# Hochschule Karlsruhe

# Faculty for Computer Science and Business Information Systems

# Module manual

# Course of studies Computer Science (Master), ER 5

# Summer semester 2024

# Module Computer Science (Master), ER 5

## Module Concepts and Designs of interactive Systems

| | |
|---|---|
| Internal number | INFM110I |
| Coordinator | Prof. Thomas Hinz |
| Scope | 7.0 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 | Students learn theoretical knowledge of designing interactive systems and put their knowledge into practice in constructing prototypes. With knowledge of design principles and concepts they are able to solve design problems. They gain practical experiences on innovative natural user interfaces and interaction in public space and can develop new forms of human-machine interfaces. |
| Exams | Written/verbal Exam 120/20 Min. (graded) |

## Lecture Design of Interactions

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|---|---|
| Internal number | INFM111I.a |
| Lecturer | Prof. Thomas Hinz |
| Scope | 3.0 ECTS points, 2.0 Contact hours<br>90 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |
| Content | The students learn a variety of methods and strategies for designing interactive systems and how to apply them. They are able to identify and solve problems in the design of corresponding systems. They deal with the cultural context of interactions and engage in critical reflection about the history of interaction design. |

| Recommended reading | Script, Literature:<br>- R. Klanten, S. Ehmann, F. Schulze: "Visual Storytelling: Inspiring a New Visual Language", 2011, ISBN-13: 978-3899553758<br>- R. Klanten, L. Feireiss: "A Touch of Code: Interactive Installations and Experiences", 2011, ISBN-13: 978-3899553314<br>- J. Sauter, S. Jaschko, J. Ängeslevä: ART+COM: "Medien, Räume und Installationen", 2011, ISBN-13: 978-3899553864<br>- J. Pannafino: Interdisciplinary Interaction Design: "A Visual Guide to Basic Theories, Models and Ideas for Thinking and Designing for Interactive Web Design and Digital Device Experiences", 2012, ISBN-13: 978-0982634813<br>- H.-D. Hellige: "Mensch-Computer-Interface: Zur Geschichte und Zukunft der Computerbedienung", 2008, ISBN-13: 978-3899425642<br>- J. Schenk, G. Rigole: "Mensch-Maschine-Kommunikation: Grundlagen von sprach- und bildbasierten Benutzerschnittstellen", 2010, ISBN-13: 978-3642054563<br>- R. Dorau: "Emotionales Interaktionsdesign Gesten und Mimik interaktiver Systeme, 2011, ISBN-13: 978-3642031007<br>- D. Wigdor, D. Wixon: "Brave NUI World: Designing Natural User Interfaces for Touch and Gesture", 2011, ISBN-13: 978-0123822314 |
|---|---|
| Exams | Module exam |
| Comments | Participation at tuition, in class group work and discussion. |

## Lecture Perception based Interaction

| Internal number | INFM111I.b |
|---|---|
| Lecturer | Prof. Dr. Matthias Wölfel |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |

| Content | Nowadays machines are already capable of communicating with human beings in a "natural" fashion through the existence of capabilities to understand natural language, recognise hand writing, and for interpreting gestures. However, they are also capable of extending human perception through augmenting situations with additional knowledge ("augmented reality"), i.e. the depiction of information is contextualised according to the situation as perceived by the machine. Examples of this are smartphones and tablets (voice-control, face recognition, "goggle", music recognition), vehicles (driver assistance systems), video game consoles (movement interpretation), but also in work-related contexts (surgery, human-robot-cooperation). The lecture covers the foundations of voice- and gesture recognition, the sensing and recognition of objects in the environment, as well as information presentation. Sample applications (e.g. using the Kinect sensor) allow students to gain deeper understanding of the covered material. Topics include: - system performance of perception-based interaction - sensor systems for the recognition of the environment (sound, video, 3d, touch, acceleration and rotation) - Recognition (object recognition in video and 3d, speech- and behaviour recognition) - interaction models (augmented reality, situation graphs) |
|---|---|
| Recommended reading | |
| Exams | Module exam |
| Comments | |

## Lecture Interactive Systems Exercise

| Internal number | INFM112I |
|---|---|
| Lecturer | Prof. Thomas Hinz |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Exercise |
| Language of instruction | German |
| Content | The participants apply their theoretical understanding of the conception and design of interactive systems. They design and develop prototypes of interactive systems. The students experiment with innovative forms of human-computer interfaces and their possibilities. They are capable of presenting their results convincingly using multimodal tools, as well as justify them in a methodical and theoretically grounded manner. |
| Recommended reading | - J. Hunt: "Talk to Me: Design and the Communication between People and Objects", 2011, ASIN: B009XR1NSY<br>- D. Roberts: "Making Things Move: Die Welt bewegen", 2011, ISBN-13: 978-3868991390<br>- T. Igor, P. Stefan: "Making Things Talk: Die Welt hören, sehen, fühlen", 2012, ISBN-13: 978-3868991628<br>- G. Borenstein: "Making Things See: 3D vision with Kinect, Processing, Arduino, and MakerBot", 2012, ISBN-13: 978-1449307073<br>- D. Schmalstieg, T. Höllerer: "Augmented Reality", 2016, ISBN-13 978-0-321-88357-5 |

| Exams | Hands-on Work 1 Semester (graded) |
|---|---|
| Comments | - Teamworking |
| | - Experiments on design and prototyping |
| | - Presentation and discussion of the results |

## Module Theory of efficient algorithms

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|---|---|
| Internal number | INFM110S |
| Coordinator | Prof. Dr. Heiko Körner |
| Scope | 7.0 ECTS points, 5.0 Contact hours |
| Placement | 1st Semester |
| Pre-requisites with regard to content | none |
| Pre-requisites according to the examination regulations | none |
| Competences | The module deals with the design of efficient algorithms in theory and practice. Students learn proof techniques for graph-theoretical problems in order to show the correctness of algorithms with exact logical conclusions. To the end, they analyze runtimes of procedures and apply suitable analysis techniques. Using the example of numerical problems such as the interpolation and approximation of mathematical models, students also independently design solution methods and then implement them. The iteration methods are implemented by the students for specific technical problems and parallelized for use on modern high-performance computers. After completing the module, students will be able to analyze and evaluate algorithms theoretically, but also to apply modeling and simulation methods for the computer-aided design of process sequences in practice. |
| Exams | Written Exam 120 Min. (graded) |

## Lecture Graph Algorithms

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|---|---|
| Internal number | INFM111S.a |
| Lecturer | Prof. Dr. Heiko Körner |
| Scope | 3.0 ECTS points, 2.0 Contact hours<br>90 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |
| Content | This couse gives an overview of some basic graph algorithms and their applications. The students learn to apply further algorithms and how to implement them. Furthermore, techniques for proving the correctness and complexity of algorithms are thoroughly studied.<br>After a brief theoretical introduction to graphs some fundamental algorithms like depth first search and breadth first search are presented. Other algorithms deal with the detection of strongly connected components, topological sorting and the calculation of shortest paths. Efficient tests concerning the existence of circuits in a graph are also discussed.<br>For this course some basic knowledge of programming and the safe handling of the O-calculus are necessary. Furthermore, the participant is assumed to be familiar with inductive proofs. Both topics are handled in an appendix of the lecture notes. |

| Recommended reading | The substance of the lecture will be discussed at the blackboard. Lecture notes containing the complete material are also available. Lecture notes, exercises and their solutions are available online. |
| --- | --- |
| | Literature: T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein: Introduction to Algorithms. MIT Press, 2001, ISBN 0-262-03293-7. |
| Exams | Module exam |
| Comments | Classical lecture. Several exercises deepen the field of study and are discussed in the classroom if desired. |

## Lecture Modeling and Simulation

| Internal number | INFM111S.b |
| --- | --- |
| Lecturer | Prof. Dr. Britta Nestler |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |
| Content | |
| Recommended reading | |
| Exams | Module exam |
| Comments | |

## Lecture Modeling and Simulation Exercise

| Internal number | INFM112S |
| --- | --- |
| Lecturer | Prof. Dr. Britta Nestler |
| Scope | 2.0 ECTS points, 1.0 Contact hours<br>60 Stunden gesamt, davon 15 Stunden Kontaktstudium. |
| Type/mode | Exercise |
| Language of instruction | German |
| Content | |
| Recommended reading | |
| Exams | Exercise 1 Semester (not graded) |
| Comments | |

## Module Intelligent Systems

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|---|---|
| Internal number | INFM120I |
| Coordinator | Prof. Dr.-Ing. Astrid Laubenheimer |
| Scope | 7.0 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 | |
| Exams | Written Exam 120 Min. (graded) |

### Lecture Model-Based Pattern Recognition

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|---|---|
| Internal number | INFM121I.a |
| Lecturer | Prof. Dr. Norbert Link |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |
| Content | Introduction: Examples and discussion of intelligent systems<br>Stochastic processes and decision theory<br>Data, features, feature assessment and feature space transformations<br>Recognition by classification<br>Attributes by estimation<br>Behaviour recognition by means of discrete and continuous models<br>Automatic diagnosis |
| Recommended reading | The matter is presented by means of animated slides and extensive derivations at the blackboard. The presentation is available on the internet. For further study four text books are recommended:<br>- Pattern classification : a unified view of statistical and neural approaches / Jürgen Schürmann New York [u.a.] : Wiley & Sons, 1996.<br>- Pattern classification / Richard O. Duda ; Peter E. Hart ; David G. Stork. - 2. ed. New York ; Weinheim [u.a.] : Wiley, 2001.<br>- Pattern recognition / Sergios Theodoridis and Konstantinos Koutroumbas. - 3. ed. Amsterdam ; Heidelberg[u.a.] : Elsevier Academic Press, 2006.<br>- Learning with Kernels : support vector machines, regularization, optimization, and beyond / Bernhard Schölkopf ; Alexander J. Smola Cambridge, Mass. [u.a.] : MIT Press, 2002. |
| Exams | Module exam |
| Comments | Class (including training) (32h), self-responsible work (58h) |

### Lecture Unsupervised Learning

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|---|---|
| Internal number | INFM121I.b |

| 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 | Module exam |
| Comments | |

## Lecture Intelligent Systems Exercise

| Internal number | INFM122I |
|---|---|
| Lecturer | Prof. Dr.-Ing. Astrid Laubenheimer |
| 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  Concepts of Programming Languages** | |
|---|---|
| Internal number | INFM120S |
| Coordinator | Prof. Dr. Martin Sulzmann |
| Scope | 7.0 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 | Students will get to know various types of programming languages and their underlying concepts as well as optimization methods to efficiently execute programs. Via practical exercises students are exposed to different styles of programming in several programming languages. They are able to judge the usefullness and effectiveness of various programming concepts. |
| Exams | Written Exam 90 Min. (graded) |

**Lecture Programming Paradigms**

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|---|---|
| Internal number | INFM121S |
| Lecturer | Prof. Dr. Martin Sulzmann |
| Scope | 3.0 ECTS points, 3.0 Contact hours<br>90 Stunden gesamt, davon 45 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |
| Content | Students of this course<br>- obtain an overview of the history of programming languages,<br>- get to know the various styles of programming (paradigms),<br>- explore their commonalities and differences,<br>- get hands on experiences by solving practical problems.<br>List of topics covered includes:<br>- Historical Overview<br>- Procedural languages Block structure Parameter Passing<br>- Object-oriented languages Subtyping Inheritance Overloading<br>- Functional languages Lambda calculus Higher-order functions Algebraic data types and pattern matching<br>- Type systems Deduction (-> Prolog / logic programming) Typinference Polymorphism Static Analysis<br>- Concurrent and distributed programming The Actor model Software Transactional Memory |
| Recommended reading | - Lecture notes and slides<br>- Exercises<br>- Textbook: Concepts in Programming Languages von John C. Mitchell |
| Exams | Module exam |

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| Comments | Prerequisites: Experience in a programming language. |
| | Mix of lectures (2/3) and practical exercies (1/3) |

## Lecture Program Optimization Laboratory

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|---|---|
| Internal number | INFM122S |
| Lecturer | Prof. Dr. Christian Pape |
| Scope | 4.0 ECTS points, 3.0 Contact hours<br>120 Stunden gesamt, davon 45 Stunden Kontaktstudium. |
| Type/mode | Exercise |
| Language of instruction | German |
| Content | The students of this course have to<br>- implement complex algorithms with a procedural or object-oriented<br>  programming language,<br>- optimize the implementation with specific techniques like CPU-cache<br>  optimization or the pardigm of hybridization,<br>- measure and analyze the time and memory consumption of the<br>  implemenation,<br>- compare algorithms with respect to different test scenarios, and<br>- documenting and discuss the final results.<br>The computer science problems of this course change from time to time.<br>Typical problems include:<br>- Fast multiplication of polynomials and numbers,<br>- geometric algorithms, or<br>- graph algorithms. |
| Recommended reading | The exercises and supplementary materials are available electronically (HTML, PDF, partial programms). |
| Exams | Exercise 1 Semester (not graded) |
| Comments | Prerequisites:<br>Deep practical knowledge of a procedural or object-oriented programming language like C, C++, C#, or Java. Implementation and testing of basic algorithms in the field of search, graphs and sorting problems.<br>Format:<br>Practical Assignment in a computer laboratory with small introductional parts as a lecture.<br>Support:<br>Individual support by the teachers in the computer lab. Contact outside laboratory time via e-mail or during the hours of the lecturers. |

## Module Semantic Web Technologies

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|---|---|
| Internal number | INFM130 |
| Coordinator | Prof. Dr. Peter Henning |
| 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 | The succesful handling of the large data volume available in a globalized information infrastructure necessitates its semantic annotation, i.e. data has to be accompanied by meta data that denotes its meaning. XML techniques, in particular the transformation of data according to XSLT style sheets are at the core of these modern concepts. |
| | Students acquire abstract and concrete knowledge about XML basics (XML concepts, DTD, Namespaces and DOM) as well as about XSLT basics (XPath, simple transformations, principles of functional programming with XSLT). |
| | Students know advanced XML topics (XML Schema, XLink/XPointer), and have dealt with various XSLT applications. |
| | Students have abstract and concrete knowledge about the Resource Description Framework RDF, its extension into RDFS and OWL; they know how to write and visualize simple ontologies. |
| | Students know machine based reasoning tools and principles of knowledge description, they have performed several reasoning tasks. Students know paradigms of learning and have been introduced to models of thinking and reasoning. |
| | The course therefore contributes to the two dimensions technical knowledge and leadership skills. Since it is held in English, participants also improve their key skills. |
| Exams | Written Exam 90 Min. (graded) |

## Lecture Semantic Web Technologies

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|---|---|
| Internal number | INFM131 |
| Lecturer | Prof. Dr. Peter Henning |
| Scope | 4.0 ECTS points, 2.0 Contact hours |
| | 120 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | English |

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| Content | - XML Basics: Documents and document types, their definition and structure (DTD, Namespaces and Schema)<br>- XSLT Basics: XPath, simple transformations, principles of functional programming with XSLT<br>- XML Schema definitions, XLink, XPointer<br>The Resource Description Framework RDF. Application to simple semantic views on data, extension into RDFS and description of simple ontologies.<br>Modeling of knowledge using OWL.<br>Machine based reasoning.<br>Science theory, formal logic and models of thinking. |
| Recommended reading | Prerequisites: Participants should have basic knowledge of descriptive languages (XML applications), at least should have practical knowledge of Web programming.<br>Participants should have sufficient knowledge of technical English Format Participation necessary in two classroom hours per week, electronic tests and essay writing on selected topics, theoretical self-study on semantic technologies.<br>Counseling Questions during course hours, electronic learning management system ILIAS, weekly online chat in ILIAS, 24 x 7 offline discussion in ILIAS Forum, eMail<br>Powerpoint transparencies, electronic whiteboard notes as PDF, eLearning courses on XML, XSLT, SMIL, additional electronic material for reading and self-assessment.<br>References<br>Geroimenko, V., Chen, C.: Visualizing Information Using SVG and X3D. XML Based Technologies for the XML Based Web (Springer 2004) ISBN 978-1852337902 Geroimenko, V., Chen, C.: Visualizing the Semantic Web. XML-Based Internet and Information Visualization (Springer 2005) ISBN 978-1852339760 Antoniou, G., van Harmelen, F.: A Semantic Web Primer. Cooperative Information Systems (The MIT Press 2004), ISBN 0262012103 Eisenberg, J.: SVG Essentials (O'Reilly 2002) ISBN 978-0596002237 Bulterman,D., Rutledge, L.: Smil 2.0: Interactive Multimedia for Web and Mobile Devices (Springer 2004) ISBN 354020234 Henning, P.A.: Taschenbuch Multimedia (Hanser 2007), ISBN 978-3446409712 |
| Exams | Module exam |
| Comments | |

## Lecture Semantic Web Technologies Laboratory

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|---|---|
| Internal number | INFM132 |
| Lecturer | Prof. Dr. Peter Henning |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Laboratory Course |
| Language of instruction | English |

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| Content | Topics covered by practical lab problems include:<br>- XML Basics: Document Type Definition and XML Schema definitions.<br>- Advanced XML techniques: Document Object Model and XPath addressing in documents. The transformation of documents using XSLT. Functional programming in XSLT.<br>- Visualization using XML: SVG and GraphML applied to semantically rich XML documents<br>- Resource Description Framework RDF: Creation of RDF documents, transformation of RDF into XML Schema definition<br>- RDFS, OWL: Basics of ontologies and their application<br>- Machine based reasoning and logical problem solution |
| Recommended reading | Prerequisites: Students should be participants of the "SemanticWeb Technologies" course, at least should have theoretical knowledge of the topics covered.<br>Format: Participation in 2 lab hours per week in small groups of 2-3 students, practical self-study and XML programming.<br>Deliverables: Successful completion (upload to ILIAS in time) of 80% of the lab problems.<br>Counseling: Personal counseling during lab hours, electronic learning managment system ILIAS, weekly online chat in ILIAS, 24 x 7 offline discussion in ILIAS forum, eMail<br>References<br>eLearning content and Books mentioned as course material for browsing, XML Editor oXygen in media::lab, Internet research during lab hours |
| Exams | Exercise 1 Semester (not graded) |
| Comments | |

## Module Management Competence

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|---|---|
| Internal number | INFM140 |
| Coordinator | Prof. Dr. rer. pol. Mathias Philipp |
| Scope | 7.0 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 | In this module the students acquire advanced skills to lead projects with budget and personnel responsibility. Special consideration will be the management of computer science departments or data centers. They are both key skills, as well as practical knowledge in their application in accordance with the standards. There are both key skills as well as the practical implementation of skills in accordance to best practice standards. |
| Exams | Written Exam 120 Min. (graded) |

## Lecture IT Project Management

| | |
|---|---|
| Internal number | INFM141.a |
| Lecturer | Prof. Dr. Uwe Haneke |
| Scope | 3.0 ECTS points, 2.0 Contact hours<br>90 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | English |
| Content | - Agile project management<br>- Requirements specification in IT-projects<br>- Special aspects of network planning in IT-projects<br>- Risk management<br>- Keeping informed: reporting systems in IT-projects<br>- Quality management |
| Recommended reading | |
| Exams | Module exam |
| Comments | |

## Lecture IT Entrepreneurship

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|---|---|
| Internal number | INFM141.b |
| Lecturer | Prof. Dr. rer. pol. Mathias Philipp |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |

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| Content | Die Vorlesung gliedert sich in die lebenszyklus orientierten Kapitel: - Grundlagen Entrepreneurship - Geschäftsmodell, Geschäftsplanung und unterneherische Handlungsstrategien - Gründungsprozess, Rechtsformen und Rechtsformenvergleich - Businessplan und Finanzierungsarten - Wachstumsmanagement und Unternehmensentwicklung - Unternehmensverkauf<br>Die Studenten sollen unternehmerische Denken und Handeln von der Entwicklung einer Geschäftsidee über die Gründung eines Unternehmens bis zum Verkauf erlernen. |
| Recommended reading | Lecture material completely on eLearning platform ILIAS and as pdf documents available, blackboard notes for interactive development of central problem positions, LARS-promoted web based training tool for specific preparations and rework of the lectures with multiple choice questions for every process). All together about 160 questions.<br>List of Acronyms and Glossary of Terms, MindMaps for all processes and the complete lecture. |
| Exams | Module exam |
| Comments | Teilnahme am seminaristischen Unterricht.<br>Übungen zum Erstellung eines Geschäftsplans, steuerrechtlich korrekten Fakturierung und Auswah der richtigen Gesellschaftsform. |

## Lecture Leadership Training

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|---|---|
| Internal number | INFM142 |
| Lecturer | Dipl. Inform. Klaus-Dieter Hüttel |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Project Lecture |
| Language of instruction | German |
| Content | |
| Recommended reading | |
| Exams | Exercise 1 Semester (not graded) |
| Comments | |

| Module Student Research Project 1 | |
|---|---|
| Internal number | INFM150 |
| Coordinator | Prof. Dr. Peter Henning |
| Scope | 4.0 ECTS points, 3.0 Contact hours |
| Placement | 1st Semester |
| Pre-requisites with regard to content | none |
| Pre-requisites according to the examination regulations | none |
| Competences | In this module, students acquire skills in scientific and/or project based work under close guidance by a professor. The scientific problem or application project is studied continuously throughout the whole term. |
| Exams | Individual exams |

| Lecture Project based scientific Project 1 | |
|---|---|
| Internal number | INFM151 |
| Lecturer | Alle Professoren |
| Scope | 4.0 ECTS points, 3.0 Contact hours<br>120 Stunden gesamt, davon 45 Stunden Kontaktstudium. |
| Type/mode | Hands-on Experience |
| Language of instruction | German |
| Content | Problems and projects may be opened by every faculty member, they are advertized on the message board at the beginning of the term.<br>Scientific research problems usually are at the leading edge of computer science research and may be carried out in cooperation with research institutions.<br>Application projects are of particular relevance for the industrial practice and may be carried out in cooperation with an industrial partner. |
| Recommended reading | According to project requirements. |
| Exams | Hands-on Work 1 Semester (graded) |
| Comments | Prerequisites According to project requirements. Format Presence time and group discussion 30 %, self study 70 %. Oral exam 30 Minutes Counseling In general, a weekly project session involving the whole team is scheduled. The counseling amounts to at least one hour per week and student. |

## Module Human Computer Interaction (HCI)

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|---|---|
| Internal number | INFM210I |
| Coordinator | Prof. Dr. Ulrich Bröckl |
| Scope | 7.0 ECTS points, 6.0 Contact hours |
| Placement | 2nd Semester |
| Pre-requisites with regard to content | none |
| Pre-requisites according to the examination regulations | none |
| Competences | Students get the theoretical foundations to efficiently evaluate new developments in Human Computer Interaction (HCI) and to transform them into effective, efficient and satisfactory products with a high User Experience (UX). This requires a high level of project management skills too, which often proves to be difficult in HCI projects. Therefore, a special emphasis is put on cross-module work on HCI projects.<br>By means of excursions and periodic evening events they get basic understanding of association work, concretely the work of the Usability Professionals' Association (UPA). |
| Exams | Individual exams |

## Lecture HCI Construction

| | |
|---|---|
| Internal number | INFM211I |
| Lecturer | Prof. Dr. Ulrich Bröckl |
| Scope | 3.0 ECTS points, 2.0 Contact hours<br>90 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | English |
| Content | - Current Research on HCI, especially the foundation of mental models.<br>- HCI theories on seeing and reading, consciousness, attention, motivation, social behavior, deciding, error handling, and social behavior.<br>- The HCI theories and processes that were already learned in the bachelor studies are enhanced by foundations on command and natural languages, guidelines, principles (esp. user involvement and user experience), and prediction theories.<br>- Finally the topic internationalization is studied in depth. That comprises the current world languages and their history, current scripts, symbols, gestures, units, standards, localization and programming concepts (translation memories, i18n packages, ...) |

| Recommended reading | Script, assignments, and test tools on the intranet, previous exams with solutions.<br>Literature<br>- Ben Shneiderman, Catherine Plaisant: "Designing the User Interface: Strategies for Effective Human-Computer Interaction: Strategies for Effective Human-computer Interaction", Addison Wesley, 2009, ISBN 0321537351<br>- Kahneman, Daniel: "Thinking, Fast and Slow", Penguin, 2011, ISBN-10: 0141033576.<br>- Donald A. Norman: "The Design of Everyday Things", Bantam Doubleday Dell Publishing Group , 1990, ISBN 978-0385267748<br>- Berne, E.: "Games People Play: The Psychology of Human Relationships", Ballantine Books, 1996, ISBN: 978-0345410030 |
|---|---|
| Exams | Written Exam 90 Min. (graded) |
| Comments | Participation at tuition, independent work (lab tests for user modelling and the evaluation of feedback with the help of Fitts' Law; presentation of the results). |

## Lecture HCI Evaluation

| Internal number | INFM212I |
|---|---|
| Lecturer | Prof. Dr. Matthias Wölfel |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | English |
| Content | - Evaluation instruments, HCI research ethics<br>- Evaluation methods (experiment, survey, case Study...)<br>- Design of experiments, surveys, questionnaire<br>- Statistical evaluation: significance, t-test, confidence intervals, correlation, inferences, ANOVA, chi-square, factor-analysis)<br>- Qualitative methods like focus groups, Q-Sort, Interviews<br>- SW/HW support: statistics frameworks like SPSS/R; user-interaction tracking, long-term monitoring, mining |
| Recommended reading | - Andy Field: "Discovering Statistics using IBM SPSS Statistics", Sage, 2013<br>- Jonathan Lazar, Jinjuan Heidi Feng, Harry Hochheiser: "Research Methods in Human-Computer Interaction", John Wiley & Sons, 2009 |
| Exams | Written Exam 90 Min. (graded) |
| Comments | Participation at tuition, in class group work and discussion, assignments.<br>Laboratory work and presentation of results.<br>Conduct survey, evaluate results, presentation. |

## Lecture Graphical User Interfaces Laboratory

| Internal number | INFM213I |
|---|---|
| Lecturer | M.Sc. Aladdin Özenir |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |

| Type/mode | Exercise |
|---|---|
| Language of instruction | German |
| Content | Students learn to write web based applications using differenz concepts:<br>- client centered<br>- server centered<br>All solutions will be based on modern frameworks or libraries like AngularJS or Vaadin. |
| Recommended reading | Online problem description, based on a selection of industrial topics. The literature is presented in each semester depending on the exercises. |
| Exams | Exercise 1 Semester (not graded) |
| Comments | Supported teamwork in the laboratory. Self study, oral exam and presentation |

## Module Software Architectures

| | |
|---|---|
| Internal number | INFM210S |
| Coordinator | Prof. Dr. Thomas Fuchß |
| Scope | 7.0 ECTS points, 6.0 Contact hours |
| Placement | 2nd Semester |
| Pre-requisites with regard to content | none |
| Pre-requisites according to the examination regulations | none |
| Competences | The students learn how to design and evaluate the architecture of large software systems. This includes, in addition to the logical organization of functions and procedures, the specific decomposition into components and connectors as well as the selection and evaluation of appropriate frameworks. |
| Exams | Individual exams |

## Lecture Software Architectures

| | |
|---|---|
| Internal number | INFM211S |
| Lecturer | Prof. Dr. Thomas Fuchß |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |
| Content | In the first part of the lecture central modeling techniques for the design of components are developed. In the second part of the lecture well known architectural patterns and concepts are examined. Students learn to identify their structures, properties, and characteristics, to understand and recognize these structures as patterns. The third part of the lecture focuses on module-level architecture. Using various scenarios and examples, the use of different patterns is demonstrated and evaluated in the respective context. |

| | |
|---|---|
| Recommended reading | - Slides and Papers<br>- Avgeriou, P; et. al (editors): Relating Software Requirements and Architectures. Springer, 2011.<br>- Clements, P.; Bass, L. and Kazman, R.: Software Architecture in Practice, 3. ed. Addison-Wesley, 2013.<br>- Clements, P.; Bachmann, F. and Bass, L.: Documenting Software Architectures: Views and Beyond 2. ed. Addison-Wesley, 2011.<br>- Fowler, M.: Patterns of Enterprise Application Architecture. Addison-Wesley, 2003.<br>- Goll, J. und Dausmann, M.:Architektur- und Entwurfsmuster der Softwaretechnik. Springer Vieweg, 2013.<br>- Gorton, Ian: Essential Software Architecture, 2. ed. Springer, 2011.<br>- Larman, Craig: Applying UML and Patterns : An Introduction to Object-Oriented Analysis and Design and Iterative Development, 3. ed. Prentice Hall, 2004.<br>- Lilienthal, Carola: Sustainable software architecture: analyze and reduce technical debt. dpunkt.verlag, 2019.<br>- Buschmann, Frank: A System of Patterns (POSA V.1). John Wiley & Sons. 1996<br>- Schmidt, Douglas C.: Patterns for Concurrent and Networked Objects (POSA V.2). John Wiley & Sons, 2000.<br>- Sommerville, Ian: Software Engineering, 10. Auflage. Pearson Studium, 2018.<br>- Vogel, O.; Arnold, I.; Chughtai, A. and Kehrer, T.: Software Architecture: A Comprehensive Framework and Guide for Practitioners. Springer, 2011.<br>- Vogel, O.; et. al: Software-Architektur: Grundlagen – Konzepte – Praxis, 2. Auflage. Spektrum, 2009. |
| Exams | Verbal Exam 20 Min. (graded) |
| Comments | The lecture will take the form of seminars with exercises. |

## Lecture Parallel Programming

| | |
|---|---|
| Internal number | INFM212S |
| Lecturer | Dipl.-Ing. Christian Meder |
| Scope | 3.0 ECTS points, 2.0 Contact hours<br>90 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |
| Content | |
| Recommended reading | |
| Exams | Exercise 1 Hours (not graded) |
| Comments | |

## Lecture Graphical User Interfaces Laboratory

| | |
|---|---|
| Internal number | INFM213S |
| Lecturer | M.Sc. Aladdin Özenir |

| | |
|---|---|
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Laboratory Course |
| Language of instruction | German |
| Content | Students learn to write web based applications using differenz concepts:<br>- client centered<br>- server centered<br>All solutions will be based on modern frameworks or libraries like AngularJS or Vaadin. |
| Recommended reading | Online problem description, based on a selection of industrial topics. The literature is presented in each semester depending on the exercises. |
| Exams | Laboratory Work 1 Semester (not graded) |
| Comments | Supported teamwork in the laboratory. Self study, oral exam and presentation |

## Module Secure Systems

| | |
|---|---|
| Internal number | INFM220 |
| Coordinator | Prof. Dr. Frank Schaefer |
| Scope | 7.0 ECTS points, 5.0 Contact hours |
| Placement | 2nd Semester |
| Pre-requisites with regard to content | none |
| Pre-requisites according to the examination regulations | none |
| Competences | Understanding of the basic techniques used in applied cryptography and modern coding theory |
| Exams | Written Exam 120 Min. (graded) |

### Lecture Applied Cryptography

| | |
|---|---|
| Internal number | INFM221.a |
| Lecturer | Prof. Dr. Frank Schaefer |
| Scope | 4.0 ECTS points, 3.0 Contact hours<br>120 Stunden gesamt, davon 45 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |
| Content | In the course the main cryptographic algorithms are presented. Blockciphers (DES, AES), Modes of Operation (ECB, CBC, Countermode), Hash functions, MACs, public key algorithms (RSA, Diffie-Helman, ElGamal) are covered by the lectures. Then we will look at and analyze applications in IT-security, which use cryptography: E/mail-security (eg. PGP, S-MIME), web-security (SSL), network-security (IP-Sec), authentication mechanisms. |
| Recommended reading | Claudia Eckert: IT-Sicherheit. Konzepte - Verfahren - Protokolle, München, Oldenbourg Wissenschaftsverlag, 2013, 8. Auflage, ISBN 978-3-486-58270-3. |
| Exams | Module exam |
| Comments | The course consist of lectures (around 2/3) and exercises (around 1/3). In the exercises the mathematical techniques introduced in the lecture will be trained. |

### Lecture Coding Theory

| | |
|---|---|
| Internal number | INFM221.b |
| Lecturer | Prof. Dr. Dirk Hoffmann |
| Scope | 3.0 ECTS points, 2.0 Contact hours<br>90 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |

| Content | This course teaches foundations about codes and codings as well as basic algorithms for source coding, channel coding and line coding. The lecture focuses on the following topics: information and coding theory, data compression, error detecting and correcting codes, limits of data transmission. |
|---|---|
| Recommended reading | Slides, blackboard, exercise sheets |
| Exams | Module exam |
| Comments | Lecture |

## Module Mobile and Distributed Systems

| | |
|---|---|
| Internal number | INFM230 |
| Coordinator | Prof. Dr. Oliver Waldhorst |
| Scope | 7.0 ECTS points, 6.0 Contact hours |
| Placement | 2nd Semester |
| Pre-requisites with regard to content | none |
| Pre-requisites according to the examination regulations | none |
| Competences | This module enables the students to understand and conceptualize mobile and distributed system architectures. They use and understand the terminology of components, layers, interfaces and standards. Students have command of functional as well as non-functional requirements upon the system and software architecture. Distribution, integration and the interaction of different technologies are also understood. |
| Exams | Written Exam 120 Min. (graded) |

## Lecture Distributed Systems

| | |
|---|---|
| Internal number | INFM231.a |
| Lecturer | Prof. Dr. Christian Zirpins |
| Scope | 3.0 ECTS points, 2.0 Contact hours<br>90 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Lecture |
| Language of instruction | German |
| Content | The lecture provides the basic knowledge for the design of distributed information systems. The starting point form general system and software architecture issues, regardless of concrete technologies. Then follows a central theme of the concept of middleware. There is a distinction with regard to application, communication and message-oriented middleware made. As a first concrete technology and to clarify the knowledge learned will be dealt with Web services. |
| Recommended reading | - Hammerschall: Verteilte Informationssysteme (Pearson Studium, 2005 , ISBN 3- 8273 - 7096 -5)<br>- Sebastian Abeck et al. "Verteilte Systeme und Anwendungen"<br>- Ralf Reussner, Wilhelm Hasselbring"Handbuch derSoftware-Architektur" |
| Exams | Module exam |
| Comments | Seminaristic lecture, exercises |

## Lecture Mobile Systems

| | |
|---|---|
| Internal number | INFM231.b |
| Lecturer | Prof. Dr. Oliver Waldhorst |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |

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|---|---|
| Type/mode | Lecture |
| Language of instruction | German |
| Content | Within the course "mobile systems" the students learn the basics and concepts of mobile computing. The first part of the course introduces the problems and challenges, which one has to solve in mobile computing. The course focuses on mobility support on higher levels. Different variants of client-server architectures are compared, and treated in principle. Also caching strategies, transaction models, and concurrency control concepts are discussed. In the second part the basics of wireless communication and cellular networks are established. Beside the different variants of medium access, infrastructure and services of global cell<br>phone standards (GSM, UMTS, LTE) are discussed, as well as their potential for mobile applications. |
| Recommended reading | Slides, textbooks, and other literature:<br>- Schiller, J. Mobile Communications - Addison-Wesley, 2000.<br>- Walke, B., Althoff M. P. und Seidenberg, P. UMTS - Ein Kurs - Schlembach, 2002.<br>- Pitoura, E and Samaras, G. Data Management for Mobile Computing - Kluwer, 1998.<br>- Roth, J. Mobile Computing: Grundlagen, Technik, Konzepte - dpunkt.verlag, 2002.<br>- Höpfner, H., Türker, C. und König-Ries, B. Mobile Datenbanken und Informationssysteme - dpunkt.verlag, 2005<br>- Fuchß, Th. Mobile Computing: Grundlagen und Konzepte für mobile Anwendungen - München: Hanser Fachbuchverlag, 2009. |
| Exams | Module exam |
| Comments | The lecture will take the form of seminars with exercises. |

## Lecture Distributed Systems Laboratory

| | |
|---|---|
| Internal number | INFM232 |
| Lecturer | Prof. Dr. Christian Zirpins |
| Scope | 2.0 ECTS points, 2.0 Contact hours<br>60 Stunden gesamt, davon 30 Stunden Kontaktstudium. |
| Type/mode | Laboratory Course |
| Language of instruction | German |
| Content | The model is defined jointly for the Distributed Systems Laboratory and the Graphical User Interfaces Laboratory. In this laboratory course, the work is focused on back end development, whereas front end and user interface are developed in the Graphical user Interfaces Laboratory. The concrete problem description is based on current industrial topics, therefore changes in each semester. |
| Recommended reading | Powerpoint transparencies, tutorial papers for frameworks |
| Exams | Laboratory Work 1 Semester (not graded) |

| Comments | Prerequisites Java Web and application components. Persistence layer and DBMS Format Presence time with supported teamwork in the laboratory 50 %, self-study 50 %. Oral exam and presentation. Counseling 2 hours guidance in the lab, introductory lecture, contact hours also according to individual schedule, eMail. |
|---|---|

## Module Student Research Project 2

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|---|---|
| Internal number | INFM240 |
| Coordinator | Prof. Dr. Peter Henning |
| Scope | 8.0 ECTS points, 5.0 Contact hours |
| Placement | 2nd Semester |
| Pre-requisites with regard to content | none |
| Pre-requisites according to the examination regulations | none |
| Competences | This module is the continuation of the course "Scientific or project based work I". In this module, students study a scientific problem or application project continuously throughout the whole term. The project may be, but is not necessarily so, a continuation of the problem studied in the first part of the course.<br>In parallel, the students prepare a scientific talk open to the faculty. |
| Exams | Individual exams |

## Lecture Project based scientific Project 1 2

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|---|---|
| Internal number | INFM241 |
| Lecturer | Alle Professoren |
| Scope | 4.0 ECTS points, 3.0 Contact hours<br>120 Stunden gesamt, davon 45 Stunden Kontaktstudium. |
| Type/mode | Hands-on Experience |
| Language of instruction | German |
| Content | Problems and projects may be opened by every faculty member, they are advertized on the message board at the beginning of the term.<br>Scientific research problems usually are at the leading edge of computer science research and may be carried out in cooperation with research institutions.<br>Application projects are of particular relevance for the industrial practice and may be carried out in cooperation with an industrial partner. |
| Recommended reading | According to project requirements. |
| Exams | Hands-on Work 1 Semester (graded) |
| Comments | Prerequisites According to project requirements. Format Presence time and group discussion 30 %, self study 70 %. Oral exam 30 Minutes Counseling In general, a weekly project session involving the whole team is scheduled. The counseling amounts to at least one hour per week and student. |

## Lecture Seminar

| | |
|---|---|
| Internal number | INFM242 |
| Lecturer | Alle Professoren |
| Scope | 4.0 ECTS points, 2.0 Contact hours<br>120 Stunden gesamt, davon 30 Stunden Kontaktstudium. |

| Type/mode | Seminar |
|---|---|
| Language of instruction | German |
| Content | According to requirements of counseling professor, in general as extension of the scientific or project based work. |
| Recommended reading | According to project requirements. |
| Exams | Presentation 20 Min. (graded) |
| Comments | Preparation of the oral presentation, written report on the subject of the talk. Exam consists of 20 minutes of scientific talk. |

## Module Thesis with Colloquium

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|---|---|
| Internal number | INFM310 |
| Coordinator | Prof. Dr. Peter Henning |
| Scope | 30.0 ECTS points, 0.0 Contact hours |
| Placement | 3rd Semester |
| Pre-requisites with regard to content | none |
| Pre-requisites according to the examination regulations | none |
| Competences | The Master's Thesis is the final work of the Master's Program in computer science. It serves as a proof of the acquired skills by addressing and solving a scientic or application problem independently. In general, this is carried out in cooperation with a private company or a public research institution. |
| Exams | Individual exams |

### Lecture Thesis

| | |
|---|---|
| Internal number | INFM311 |
| Lecturer | Alle Professoren |
| Scope | 29.0 ECTS points, 0.0 Contact hours<br>870 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 and knowledge of the subject. They structure the task, compile the necessary resources and work on the problem according to a timetable. They are then able to present the results of their work. |
| Recommended reading | |
| Exams | Master Thesis 6 Months (graded) |
| Comments | All work will be individual work and will include basic literature research, system analysis, coding, documentation, and oral presentation. |

### Lecture Thesis Defense

| | |
|---|---|
| Internal number | INFM312 |
| Lecturer | Alle Professoren |
| Scope | 1.0 ECTS points, 0.0 Contact hours<br>30 Stunden gesamt, davon 0 Stunden Kontaktstudium. |
| Type/mode | Colloquium |
| Language of instruction | German |
| Content | |
| Recommended reading | |

| Exams | Verbal Exam 30 Min. (not graded) |
|---|---|
| Comments | |