing

Internal number	I W913
Lecturers	Dipl. Inform. (FH) Georg Magschok Dipl. Inform. (FH) Michael Fischer
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The buzzword "Cloud" represents a variety of interesting technologies which gained importance in the life of a computer science professional. Those are being collected, examined, explained and understood during the course. Primary objective is usefulness for the student, regardless of whether he acts as a cloud user, developer, administrator or even entrepreneur. Understand the broad meaning of "Cloud Computing" from a variety of perspectives: Definition, use cases, technology basics, key players, APIs, scaling, redundancy …
Recommended reading	Powerpoint slides
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture Affective Computing

Internal number	I W924

Lecturer	Prof. Thomas Hinz
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Emotional expressions are important signals for people to make sense of situations, actions and relationships in their social interactions with each other. Is the empowerment of technological systrms with the capacity to also sense and express emotions able to improve their users' interactions with them? This question is the driving force behind the field of Affective Computing. The students know different theories of emotions, contrast them with each other and debate them. They apply the acquired knowledge by addressing problems from within the primary areas of application for Affective Computing through the development of prototypical interactive systems that are capable of sensing or expressing emotions.
Recommended reading	Lecture notes, case studies.
Exams	Homework 1 Semester (graded)
Comments	

Lecture Video	
Internal number	I W925
Lecturers	Prof. Thomas Hinz Marc Steinmetz
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Homework 1 Semester (graded)
Comments	

Lecture Big Data Engineering	
Internal number	I W926
Lecturer	Prof. Dr. Christian Zirpins
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The lecture Big Data Engineering addresses the systematic construction of data-intensive systems. Generic architectural approaches are introduced in order to design robust, performant and scalable data systems for various applications. For different architectural areas various kinds of data storage and processing models are discussed. Topics include, among others, distributed file systems, serialization, batch and stream processing with MapReduce and other programming models, queuing mechanisms and NoSQL databases. These are both conceptually described as well as implemented by means of exemplary tools and techniques. The focus is on established industry standards such as Apache Thrift, Hadoop, Kafka, Cassandra, Storm. These are illustrated by means of an exemplary Web Analytics application. During the course students acquire, among others, the following abilities: - They evaluate different approaches of data systems for given application problems with specific requirements. - They describe structure and function of specific architectural approaches for Big Data systems. - They categorize tools and techniques for Big Data systems and utilize them professionally. - They design architecture and data models as well as processing logic and queries for given Big Data applications and implement these based on specific open source tools and techniques.
Recommended reading	- Nathan Marz, James Warren, "Big Data: Principles and best practices of scalable realtime data systems", Manning, 2015, ISBN: 1-617290-34-3 - Martin Kleppmann, "Designing Data-Intensive Applications", O'Reilly, 2014 (Early Release), ISBN: 978-1-4493-7332-0 - Tom White, "Hadoop: the definitive guide: storage and analysis at internet scale", 4. ed., O'Reilly, 2015, ISBN: 978-1-491-90163-2 - Michael Frampton, "Big Data Made Easy: A Working Guide to the Complete Hadoop Toolset", Apress, 2015, ISBN: 978-148-420-094-0 - Vivek Mishra, "Beginning Apache Cassandra Development", Apress, 2014, ISBN: 978-148-420-142-8 - Additional literature will be announced during the lecture
Exams	Written Exam 90 Min. (graded)
Comments	Independent work relates to the preparation and followup of lectures, laboratory exercises and exam preparation.

Lecture Digital Transformation & digital marketing

Internal number	I W929
Lecturers	Marc Steinmetz Prof. Thomas Hinz
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	

Recommended reading	
Exams	Homework 1 Semester (graded)
Comments	
Lecture Seminar	
Internal number	I Wsem
Lecturer	Alle Dozenten
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Seminar
Language of instruction	German
Content	Each participant of the seminar creates under the guidance of a supervising faculty staff a written report in housework. The contents of the report should be computer science related. Based on the report suitable presentation techniques (slides, video sequences, programmed examples) are selected. Each participant individually presents his report followed by a discussion. The seminar topics are classified into thematic groups. Besides the technical problem the student has to learn how to do 'self-marketing'. The assessment of the student is based on the following criteria: degree of difficulty, quality of written preparation; didactically skillful presentation.
Recommended reading	Depends on the topic
Exams	Presentation 20 Min. (graded)
Comments	Meetings with the faculty supervisor; eventually experimental studies, literature refurbishment; presenting the work-out; defend the own presentation; active participation in discussing the presentations of others.
Lecture Computer Graphics	
Internal number	I Wxxxx
Lecturer	Prof. Dr. Christian Pape
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The students learn to store, code and display two-dimensional graphics in the computer and external storage media. They will be able to apply their mathematical skills to simple areas of computer graphics, such as the use of coordinate systems, modeling three-dimensional objects with polygons, designing algorithms to calculate sections of geometric objects. The students learn about photorealistic image generation using ray tracing techniques. They can describe and implement homogeneous coordinates in object space and model space. OpenGL can be used in principle for practical programming.
Recommended reading	- Lecture notes - Steve Marschner, Peter Shirley. Fundamentals of Computer Graphics. O'Reilly. - John Vince. Mathematics for Computer Graphics. Springer. - Matt Pharr, Wenzel Jakob, Greg Humphreys. Physically based Rendering. https://pbrt.org/
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture Workshop Empirical Software Engineering

Internal number	I Wxyz
Lecturers	Prof. Dr. Christian Zirpins Prof. Dr. Oliver Waldhorst Prof. Dr. Zoltán Nochta
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Project Lecture
Language of instruction	German

Content	The course teaches practical methods of empirical software engineering and focuses on analysing and evaluating software systems in real-life use. The focus is on field and case studies that deal with the behaviour of users, the interaction with software and its technical and functional properties. By analysing authentic usage contexts, realistic insights are gained that are important for both science and industry. Students actively participate in the planning, implementation and evaluation of a real field study, which is carried out in cooperation with the university's IDSS research institute and partners from industry. They work as part of an ongoing research project and test scientific methods in an application-oriented environment. The tasks include the systematic collection and evaluation of usage data as well as the organisational support of the study and the technical validation of the software under investigation. Through practical experience, participants develop an in-depth understanding of the empirical investigation of software systems and their utilisation. They acquire skills in project management, in the application of empirical research methods and in software-supported data analysis. They also learn how to systematically gain scientific knowledge and critically assess its relevance for the further development and optimisation of software systems.
Recommended reading	1. Vorlesungsfolien und Dokumentation in ILIAS 2. Wohlin, Claes, et al. Experimentation in Software Engineering. Springer Nature, 2024. 3. Further literature will be announced during the course
Exams	Hands-on Work 1 Semester (graded)
Comments	Seminar work with practical components, practical group work + final presentation

Module Embedded Software	
Internal number	INFB610
Coordinator	Prof. Dr. Dirk Hoffmann
Scope	5.0 ECTS points, 4.0 Contact hours
Placement	6th Semester
Pre-requisites with regard to content	Computer Science 2, Computer Engineering 1, Computer Engineering 2
Pre-requisites according to the examination regulations	Modul Internship
Competences	The lectures in this module impart advanced knowledge in the field of embedded systems. Students know the basic terms in the field of embedded systems and are able to differentiate between different types of real-time systems. With CAN bus, the students have become familiar with a typical communication medium and with CDMA technology, an important coding used, for example, in satellite communication. Students are able to implement typical programming tasks in the field of embedded systems in the C language. During the course, students learn how to use software tools that can be used to measure and optimize the program runtime of the software created.
Exams	Individual exams
Lecture Embedded Software	
Internal number	INFB611
Lecturer	Prof. Dr. Dirk Hoffmann
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Students will be able to understand the fundamental concepts of software development for embedded real-time systems. In the context of this lecture, embedded systems are all computers controlled by software that are part of a larger system and whose primary function is not computing. Real-time systems also involve aspects of temporal behavior, i.e., they are systems that not only have to provide a correct answer, but also have to calculate the system answer within a predetermined and guaranteed period of time. In detail, topics from the following areas are covered: design and architecture of automotive control units, fundamentals of real-time programming, coding for data transmission, embedded C. The participants of the lecture apply their knowledge on the basis of exercises.
Recommended reading	Slides, blackboard, exercise sheets
Exams	Written Exam 90 Min. (graded)
Comments	Lecture
Lecture Embedded Software Laboratory	

Internal number	INFB612
Lecturer	Prof. Dr. Dirk Hoffmann
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German
Content	Students will be able to develop typical algorithms used in embedded systems in the C++ programming language. Students will develop a prototypical CDMA decoder that is able to extract the bits sent by GPS satellites from a composite signal.
Recommended reading	Software and hardware tools für designing automative ECUs
Exams	Laboratory Work 1 Semester (not graded)
Comments	Practical work

Module Modern Programming Methods	
Internal number	INFB620
Coordinator	Prof. Dr. Martin Sulzmann
Scope	5.0 ECTS points, 4.0 Contact hours
Placement	6th Semester
Pre-requisites with regard to content	System Software, Computer Engineering 2
Pre-requisites according to the examination regulations	Modul Internship
Competences	Software is becoming more complex. Programs operate in a concurrent environment. Making sure that these programs function correctly is a challenging task. This course covers the design, implementation, and analysis of concurrent programs. After this course, students will be able to understand the conceptual foundations of concurrent programming, how to implement these concepts in the Go programming language and several methods to predict potential concurrency bugs. Lectures introduce concepts via some live coding, followed by some lab sessions where students work on smaller practical exercises. Several (online) quizzes allow students to test their knowledge. Content. Introduction to Go. * C-like syntax * Simple type inference * Structural subtyping Concurrent programming in Go. * Multi-threading * Locks and semaphores * Channel-based communication * Further concurrency abstractions (barriers, async-wait, futures) Program analysis methods. * Static versus dynamic analysis * Dynamic data race and deadlock prediction * Go-specific analysis scenarios Written final exam, closed book. Exam questions refer to algorithms and practical exercises that are covered in the lecture and lab.
Exams	Individual exams

Lecture Modern Programming Methods	
Internal number	INFB621
Lecturer	Prof. Dr. Martin Sulzmann
Scope	3.0 ECTS points, 2.0 Contact hours 90 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Students in this course - obtain an overview of methods for formal modelling and verification of autonomous/reactive systems, - get to know programming concepts to master highly concurrent/distributed systems.l Selection of topics covered: (1) Modeling and Verification - Statemachine models - Mealy/Moore - Communication statemachines - Timed statemachines - Harel Statecharts - Specification - Reguar languages - Temporal logic (CTL) - Modelchecking - Testcasegeneration via modelchecking - Run-Time Verification - Coverage criteria - UPPAAL (2) Concurrency and Synchronisation - Shared memory - Threads and Locks - Lock-free Algorithms - Software Transactional Memory - Message-passing - Foundations: CSP, Join - Haskell, Go

Recommended reading	- Lecture notes and slides - Exercises - Selection of textbooks: - Real World Haskell - by Bryan O'Sullivan, Don Stewart, and John Goerzen - Real-Time Systems and Programming Languages (Fourth Edition) Ada 2005, - Real-Time Java and C/Real-Time POSIX - by Alan Burns and Andy Wellings - Principles of Model Checking - Christel Baier and Joost-Pieter Katoen - Real-Time UML: Developing Efficient Objects for Embedded Systems (2nd Edition)
Exams	Written Exam 90 Min. (graded)
Comments	Mix of lecture and theoretical and practical exercises.

Lecture Modern Programming Methods Laboratory

Internal number	INFB622
Lecturer	Prof. Dr. Martin Sulzmann
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	In the lecture we will deal with the most important principles of organization and design of microprocessors. Microprocessors are the central building blocks of practically all current computer systems, from smartphones to supercomputers and thus of the complete digital world. The focus of the lecture will be the programming of 64-bit ARMv8 processors and the logical design of processors with the help of Verilog. In addition to teaching the theoretical basics, great emphasis is placed on practical programming exercises. The following topics are covered: - Computer Abstractions and Technology - Instructions: Language of the Computer - Arithmetic for Computers - Performance Analysis - Logic Design with Verilog - The Processor - The Memory Hierarchy - Parallel Processors
Recommended reading	Computer Organization and Design : The Hardware/Software Interface , ARM Edition, D.A. Patterson, J.L. Hennessy, Elsevier Inc. 2017
Exams	Exercise 1 Semester (not graded)

Comments	In general, the lectures start with a discussion of the exercises associated with the previous lecture. Afterwards we address new topics. Questions and feedback are always welcome!

Module Student Research Project	
Internal number	INFB630
Coordinator	Prof. Dr. Heiko Körner
Scope	5.0 ECTS points, 4.0 Contact hours
Placement	6th Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	none
Competences	Students will be able to independently apply the knowledge they have acquired in their previous studies to a complete task. They can analyse the problem, create a solution concept, find an implementation and implement it on their own. They can also write down their results observing scientific standards. They can also present their work in a short presentation and defend it in a subsequent discussion.
Exams	Verbal Exam 20 Min. (graded)
Lecture Student Research Projekt	
Internal number	INFB631
Lecturer	Alle Dozenten
Scope	5.0 ECTS points, 4.0 Contact hours 150 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Hands-on Experience
Language of instruction	German
Content	A student research project deals with a topic in the field of software or hardware. The aim is to carry out a practical task, but work in the areas of evaluation or literature research is also possible. Students analyse the task and research which tools are best suited to solve it. They then use these accordingly. Comprehensive documentation must be prepared for the project work, covering all steps of the task and its completion (e.g. the exact problem definition, the concept, the implementation, operating instructions and more). A joint colloquium concludes the project work. The students show their results in a short presentation and then take part in a discussion. The project work is thus a preparation for the later final thesis, which the students will write according to very similar guidelines.
Recommended reading	Depending on the task
Exams	Hands-on Work 1 Semester (graded)
Comments	

Module Key Qualification	
Internal number	INFB6407
Coordinator	Prof. Dr.-Ing. Holger Vogelsang
Scope	6.0 ECTS points, 6.0 Contact hours
Placement	6th Semester
Pre-requisites with regard to content	Language Competence
Pre-requisites according to the examination regulations	Modul Internship
Competences	On successful completion of the module, students will be able to - behave appropriately towards people from other cultures in relation to the increasing globalisation of their work, - understand statements made by these people, - understand simple legal issues and contracts, - present the results of their own work in the form of a specialised presentation.
Exams	Written Exam 120 Min. (graded)
Lecture Intercultural Communication	
Internal number	INFB641
Lecturer	Prof. Dr. Andrea Cnyrim
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	English
Content	Participants learn to understand intercultural competence as a strategic competitive factor and to organise their own actions in a culturally appropriate way: - Key aspects of intercultural communication (e.g. culturally determined norms, behaviours, values, verbal and non-verbal communication) with particular emphasis on differences between fact-oriented cultures such as Germany and relationship-oriented cultures such as China and India - Influence of different cultural standards on international business relationships (e.g. business initiation, negotiations, employee management, decision-making, conflict resolution, etc.) - Empirical studies (e.g. Geert Hofstede, Fons, Trompenaars etc.) - Case studies from different cultural areas (e.g. Germany, France, USA, Japan, China, India, etc.).
Recommended reading	
Exams	Exercise 1 Semester (not graded)
Comments	
Lecture Law	
Internal number	INFB642.a

Lecturer	RA Karin Raab
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	- Introduction to the right - That "Bürgerliches Gesetzbuch” (BGB) - The "Handelsgesetzbuch” (HGB) - The judicial procedure
Recommended reading	
Exams	Module exam
Comments	

Lecture IT and media law

Internal number	INFB642.b
Lecturers	RA Josua Neudeck RA Jeremias Held
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Exercise
Language of instruction	German
Content	The lecture deals with legal issues in information technology and media law that students encounter in their everyday work. For example, students learn the basics of dealing with copyright-protected works, data, trademarks, designs or personal rights as well as the legally compliant design of websites, web shops and apps. - Basics of copyright law and the relevant industrial property rights - (IT) contract law - AI and data protection - Conclusion of contracts on the internet - General legal requirements for websites - Internet and email marketing - Legal relationships with apps - Special legal features of social media
Recommended reading	- PowerPoint-Folien zum Referat - Herzog, Recht für Designer, 2. Auflage 2022
Exams	Module exam
Comments	RA Josua Neudeck (https://www.vogel-partner.eu/team/josua-neudeck/) RA Jeremias Held (https://www.vogel-partner.eu/team/jeremias-held/)

Module Elective courses 2	
Internal number	INFB650
Coordinator	Prof. Dr.-Ing. Holger Vogelsang
Scope	10.0 ECTS points, 10.0 Contact hours
Placement	6th Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	Modul Internship
Competences	
Exams	Individual exams
Lecture Digital audio signal processing	
Internal number	EITB622A
Lecturer	Prof. Dr. Christian Langen
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The course teaches the basics of digital signal processing in audio systems that are used in artistic and commercial applications. The first part of the course provides knowledge and skills for understanding basic concepts such as - periodic sampling of signals - reconstruction of sampled signals and aliasing - non-recursive and recursive systems - basic non-recursive filter algorithms are taught. In the second part, the basics of - recursive filters - Spectral analysis using discrete and fast Fourier transforms (DFT, FFT) - Adaptive filters for the suppression of noise and digital audio effects such as Compressor/limiter - ring and phase modulation (chorus, flanger) are discussed and implemented in real time using a consistent methodology for development and implementation using the C/C++ programming language. This serves to provide knowledge of classic digital signal processing algorithms and to deepen this knowledge through technical programming implementation. In addition to classic signal processing, these algorithms are used in the pre-processing of training and inference patterns for artificial intelligence, machine learning and neural networks. Other proposed topics such as and aspects of neural networks and artificial intelligence for noise cancellation using CUDA C/C++ in offline operation on a GPU server will be presented in the seminar.

Recommended reading	- Reay, Donald: Digital Signal Processing and Applications with the OMAP - L138 eXperimenter, Wiley, 2012 - J Welch, Thad: Real-Time Digital Signal Processing from MATLAB® to C with the TMS320C6x DSPs Second Generation, CRC Press, 2012 - Chassaing, Rulph: Digital Signal Processing and Applications with the C6713 and C6416 DSK, Wiley, 2005. Schuler, H.: Prozessführung, Oldenbourg, 1999 - Doblinger, Gerhard: Signalprozessoren: Architekturen, Algorithmen, Anwendungen, Schlembach, Weil der Stadt, 2004 - Dahnoun, Naim: DSP implementation using the TMS320C6000 DSP platform, Prentice Hall, Harlow, 2000 - Bateman, Andrew: The DSP handbook: algorithms, applications and design techniques, Prentice Hall, Harlow, 2002 - Kehtarnavaz, Nasser; Simsek, Burc: C6x-Based Digital Signal Processing, Prentice Hall, Upper Saddle River, NJ, 2000
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture IoT Internet of Things - Use cases and algorithms	
Internal number	I W000x
Lecturer	Prof. Dr. Christine Preisach
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Verbal Exam 20 Min. (graded)
Comments	

Lecture HKA-APP	
Internal number	I W155
Lecturers	Prof. Dr. Manfred Seifert M.Sc. Daniel Weisser
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Hands-on Experience
Language of instruction	German

Content	HsKAmpus is intended to provide comprehensive functions for students of all faculties of the HsKA: - https://www.h-ka.de/hskampus/ - https://www.youtube.com/watch?v=OcyRZrwXzVM This primarily includes functions from the so-called. Online services based on the LSF server (events/schedule, facilities, people, student life), the QIS server (grade view) and other servers (canteen, KIT, KVV, ...). Other formats and functions are possible: - Creation or further development for Android, iOS, Windows, Web and our Broker/Server as well as the new Ersti-Hilfe - Provision in Google Play, Apple App Store, Microsoft Windows Store and as a web app - Marketing on various channels (website, FaceBook, Instagram, HsKA site, advertising material, ...) - User support - Communication at the university (campus day).
Recommended reading	http://www.hskampus.de https://www.facebook.com/hskampus https://www.instagram.com/hskampus/
Exams	Hands-on Work 1 Semester (graded)
Comments	

Lecture Graphical-geometric algorithms

Internal number	I W158
Lecturer	Prof. Dr. Christian Pape
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Graphical-geometric algorithms solve problems based on geometric objects as input such as points, lines, surfaces and bodies in two- or multi-dimensional space (algorithmic geometry, computational geometry). These algorithms and their underlying data structures are used in the areas of computer graphics, robotics and geoinformation systems, among others. Students learn about typical algorithms from algorithmic geometry, their design principles and areas of application. They are able to examine and compare the algorithms in terms of their correctness, resource consumption and robustness. The following problems are treated as examples, among others: Calculation of convex hulls, intersection and distance problems, triangulation of polygons, geometric data structures such as kd trees.

Recommended reading	Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars: "Computational Geometry: Algorithms and Applications", 2008, 3. Edition, Springer-Verlag Franco P. Preparata, Michael Shamos: "Computational Geometry: An Introduction", 1985, Springer-Verlag
Exams	Written/verbal Exam 90/20 Min. (graded)
Comments	

Lecture Cyber espionage

Internal number	I W165
Lecturer	B.Sc. Florian Dalwigk
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The students learn - the history of espionage and cyber espionage. - what is meant by hybrid warfare and which techniques are techniques used by intelligence services, among others. - how Germany's security architecture is organised. - know the legal aspects of cyber espionage. - know the espionage techniques used by intelligence and secret services. - how cyber attacks are attributed to specific actors and espionage groups (APTs). - what types of malware are used in the field of cyber espionage. - how threats in the context of cyber espionage can be technically detected and categorised/analysed using various frameworks. - know known cyber espionage cases from the past. - know technical possibilities for covert communication. Contents: - History of espionage and secret services - Security architecture in Germany (BND, MAD, BfV, LfV, ...) - Legal aspects of cyber espionage (Article 10 law, BNDG, BVerfSchG, § 99 StGB, ...) - Intelligence service espionage techniques - Operational security - Attribution procedures - Critical infrastructures - Advanced persistent threats - Hybrid warfare - Malware taxonomy - Social engineering - Stuxnet, SolarWinds, Pegasus, WannaCry, Krypto AG etc. - Threat intelligence - Covert communication - Threats from artificial intelligence Basic knowledge of ethical hacking is advantageous.

Recommended reading	- Huber, E. (2019). Cybercrime: Eine Einführung. Springer VS. - Oelmaier, F., Knebelsberger, U., & Naefe, A. (2023). Krisenfall Ransomware: Strategien für Wiederaufbau, Forensik und Kommunikation. Springer Fachmedien Wiesbaden.
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture Augmented and virtual reality

Internal number	I W171
Lecturer	Prof. Dr. Matthias Wölfel
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture ERP Special Chapters

Internal number	I W182
Lecturer	Prof. Dr. rer. pol. Mathias Philipp
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Enterprise analysis, software choice, system integration, basics of customizing, small development task in ABAP in addition to an ABAP introduction, optional: project office: integrated project and service processing with SAP ECC 6.0
Recommended reading	Lecture material completely as pdf documents, blackboard notes for interactive development of central problem positions, extensive material for every case study.
Exams	Written Exam 90 Min. (graded)
Comments	Lecture, workshops, lab: Case study based participation in group oriented workshops about enterprise analysis, presentation of group results, independent implementation of the analysis results of into SAP by appropriate system customizing in the lab. Independent treatment of another lab task (e.g., ABAP course, case study project office)

Lecture IT Security

Internal number	I W210
Lecturers	Dipl. Inform. (FH) Georg Magschok Dipl. Inform. (FH) Michael Fischer

Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Technological and topological mechanisms for securingnetworks, attack patterns and defense mechanisms againstthem. Basics of, variants of and defense against maliciousssoftware. Analysis and judgement of security mechanismsand related activities. Excercies at the end of each semester provide practicalexperience in dealing with security topics.
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	Presentation with a lot of room for discussions andinteraction. Finalized by a hands-on session.
Lecture Robotics	
Internal number	I W233
Lecturer	Prof. Dr. Björn Hein
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written/verbal Exam 90/20 Min. (graded)
Comments	
Lecture Graphical User Interfaces	
Internal number	I W332
Lecturer	Dipl.-Inf. Per Sterner
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The lecture first deals with SWT/JFace and the Eclipse Rich Client Platform 4 (RCP), which uses SWT and JFace as its basis. The most important topics are the model-view-controller pattern, layout management and event handling using the observer pattern. Based upon this techniques advanced technologies like the separation of business logic and user interface code using data binding and dialog control are presented. Other topics are internationalization and multithreading in the context of user interfaces. The last part of the lecture shows the declarative construction of user interfaces and the application of the RCP framework.

Recommended reading	Books and Web sites: - Marc Teufel, "Eclipse 4", entwickler.press, Oktober 2012 - Lars Vogel, "Eclipse 4 Application Development", Mai 2012 - M. Marinilli, "Professional Java User Interfaces", Wiley & Sons, 2006 - R. Warner, R. Harris, "The Definite Guide to SWT and JFace", Apress, 2007 - M. Scarpino et.al., "SWT/JFace in Action", Manning Publications Co., 2005 - J. McAffer, J. M. Lemieux, "Eclipse Rich Client Platform", Addison-Wesley Longman (Pearson Education), 2010 - G. Wütherich, N. Hartmann, B. Kolb, M. Lübken, "Die OSGi Service Platform", dpunkt-Verlag, 2008 - http://www.ralfebert.de/rcpbuch/ - http://www.eclipse.org/swt/ - http://www.eclipse.org/articles/Article-UI-Guidelines/Index.html - http://www.eclipse.org/swt/snippets/ - http://wiki.eclipse.org/index.php/JFaceSnippets - http://www.java2s.com/
Exams	Written Exam 90 Min. (graded)
Comments	Lecture preparation, exam preparation, implementing the bonus exercise, 30% of the lecture is held as a computer exercise
Lecture IT Consulting	
Internal number	I W433
Lecturer	Prof. Dr. rer. pol. Mathias Philipp
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	First, students are given an overview of the international consulting market and learn the methodological principles of this industry as well as the main areas of work of IT consulting. Various approaches to strategy consulting, process consulting and IT system consulting are discussed, along with the respective consulting tools and methods.
Recommended reading	Lecture material completely as pdf documents, blackboard notes for interactive development of central problem positions, instructions for interactive role play and case study material
Exams	Written Exam 90 Min. (graded)
Comments	Participation lecture, development of an interactive role play in the group, individual execution of a short case study.
Lecture Enterprise software from the cloud	
Internal number	I W779
Lecturer	Prof. Dr. Zoltán Nochta
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture

Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Python frameworks	
Internal number	I W800
Lecturer	Prof. Dr. Jürgen Zimmermann
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Sound design	
Internal number	I W801
Lecturer	B.Sc. Noah Ibers
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	This lecture introduces various concepts and areas of sound design. Besides technical basics to: - Sound theory and waves - Recording technology, storage and processing - sound synthesis creative applications of sound design like: - Audio processing - music and audio production - music theory - use and effect of sound in applications or films will also be thematized. The lecture teaches how professional soundscapes and moods can be created to achieve desired effects. The lecture is accompanied by exercises in which the knowledge is practically applied. The content of the assignments ranges from editing audio tracks, sound synthesis and scoring of film scenes to the development of sound brands.
Recommended reading	
Exams	Written Exam 60 Min. (graded)
Comments	

Lecture Business Process Management	
Internal number	I W854
Lecturer	Prof. Dr. Uwe Haneke
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	Starting with clarifying the terminology of business process management, the lecture gives an introduction and analysis of various concepts for business process documentation and modeling. This includes a discussion of support through appropriate methodologies and software tools. Modern concepts such as process mining are also covered. Using different tools, business processes are documented and subsequently simulated as part of a case study. Finally, aspects of process quality assurance, performance evaluation, and process cost accounting are addressed. Students are enabled to independently handle processes in a business environment, including documentation, modeling, and analysis. Overview: - The concept of processes and types of processes - Methodologies in process management - Process analysis (documenting processes) - Process modeling (modifying processes) - Tools for process modeling - Process simulation - Process mining - Key performance indicators for evaluating business processes
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture Databases Special Chapters

Internal number	I W907
Lecturer	M.Sc. Tobias Wink
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written/verbal Exam 90/20 Min. (graded)
Comments	

Lecture SAP Certification

Internal number	I W908
Lecturers	M.Sc. Matthias Mruzek-Vering Prof. Dr. rer. pol. Mathias Philipp
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	TERP10: SAP ERP - Integration of Business Processes is a 10-day training course held at the universities participating in the pilot project. The students learn how the fundamental integrative business processes in procurement, production, planning, project management, sales, customer service, asset management, financial accounting, human resources, and analytics interact within the SAP ERP application. The course provides students with a broad basic knowledge of the core business processes, business interrelations, and integration of business processes in SAP ERP. At the end of the course, students take a certification examination. If they pass the examination, they receive an SAP certificate, which is a fully recognized qualification in the industry.
Recommended reading	cource book
Exams	Written Exam 90 Min. (graded)
Comments	10-day training: in the moring: theory in the evening: laboratory last day: SAP certification 3 hours multiple chioce and multiple responce questions
Lecture Serious Games	
Internal number	I W910
Lecturer	Prof. Daniel Schwarz
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Model-based Software Development	
Internal number	I W911
Lecturer	Prof. Dr. Martin Sulzmann
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	This course covers the following areas. 1. Embedded software engineering 2. Programming language design and analysis. We will use the Go programming language to cover various aspects of programming language design and analysis. - Introduction to Go, a C style language with garbage collection. - Type inference - Method overloading Go interfaces Connection to other overloading approaches - Syntax analysis - Program analysis - Concurrency Multi-threading Message-passing Shared memory and data races
Recommended reading	- lectures notes and slides - exercies - online references
Exams	Written Exam 90 Min. (graded)
Comments	Prerequisistes: Softwareprojekt + Autonome Systeme

Lecture Mobile communication

Internal number	I W914
Lecturer	Prof. Dr. Oliver Waldhorst
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	In this course, students learn about the basic principles and technologies of mobile communication systems. After completing the course, they will be able to describe problems of mobile networks such as wireless signal transmission, media access and mobility management, identify and apply solution modules to solve these problems and evaluate existing solutions. They will also be able to analyze the characteristics and applications of various wireless systems such as WLAN, Bluetooth, mobile radio technologies (e.g. GSM, UMTS, LTE, 5G) and their underlying protocols and architectures. The lecture covers the following topics: - Basics of mobile communication: wireless signal transmission, multiplexing techniques, band spreading, OFDM, MIMO and multipath propagation. - Media access: methods such as Aloha, Carrier Sense Multiple Access (CSMA) and time-slot-based protocols. - Mobility management: position management, handover and routing in mobile networks. - Technologies and standards: WLAN (IEEE 802.11), Bluetooth, mobile networks (GSM, UMTS, LTE, 5G). The course is held in a flipped classroom format. Students prepare for the live sessions independently using lecture slides and explanatory videos. In the classroom sessions, the content is deepened through case studies and practical exercises. The examination consists of an oral examination or a written exam, depending on the agreement. The total workload is 60 hours, of which 20 hours are spent on asynchronous learning, 20 hours on face-to-face events and 20 hours on exam preparation.
Recommended reading	- Slide collection and explanatory videos in the ILIAS system - Jochen Schiller, Mobile Communication. Pearson Studium, 2003. - Martin Sauter, Grundkurs Mobile Kommunikationssysteme, 8th edition, 2022 (available as an e-book via the KIT library) - Further information in ILIAS and in the lecture
Exams	Verbal Exam 20 Min. (graded)
Comments	
Lecture Concept, Design und Presentation of interactive Projects	
Internal number	I W915
Lecturer	Prof. Thomas Hinz
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Homework 1 Semester (graded)
Comments	
Lecture CC Operation	
Internal number	I W917

Lecturer	Dr. Günther Schreiner
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture In-memory Databases	
Internal number	I W920
Lecturer	Prof. Dr. Zoltán Nochta
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Planning and optimisation with evolutionary methods	
Internal number	I W927
Lecturer	Dr.-Ing. Wilfried Jakob
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Predictive Modelling and Machine Learning	
Internal number	I W928
Lecturer	Prof. Dr. Martin Sulzmann
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	English
Content	

Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture Microservices

Internal number	I W930
Lecturer	Prof. Dr. Jürgen Zimmermann
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Students learn in a practical way about the architectural principle of microservices, which have established themselves alongside conventional, cumbersome application servers. Using a consistent example, microservices are developed with the following platform: - Kubernetes (incl. Helm) and Docker images for virtualisation, orchestration, service registry, etc. The products Docker Desktop Community and Lens are used as administration tools. - Spring Boot as a framework to implement microservices with REST and also GraphQL as an interface. - Spring Data JPA to access relational database systems with Hibernate and the Jakarta Persistence standard. - PostgreSQL, MySQL and Oracle XE are used as relational database systems with the administration tools pgadmin, phpMyAdmin and SQL Developer and are all installed and operated in Kubernetes. - IntelliJ IDEA Ultimate is used as the IDE. For IntelliJ IDEA Ultimate - and other JetBrains products - HKA students have been able to obtain a free licence, valid for 1 year, on the initiative of the lecturer since 2014. - Gradle with Cloud Native Buildpacks is used as a build system. As a result, students acquire the skills to weigh up the advantages and disadvantages of microservices against monolithic architectures (WOZU).
Recommended reading	"Spring Framework Documentation", https://docs.spring.io/spring/docs/current/spring-framework-reference "Spring Boot Reference Guide", https://docs.spring.io/spring-boot/docs/current/reference/htmlsingle "Spring GraphQL Reference", https://docs.spring.io/spring-graphql/docs/1.0.0-M2/reference/html "Spring Data JPA", https://docs.spring.io/spring-data/jpa/docs/current/reference Docker, https://www.docker.com/why-docker Kubernetes, https://kubernetes.io/docs
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture App Programming for iOS

Internal number	I W931
Lecturer	B.Sc. David von Knobelsdorff

Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Thesis
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Practical SAT Solving and Automated Planning	
Internal number	I W933
Lecturer	Dr. Tomas Balyo
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	English
Content	The course offers an introduction to the methods and techniques used in Boolean Satisfiability (SAT) solving and Aautomated Planning. The students will learn how to use SAT solvers and automated planners and also how they work. The topics covered in the lecture include: - Practical applications of SAT solving - The DPLL/CDCL algorithm and how they are implemented - Local search SAT solving algorithms - Encoding problems as SAT problems and selecting the proper SAT solver - Applications of automated planning - Formalization of planning problems and the PDDL language - Basic state space search algorithms (forwards/backwards search) - Heuristic search algorithms and planning heuristics - Satisfiability based planning - Hierarchical task network planning - classical scheduling approaches - constraint-based scheduling - planning for virtual agents in computer games Ziele: - The students will be able to model various problems as SAT or as planning tasks in the PDDL language and solve them using off-the-shelf solvers. - The students will understand the approaches used in SAT solving and automated planning algorithms, which will allow them to efficiently model and solve real world problems by selecting the proper tools for the given task.
Recommended reading	
Exams	Homework 1 Semester (graded)
Comments	
Lecture Modern server applications and web apps with TypeScript	
Internal number	I W934

Lecturer	Prof. Dr. Jürgen Zimmermann
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture Microtechnology Laboratory	
Internal number	I W935
Lecturer	Prof. Dr. rer. nat. Oliver Schecker
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Laboratory Course
Language of instruction	German
Content	Development of applications with a microtechnology focus. Examples include autonomous micro airships, self-monitored first aid kits, energy self-sufficient door signs, components of the "High Speed Karlsruhe" racing car if the student is involved in this project (https://www.highspeed-karlsruhe.de/).
Recommended reading	
Exams	Hands-on Work 1 Semester (not graded)
Comments	

Lecture Data protection according to GDPR	
Internal number	WIB179
Lecturer	Prof. Dr. Ingo Stengel
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	

Module Elective courses 3	
Internal number	INFB710
Coordinator	Prof. Dr.-Ing. Holger Vogelsang
Scope	8.0 ECTS points, 8.0 Contact hours
Placement	7th Semester
Pre-requisites with regard to content	none
Pre-requisites according to the examination regulations	Modul Internship
Competences	The student should be able to lay his emphasis on individual interests.
Exams	Individual exams
Lecture Embedded Firmware for the Internet of Things	
Internal number	I W161
Lecturer	M.Sc. Nils Ruf
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	The Internet of Things (IoT) networks a large number of sensors and actuators in the private smart home sector as well as in the industrial environment. The end devices only have very limited resources in terms of computing power, memory size and energy budget. Nevertheless, the end devices must be able to fulfil their task in a timely and reliable manner without becoming a target for cyber attacks. This course provides an overview of the special requirements for software development for embedded, networked systems in order to be able to operate them in an energy-efficient manner and with limited resources. Topics covered include memory management, multitasking and scheduling, access to hardware and peripherals, various bus protocols, connectivity and security aspects. These topics are deepened practically in a laboratory and the students will implement the knowledge they have learnt in an example project.
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture Practical application of network engineering and system operations	
Internal number	I W162
Lecturer	B.Sc Erik Dyka
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture

Language of instruction	German
Content	In the course "Practical Application of Network Engineering and System Operations", students acquire practical skills in the planning, configuration and implementation of company networks. They learn to create network concepts, apply subnetting and configure switches with VLANs and redundant connections. In addition, basic firewall settings are made with PfSense, including security policies such as DMZ, NAT and zero trust principles. Another focus is on setting up NAS systems with suitable RAID levels and creating highly available storage and Proxmox clusters. The students deploy virtual machines and simulate system failures. In the final project, they develop a complete network and hosting concept for a practical scenario, implementing redundancy, VPN access and encrypted communication. At the end of the course, students will be able to plan, set up and operate company networks securely. After successfully completing this module, students will be able to - Set up and configure a network: Design, plan and set up a small business network. Identify network components such as switches, firewalls and routers and explain their tasks in the OSI model. Create a network concept and carry out correct subnetting. Configure VLANs (access, tagged and trunk ports) and set up redundant connections between switches. - System configuration: Configure a switch via console cable or SSH and make basic VLAN settings. Install and configure a PfSense firewall (WAN/LAN ports, DNS, DHCP). Set up firewall rules for network security (DMZ, default no-access, zero trust, microsegmentation, NAT, port forwarding). Implement the combination of switches and firewalls to realise a secure network. - Server and storage clusters: Configure NAS systems with appropriate RAID levels and set up file shares. Set up and administer high-availability storage clusters. Install and configure Proxmox clusters and deploy virtual machines (VMs). Perform live migrations between cluster nodes and simulate system failures. - Practical network planning and operation: Design an enterprise network for 24/7 operation and overcome the challenges of continuous operation. Identify and eliminate sources of error such as single points of failure. Plan and implement network segmentation and cabling strategies for different use cases. - Final project - realisation of a scenario: Develop a network and hosting concept for a specific scenario (e.g. corporate network). Implement VPN solutions for different user groups. Consistently implement security guidelines such as "default no access" and encrypted communication. Create and partially implement a concept for fail-safe and redundant networks.

Recommended reading	Lecture notes KN1+2
Exams	Laboratory Work 1 Semester (graded)
Comments	Prerequisites: - Successful completion of KN1 - KN2 content is a prerequisite - Creation of a boot stick and independent installation of a computer with a Linux distribution
Lecture Game Design	
Internal number	I W163
Lecturer	M.Sc. Kevin Torner
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Hands-on Experience
Language of instruction	German
Content	This course will give you an insight into the multifaceted world of game design. You will deal with fundamental questions such as the definition of a game, the constituent elements of a game and what actually constitutes fun. The aim of the course is to provide you with basic tools to help you analyze and design games.
Recommended reading	- Jesse Schell, "The Art of Game Design: A book of lenses", CRC Press. 1st edition, 2008. - Ernest Adams, Joris Dormans, "Game Mechanics: Advanced Game Design", New Riders Publishing, 1st edition, 2012. - Raph Koster, "Theory of Fun for Game Design", O'Reilly Media, 2nd edition, 2013.
Exams	Homework 1 Semester (graded)
Comments	
Lecture Leadership Training	
Internal number	I W170
Lecturers	Prof. Dr. rer. pol. Mathias Philipp Dipl. Inform. Klaus-Dieter Hüttel
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Project Lecture
Language of instruction	German
Content	Boundary conditions and expectations of communication are developed in intense discussion. Strategies and tactics for discussions and the management of critical situations are trained.
Recommended reading	Blackboard and whiteboard-poster
Exams	Module exam
Comments	Seminary lecture, block course after the end of the term
Lecture Autonomous Systems Labor	

Internal number	I W276
Lecturers	Prof. Dr. Norbert Link M.Sc. Mickael Cormier
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Project Lecture
Language of instruction	German
Content	Project 1: Implementation of an image-processing-based handling system, which performs transport activities on the basis of information extracted from a digital video camera Project 2: Implementation of the core functionality of an aircraft docking guidance system, which directs aircraft to their respective stopping position at the airport gate Project 3: Autonomous navigation, obstacle avoidance and object following with robots
Recommended reading	Lecture notes, task descriptions, project guidelines and FAQs, all accessible via the internet. Handbooks and relevant literature is available on site and for homework in the library.
Exams	Laboratory Work 1 Week (graded)
Comments	Theoretical familiarisation, practical work, reporting, partly as self-responsible work
Lecture Software Quality	
Internal number	I W392
Lecturer	Prof. Dr. Dirk Hoffmann
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Students gain practical access to the field of software quality assurance. They work on a specific chapter from the field of software quality assurance and present their results to the other students in a series of short presentations. The participants then discuss the results.
Recommended reading	Hoffmann: "Software-Qualität", Springer-Verlag, 2013
Exams	Presentation 20 Min. (graded)
Comments	Lecture, student presentations
Lecture Search Engines	
Internal number	I W393
Lecturer	B.Sc. Michael Siebers
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	
Recommended reading	
Exams	Concept 1 Semester (graded)
Comments	
Lecture Project Management	
Internal number	I W422
Lecturer	Prof. Dr. Uwe Haneke
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Project Lecture
Language of instruction	German
Content	The lecture focuses mainly on practice oriented project management and new procedure models like Scrum. - Introduction to IT project management - Procedure models in IT project management - Defining a project - The project plan: the heart of the project - Getting started: Initialisation of the project - Project controlling - The final words: how to complete a project
Recommended reading	
Exams	Verbal Exam 20 Min. (graded)
Comments	
Lecture Artificial intelligence in cyber security	
Internal number	I W506
Lecturer	B.Sc. Florian Dalwigk
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The students - can categorise terms such as LLMs, ML, DL, NN etc. in an overall context. - understand how LLMs work and where they can (not) be used. - learn how to generate and detect deep fakes. - can develop small scripts to address LLM APIs (online and local) and model attacks and defence strategies based on them. - are familiar with various attacks on LLMs/LLM applications and can carry them out independently. - can confidently apply various prompt engineering techniques to practical problems. Contents: - Basics of cyber security - Basics of generative AI - Generating and detecting deep fakes - Local language models, ChatGPT - ShellGPT - OWASP Top 10 for LLM Applications - LLM exploits (Art-Prompt, Grandma-Exploit, ...) - Social engineering with AI - Cyber defence with AI - Prompt engineering
Recommended reading	Florian Dalwigk, "Hacking and cybersecurity with AI" (will be provided as script)
Exams	Written/verbal Exam/Hands-on Work 90/20/1 Min./Min./Semester (graded)
Comments	Prerequisites: Basic knowledge of programming (preferably Python), basic knowledge of network technology
Lecture Ethical hacking	
Internal number	I W507
Lecturer	B.Sc. Florian Dalwigk
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	The students - understand the legal and ethical problems associated with ethical hacking, - learn how to set up their own pentest lab with Kali Linux and VirtualBox, - can identify and exploit security vulnerabilities in web applications and servers, - are able to develop simple scripts to identify and exploit vulnerabilities, - learn how to carry out cyber attacks with AI, - learn how to summarise the vulnerabilities found in a pentest report. Content: - Legal and ethical basics of ethical hacking - Cyber kill chain - Pentesting tools, including Hashcat, Hydra, Gobuster and Nmap - Reverse shells - Secure saving and cracking of passwords - XSS, SQL injections, buffer overflows - OWASP Top 10 - Social engineering - Metasploit - The role of AI in cyber security - Pentest reports
Recommended reading	Florian Dalwigk, "Ethical Hacking - The big book on hacking with Python" (provided as script)
Exams	Written/verbal Exam/Hands-on Work 90/20/1 Min./Min./Semester (graded)
Comments	

Lecture Post-quantum cryptography

Internal number	I W508
Lecturer	B.Sc. Florian Dalwigk
Scope	4.0 ECTS points, 4.0 Contact hours 120 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture External selected chapter 1

Internal number	I W600
Lecturer	Prof. Dr.-Ing. Holger Vogelsang
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German

Content	This course is a placeholder for an external, graded course from another faculty or university. You must obtain authorisation for the external subject before attending it.
Recommended reading	
Exams	Written Exam 90 Min. (graded)
Comments	
Lecture InspirING	
Internal number	I W600.a
Lecturer	Prof. Dr.-Ing. Holger Vogelsang
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Hands-on Experience
Language of instruction	German
Content	
Recommended reading	
Exams	Verbal Exam 20 Min. (graded)
Comments	
Lecture External selected chapter 2	
Internal number	I W700
Lecturer	Prof. Dr.-Ing. Holger Vogelsang
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	This course is a placeholder for an external, graded course from another faculty or university. You must obtain authorisation for the external subject before attending it.
Recommended reading	
Exams	Written Exam 90 Min. (not graded)
Comments	
Lecture Softwareengineering Special Chapters	
Internal number	I W701
Lecturer	Prof. Dr. Peter Henning
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Seminar
Language of instruction	German

Content	The course focuses on fundamental object-oriented design methods with an emphasis on design patterns and model driven concepts. The students learn to recognize, to know when to use, and to apply design patterns in varying situations in the context of an evolutionary development process. Furthermore the ability of an axiomatic rule base application of patterns, within a model driven approach, are discussed.
Recommended reading	Slides, textbooks, and other literature: Folien-Skript, Lehrbücher: - Gamma, Erich et. al. Entwurfsmuster: Elemente wiederverwendbarer objektorientierter Software - München : Addison-Wesley, 2001. - Buschmann, Frank. A system of patterns (Pattern-Oriented Software Architecture Volume 1) - John Wiley & Sons. 1996. - Schmidt, Douglas C. Patterns for concurrent and networked objects (Pattern-Oriented Software Architecture Volume 2) - John Wiley & Sons. 2000. - Michael Kircher, Prashant Jain. Patterns for Resource Management (Pattern-Oriented Software Architecture Volume 3) - John Wiley & Sons. 2004. - Frank Buschmann, Kevlin Henney, Douglas C. Schmidt. A Pattern Language for Distributed Computing (Pattern-Oriented Software Architecture Volume 4) - John Wiley & Sons. 2007. - Frank Buschmann, Kevlin Henney, Douglas C. Schmidt. On Patterns and Pattern Languages (Pattern-Oriented Software Architecture Volume 5) - John Wiley & Sons. 2007. - Fowler, Martin. Analysemuster: wiederverwendbare Objektmodelle: Ein Pattern-Katalog für Business-Anwendungen - Addison-Wesley-Longman. 1999. - OMG Object Management Group. Meta Object Facility (MOF) Specification - Version 2.4.1: OMG, 2011.
Exams	Presentation 20 Min. (graded)
Comments	The lecture will take the form of seminars with exercises.

Lecture Teamteaching

Internal number	I W730
Lecturers	Alle Dozenten Prof. Dr.-Ing. Holger Vogelsang
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Project Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Verbal Exam 20 Min. (graded)
Comments	- Preparation of a tutorial, support of student groups - Organisation of events

Lecture Multimedia (Blended Learning)

Internal number	I W774

Lecturer	Prof. Dr. Peter Henning
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Project Lecture
Language of instruction	German
Content	
Recommended reading	Book: Henning, Taschenbuch Multimedia.
Exams	Online Test 4 Parts (graded)
Comments	

Lecture Reinforcement Learning

Internal number	I W775
Lecturer	Prof. Dr. Patrick Baier
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	This lecture teaches the basics of "Reinforcement Learning", which is an important part of machine learning. The goal of reinforcement learning is to choose the optimal action in different situations so that the behavior of an agent can be optimally controlled. Well-known examples of reinforcement learning include: - Learning Atari Games; - Alpha-Go - the algorithm that was the first to beat the world champion at playing Go; - Solving a Rubik's Cube with the help of a robotic arm. As part of the lecture, the basic idea of reinforcement learning is first conveyed and the underlying formal framework is introduced. Starting with simple approaches, increasingly more advanced methods are highlighted, up to the training of an agent that automatically learns to play Atari games. The lecture contains a practical component in which the presented approaches are implemented using Python and PyTorch. Previous knowledge of Python is desirable but not essential.
Recommended reading	Sutton and Barto, "Reinforcement Learning: An Introduction", The MIT Press, 2nd edition, 2018.
Exams	Written/verbal Exam 90/20 Min. (graded)
Comments	

Lecture Social commitment

Internal number	I W776

Lecturer	Prof. Dr.-Ing. Holger Vogelsang
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Hands-on Experience
Language of instruction	German
Content	This course enables students to obtain ECTS credits for social work done at Karlsruhe University of Applied Sciences. The activity must be closely coordinated with a professor of the faculty. This can be, for example, support for the O-Phase or support for visually impaired students. In the case of the O-Phase, you will usually have to work on two semesters in order to achieve the required minimum number of hours. If you are interested, you can also obtain the "Certificate of International and Intercultural Competence (CIIC)". It certifies the intercultural competences and foreign language skills acquired during the degree programme, provides evidence of study-related experiences abroad and lists the framework in which the participants have been involved in intercultural activities. To earn the CIIC, you must cover three of four subject areas. The main component in subject area 1 is the voluntary commitment of at least 50 hours (about 2 hours per week in one semester), which can be completed in institutions or projects with an international and/or intercultural connection. In addition to the commitment, you will attend an introductory event as well as a reflection workshop and prepare an experience report, which is necessary to pass the subject area. If you have any questions about the certificate, please contact the Center of Competence: https://www.h-ka.de/ciic Through the Center of Competence, it is also possible to obtain the "Certificate for Social Engagement (ZGE)". It takes into account an even wider range of opportunities to get involved. Find your suitable area, whether it is community, social, cultural or ecological engagement. Your social engagement should comprise at least 100 time hours and last for at least one year. In addition to your commitment, you will attend various seminars from the Studium Generale (a total of 8 ECTS) to link your practical experience with theoretical knowledge. This certificate cannot be recognised as an elective subject. You can find more information here: https://www.h-ka.de/zge At regular intervals, the Center of Competence offers introductory events and reflection workshops for HKA students who are involved in voluntary work outside of their studies. This gives them the opportunity to exchange their experiences as volunteers with other participants and learn to reflect on and classify the insights they have gained. The next dates can be found on the CIIC website.
Recommended reading	
Exams	Verbal Exam 20 Min. (not graded)
Comments	

Lecture Real-time graphics

Internal number	I W777
Lecturer	B.Sc. Tim Hänlein
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Hands-on Work 1 Semester (graded)
Comments	

Lecture High Performance Computing

Internal number	I W909
Lecturer	Prof. Dr. Britta Nestler
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Written/verbal Exam 90/20 Min. (graded)
Comments	

Lecture ABAP Programming

Internal number	I W918
Lecturers	B.Sc. Stefan Schorn Prof. Dr. rer. pol. Mathias Philipp
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Lecture
Language of instruction	German
Content	Introduction to the ABAP programming language with practical exercises in SAP NetWeaver Application Server ABAP. Students should familiarise themselves with language elements, workbench, database, selection screens, function modules and ABAP OO and be able to apply them independently to new problems.
Recommended reading	- Lecture material completely in PowerPoint slides - Blackboard notes for interactive development of core problems - Exercise sheets and independent practical exercises on the SAP system
Exams	Written Exam 90 Min. (graded)
Comments	

Lecture High Speed Karlsruhe

Internal number	I W936
Lecturer	Prof. Dr.-Ing. Holger Vogelsang
Scope	2.0 ECTS points, 2.0 Contact hours 60 Stunden gesamt, davon 30 Stunden Kontaktstudium.
Type/mode	Hands-on Experience
Language of instruction	German
Content	Collaboration on the "High Speed Karlsruhe" project in the MMT faculty. If you are interested, please contact Mr Stumpf: oliver.stumpf@h-ka.de
Recommended reading	http://www.hskampus.de https://www.facebook.com/hskampus https://www.instagram.com/hskampus/
Exams	Hands-on Work 1 Semester (graded)
Comments	

Lecture Smart Technologies

Internal number	SHELLSST
Lecturer	Prof. Dr.-Ing. Holger Vogelsang
Scope	5.0 ECTS points, 4.0 Contact hours 150 Stunden gesamt, davon 60 Stunden Kontaktstudium.
Type/mode	Project Lecture
Language of instruction	German
Content	
Recommended reading	
Exams	Student Research Project 1 Semester (graded)
Comments	

Module Scientific Working	
Internal number	INFB720
Coordinator	Prof. Dr. Heiko Körner
Scope	5.0 ECTS points, 0.0 Contact hours
Placement	7th Semester
Pre-requisites with regard to content	Student Research Project, Key Qualification
Pre-requisites according to the examination regulations	Modul Internship
Competences	This module enables students to apply the basic principles of research in computer science in a method-based manner. They can evaluate scientific literature to use it in their own work. They are then able to write their own scientific papers.
Exams	Individual exams
Lecture Scientific Working	
Internal number	INFB721
Lecturer	Alle Dozenten
Scope	5.0 ECTS points, 0.0 Contact hours 150 Stunden gesamt, davon 0 Stunden Kontaktstudium.
Type/mode	Hands-on Experience
Language of instruction	German
Content	Students work independently on a practical problem using scientific and practical methods. Topics include the independent development of the methodology, the topic and the exact problem as well as the structure of the paper and the creation of a bibliography. The results are discussed and presented with the lecturers. The students thus learn the procedure for writing the final Bachelor's thesis.
Recommended reading	- Documents on the process, the structure of a paper and citation - Peter Rechenberg, Gustav Pomberger: Informatik-Handbuch. Hanser Fachbuch, 2006, ISBN 3446218424 - Jürg Niederhauser: Die schriftliche Arbeit - kurz gefasst. Bibliographisches Institut, Mannheim, 2006, ISBN 3411042346
Exams	Exercise 1 Month (not graded)
Comments	

Module Thesis	
Internal number	INFB730
Coordinator	Prof. Dr. Heiko Körner
Scope	12.0 ECTS points, 0.0 Contact hours
Placement	7th Semester
Pre-requisites with regard to content	System Software, Business Administration and Service Management, Databases and Communication Networks 1, Databases and Communication Networks 2, ERP Systems, Antomation and Declarative Programming, Embedded Software, IT Security, Computer Science 1, Computer Science 2, Mathematics 1, Mathematics 2, Modern Programming Methods, Internship, Student Research Project, Key Qualification, Software Engineering and Distributed Systems 2, Software Laboratory, Language Competence, Computer Engineering 1, Computer Engineering 2, Man-Machine-Communication, Scientific Working
Pre-requisites according to the examination regulations	Modul Internship
Competences	After successfully completing this module, students are able to independently solve a practical problem or research task using scientific methods within a specified period of time. They can structure the task, check dependencies, collect the necessary resources and then work on the task using a specially derived schedule. They can present the written results in an appealing form.
Exams	Individual exams
Lecture Thesis	
Internal number	INFB731
Lecturer	Alle Professoren
Scope	12.0 ECTS points, 0.0 Contact hours 360 Stunden gesamt, davon 0 Stunden Kontaktstudium.
Type/mode	Thesis
Language of instruction	German
Content	In the final thesis, students work independently on a practical problem or research task within a specified period of time using scientific methods. They structure the task, check dependencies, collect the necessary resources and work on the problem according to a timetable. The written thesis summarises the results in a didactically meaningful way and meets academic standards.
Recommended reading	Suitable for the task as agreed
Exams	Bachelor Thesis 4 Months (graded)
Comments	

Module Final examination	
Internal number	INFB740
Coordinator	Prof. Dr. Heiko Körner
Scope	3.0 ECTS points, 0.0 Contact hours
Placement	7th Semester
Pre-requisites with regard to content	Thesis, System Software, Business Administration and Service Management, Databases and Communication Networks 1, Databases and Communication Networks 2, ERP Systems, Antomation and Declarative Programming, Embedded Software, IT Security, Computer Science 1, Computer Science 2, Mathematics 1, Mathematics 2, Modern Programming Methods, Internship, Internship Preparation and Roundup, Student Research Project, Key Qualification, Software Engineering and Distributed Systems 2, Software Laboratory, Language Competence, Computer Engineering 1, Computer Engineering 2, Man-Machine-Communication, Scientific Working
Pre-requisites according to the examination regulations	Modul Internship
Competences	Participation in this module enables students to convincingly present the results achieved within a specialised, application-related thesis to an expert audience. They can analyse the content of such work, select the key aspects and present these in a didactically appropriate short presentation. In a subsequent discussion, they are also able to defend their results.
Exams	Individual exams
Lecture Final examination	
Internal number	INFB741
Lecturer	Alle Professoren
Scope	3.0 ECTS points, 0.0 Contact hours 90 Stunden gesamt, davon 0 Stunden Kontaktstudium.
Type/mode	Colloquium
Language of instruction	German
Content	The final examination covers all topics relevant to computer science in the main study programme. Students demonstrate that they have understood and can apply interdisciplinary contexts. They answer questions from various areas of computer science that are related to their final thesis. With the final examination, they demonstrate that they have the competence to work independently on novel problems in computer science, defend them in a technically sound manner in front of an appropriate audience and can also provide them for further work.
Recommended reading	
Exams	Verbal Exam 20 Min. (not graded)
Comments	