Faculty of Information Systems and Applied Computer Sciences (WIAI)

Undergraduate and Graduate Studies in Information Systems and Computer Science

Module Handbook and Student Guide Academic Year 2019-2020

WIAI

www.uni-bamberg.de/wiai

Contact

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Legal notice

Contents

1 Introduction and General Information

This document lists all modules offered in the Faculty of Information Systems and Applied Computer Sciences during the academic year 2019-2020.

To prevent problems arising from late changes on these offerings, you are advised to confirm module specifications and schedules through the research groups' web pages or directly with the responsible teaching staff. There may also be new courses becoming available on short notice. Please see the faculty's web pages for relevant announcements. The official German module handbooks for the various degree courses can be accessed through the following links:

- BSc Angewandte Informatik
- BSc International Information Systems Management
- BSc Software Systems Sciences
- BSc Information Systems (Wirtschaftsinformatik)
- MSc Applied Computer Sciences
- MSc Computing in the Humanities
- MSc International Software Systems Science
- MSc Information Systems (Wirtschaftsinformatik)
- MSc International Information Systems Management
- MSc Wirtschaftspädagogik

1.1 Fees and Registration

All modules are currently open free of charge to foreign guest students who will study at Bamberg University within the frame of a partnership exchange programme, such as ERASMUS+. There are no tuition or bench fees. Enrolment with the University incurs a nominal registration fee covering administration charges, student union membership (*Studentenwerk*) and the City of Bamberg travel ticket.

Information on the registration and enrolment process may be obtained from the Academic Exchange Office (*Akademisches Auslandsamt*, see address below) who will also be able to advise you on any exchange scheme that may exist between Bamberg University and your home institution.

Once admitted to and enrolled with Bamberg University you do not need to register for attending a teaching module. Feel free to sit in and participate in any course offering that fits your educational needs and time table. Be aware, though, that some courses may have entry requirements and/or class size restrictions.

1.2 Teaching Times

The academic year 2019-2020 consists of two teaching periods:

Winter Semester: 14th October 2019 – 7th February 2020,

Summer Semester: 20th April 2020 – 24st July 2020.

1.3 Assessment

The course assessment is done mostly by written exams and optionally also by way of homework assignments and/or lab practicals. In a number of cases, typically for graduate level modules, the final exam is oral.

Final written exams are usually held immediately after the end of the semester, i.e. February/March for the Winter Semester and end of July/August for the Summer Semester. Make sure you plan your travelling so you are in Bamberg during the exams.

Be aware that there are firm deadlines for exam registration some time at the end of the first half of the semester. Watch out for the emails announcing the registration period and check up with your class mates if you are not sure. There is a short period of time during which you can deregister from an exam. Once this period has passed and you are registered you **must take** the exam at the specified day and time. Also, if you miss the online registration deadline, then you **cannot participate** in the exam.

There is one more thing to know: for written exams the registration in FlexNow! is sufficient. For oral exams, however, you also need to arrange an exam time with the lecturer in addition to the FlexNow! registration.

If for some reason you cannot attend the regular written exam, say because you are required to return home early, talk to the course lecturer before the FlexNow! registration period has passed. There are two options:

> **Option 1:** The course lecturer may be able to arrange an oral exam for you at an earlier date instead. In this case, because you are not writing the official exam, you **must not register** with the FlexNow! system.
>
> **Option 2:** It is sometimes possible that we schedule the regular exam at your Home University on the same day and at the same time when it is written in Bamberg. For this option you **must register** via FlexNow!

Whether such options are available is entirely at the discretion of the course lecturer.

The official exam language is German, but many courses may offer written or oral exams in English if required. Some modules are fully taught in English, some only at the discretion of the lecturer. If you need to be set an English exam for a module delivered in German you should contact the module lecturer early to find out if this is possible. The description of each module listed below in this booklet indicates if all or some part of the module is delivered in English.

1.4 Workload

The module descriptions below specify the total module workload in terms of ECTS (European Credit Transfer System) credit points according to the following approximate accounting scheme:

- 1 ECTS = 25-30 hrs total student workload (all inclusive)
- 30 ECTS = total module load per semester
- 6 ECTS = single standard course module of 4 contact hrs/week, combining lectures+tutorials

1.5 Course Levels and Teaching Format

In line with our traditional Diploma degree structure, modules are taught at 2 levels:

- Basic Studies

These are foundational and introductory courses in the general disciplines of Information Systems, Applied Computer Science and Software Systems Science corresponding to the 1st and 2nd year of the undergraduate BSc programmes.

- Advanced Studies

  These are introductory courses to specialised fields within Information Systems, Applied Computer Science and Software Systems Science corresponding to the 3rd and 4th year of the BSc degree and advanced modules in particular research areas which correspond to the 1st and 2nd year of the graduate MSc programmes.

As our guest students you may attend modules at any of these levels. It is your responsibility to judge if your background will be sufficient to participate successfully in the course. Also, whether or not the credits you earn are valid towards your home degree, is not decided by us, but by your home institution.

Keep in mind, however, that graduate level modules normally assume a significant amount of background in the relevant subject area.

Most modules are based on combined lectures and tutorials. Some courses may also involve lab classes, excursions, blended learning and other teaching arrangements. Research groups regularly offer advanced level seminars and project modules on varying research topics. These may have special entry prerequisites.

1.6 Other Information

The Academic Exchange Office provides information on accommodation, living expenses, language courses and many other aspects of student life at Bamberg.

Academic Exchange Office (*Akademisches Auslandsamt*)

Mrs. Stephanie Hofmann

Secretary - Foreign Student Affairs

Akademisches Auslandsamt

Otto-Friedrich-Universität Bamberg

D-96047 Bamberg, Germany

Kapuzinerstraße 25

Tel: ++49 (0)951 863-1051

Fax: ++49 (0)951 863-1054

Email: auslandsamt@uni-bamberg.de

URL: http://www.uni-bamberg.de/auslandsamt/

You are also welcome to contact the International Affairs Representative of the WIAI Faculty (see address page 2).

2 Introducing the Faculty's Teaching and Research Groups

2.1 MI - Media Informatics

Prof. Dr. Andreas Henrich

Chair of Media Informatics

Office 02.031

An der Weberei 5

96047 Bamberg

Tel.: +49-951 / 863-2850

Fax: +49-951 / 863-2852

E-Mail: andreas.henrich@uni-bamberg.de

Internet: http://www.uni-bamberg.de/minf/

Media Informatics aims at a purposeful application of single media types and multimedia systems in various application areas. It considers aspects like media technique, media design, media storage and retrieval as well as the use of media with a focus on the development of multimedia systems. The main focus of this chair is on media storage and retrieval and the development of domain specific multimedia applications.

2.2 KTR - Communication Systems and Computer Networks

Prof. Dr. Udo R. Krieger

Head of Computer Networks Group

Office 05.037

An der Weberei 5

96047 Bamberg

Tel.: +49-951 / 863-2820

Fax: +49-951 / 863- 5528

E-Mail: udo.krieger@ieee.org

Internet: http://www.uni-bamberg.de/ktr

Research and development of the group is devoted to traffic and network management of current telecommunication networks and future IP based fixed and mobile computer networks. Current research topics include the evaluation of resource management processes in wireless local IP networks, the development of QoS management architectures for IP communication networks, teletraffic theory and performance evaluation of such distributed systems, the statistical analysis and characterization of Internet traffic, and the estimation of corresponding generic model parameters.

2.3 SWT - Software Technologies and Programming Languages

Prof. Dr. Gerald Lüttgen

Head of Software Technologies Research Group

Office 03.014

An der Weberei 5

96047 Bamberg

E-Mail: info@swt-bamberg.de

Internet: www.uni-bamberg.de/swt/

The group's teaching is heavily influenced by research and currently encompasses the modules Software Engineering, Project Management, Compiler Construction, Imperative Programming and Parallel Programming, with accompanying seminars and student projects. The group's research comprises the foundations and practice of software specification, verification and analysis. Foci of application are concurrent, reactive and embedded software. A further competence of the research group is requirements engineering.

2.4 GdI - Foundations of Computer Science

Prof. Michael Mendler, PhD (Edinburgh)

Informatics Theory Group

Office 05.041

An der Weberei 5

96047 Bamberg

Tel.: +49 (0) 951 / 863-2828

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E-Mail: michael.mendler@uni-bamberg.de

Internet: http://www.gdi.uni-bamberg.de

The group teaches the foundational aspects of computer science in all degree programmes, such as logic, automata and formal language theory, cryptography, functional programming and the theory of distributed systems. In our research we are mainly concerned with constructive modal logic and type theory and their applications as well as the semantics of synchronous programming languages.

2.5 KInf - Computing in the Cultural Sciences

Prof. Dr. Christoph Schlieder

Chair of Computing in the Cultural Sciences

Office 02.033

An der Weberei 5

96047 Bamberg

Tel.: +49 (0) 951 / 863-2840

Fax: +49 (0) 951 / 863-5841

E-Mail: christoph.schlieder@uni-bamberg.de

Internet: http://www.uni-bamberg.de/kinf/

In research and teaching, we focus on computational issues relevant to the cultural sciences. At our laboratory we develop software solutions that assist, for instance, preservation scientists working with built heritage or sociologists studying web-based communication processes. Technologically speaking, our software relies on methods from semantic information processing that we continue to improve. Our key areas of interest are Geoinformation systems and services, Digital libraries and archives, Mobile assistance systems, and Computer-mediated communication.

2.6 KogSys - Cognitive Systems

Prof. Dr. Ute Schmid

Head of Cognitive Systems Group

Applied Computer Science

Office 05.043

An der Weberei 5

96047 Bamberg

Tel.: +49-951 / 863-2860

Fax: +49-951 / 863-2862

E-Mail: ute.schmid@uni-bamberg.de

Internet: http://www.uni-bamberg.de/kogsys

In the research domain Cognitive Systems (CogSys) we are concerned with the development of approaches, concepts, and methods for design, description, construction and analysis of intelligent systems based on cognitive principles. Our research strategy is to combine empirical studies of cognitive phenomena, development of algorithms, and their testing in different areas of application. Main topics of our group are induction and learning as well as planning and problem solving in single- and multi-agent settings. Especially, we are interested in the inductive synthesis of recursive functional programs from incomplete specifications (e.g., input/output examples) which can be seen as a general approach to learning productive rules from experience. Furthermore, we investigate analogical reasoning as a powerful approach to problem solving as a special mechanism of knowledge acquisition. Application areas are, for example, support of human problem solvers in the domains of software development, classifier learning for medical diagnostics, quality control, decision support or incident mining and assistant systems for activities of daily life.

2.7 ISDL - Information Systems in the Service Industry

Prof. Dr. Tim Weitzel

Chair of Information Systems, esp. Information systems in the service industry

Office 04.040

An der Weberei 5

96047 Bamberg

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E-Mail: tim.weitzel@uni-bamberg.de

Internet: http://www.uni-bamberg.de/isdl

The four main research areas of the ISS team are (1) Business-IT Alignment and Business Value of IT, (2) (Social) Networks and IT, (3) IT Adoption and Usage and (4) Outsourcing Management. You can find a detailed description of our research projects in the section "for researchers". Our research results have been published in scientific journals and conferences.

2.8 DSG - Practical Computer Science (Distributed Systems)

Prof. Dr. Guido Wirtz

Chair of Practical Computer Science

Distributed Systems Group

Office 03.016

An der Weberei 5

96047 Bamberg

Tel.: +49 /0951 / 863-2527

Fax: +49 /0951 / 863- 2529

E-Mail: guido.wirtz@uni-bamberg.de

Internet: http://www.uni-bamberg.de/en/pi

Besides introductionary courses for 1th and 2nd year students, our teaching activities put an emphasis on combining the theoretical background of distributed systems with knowledge about middleware and architecture for complex systems. This is done by advanced courses and seminars as well as practical labs to get hands-on experience with real-life systems.
The DSG's research directions are centered around issues regarding the software development for complex, esp. distributed, systems on all levels. Our current research activities are focussed on service-oriented architectures, service eco systems, enterprise application integration and B2Bi, seamless transition from business processes to their implementation in SOA-like settings, visual design and programming languages as well as visualization of complex software systems.

2.9 HCI - Human-Computer Interaction

Prof. Dr. Tom Gross

Chair of Human-Computer Interaction

An der Weberei 3, Room WE5/01.032

D-96047 Bamberg

Tel.: +49-951 / 863-3940

Fax: +49-951 / 863-3945

E-Mail: tom.gross@uni-bamberg.de

Internet: http://www.uni-bamberg.de/hci

Human-Computer Interaction (HCI) aims at optimally supporting users through technology (mainly computer technology) by amplifying their strengths and compensating their weaknesses. The Special Interest Group HCI of the German Informatics Society provides the following definition: “The field of Human-Computer Interaction comprises the analysis, design, and evaluation of human- and task-centred computer applications" (in German). In the context of HCI interactive systems are often mentioned—an interactive (computer-) system thereby is described as a unity consisting of software and hardware that receives input from users and gives immediate feedback. The usability of interactive systems can be evaluated along three factors: effectiveness (accuracy and completeness with which users achieve their goals), efficiency (resources expended by users to achieve these goals), and satisfaction (the users' positive attitudes towards the use of the system).

2.10 SNA - Social Networks

Prof. Dr. Kai Fischbach

Chair in Information Systems, esp. Social Networks

Office 05.128

An der Weberei 5

96047 Bamberg

Tel.: +49 (0) 951 / 863-2890

Fax: +49 (0) 951 / 863-2872

E-Mail: kai.fischbach@uni-bamberg.de

Internet: http://www.uni-bamberg.de/sna

We dedicate our work to research and education on the role of information systems in social networks and the use of social media (e.g. blogs, wikis) for managing knowledge within and between organizations as well as on digital transformation.
We conduct theoretical and empirical research and collaborate with industry partners in these fields.

2.11 EESYS - Energy Efficient Systems

Prof. Dr. Thorsten Staake

Chair of Information Systems, esp. Energy Efficient Systems

Office 02.057

An der Weberei 5

96047 Bamberg

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Internet: http://www.uni-bamberg.de/eesys

The Energy Efficient Systems Group focuses on the development of Information Systems (IS) for supporting and motivating sustainable consumer behavior. Particular consideration is given to smart metering and smart grid infrastructure and the design of related systems that enable energy efficiency services for private households. With a clear focus on the development and assessment of applications that are applicable to the mass market, the group closely works together with both, industry partners and startup companies. The research results build an important cornerstone of the teaching activities at bachelor and master level.

2.12 SME - Smart Environments

Prof. Dr. Diedrich Wolter

Chair of Smart Environments

Office 03.040

An der Weberei 5

96047 Bamberg

Tel.: +49-951 / 863 2897

E-Mail: diedrich.wolter@uni-bamberg.de

Internet: http://www.uni-bamberg.de/

Smart environments is a young area of research in applied artificial intelligence (AI). The field draws its motivations from recent advancements in AI as well as in technology (disappearing computers, sensors) and human-centered computing. At the university of Bamberg, we contribute by tackling the following research questions:

- How can sensor data be interpreted to obtain useful knowledge?
- How can knowledge about space, time, events, and context be represented?
- And how can we reason with this knowledge in order to obtain smart decisions?

2.13 IIS - Industrial Information Systems

Prof. Dr. Sven Overhage

Chair of Information Systems, esp. Industrial Information Systems

Office 04.042

An der Weberei 5

96047 Bamberg

Tel.: +49 /0951 / 863-2910

E-Mail: sven.overhage@uni-bamberg.de

Internet: http://www.uni-bamberg.de/iis

The Chair of Industrial Systems focuses on the design and the operation of industrial information systems, which are the backbone of production and commerce businesses. We offer courses for bachelor, master, and PHD students alike. Amongst others, our courses focus on the development and design of application systems, enterprise architecture management, electronic business, intra-organizational systems, and modular and on-demand systems.

2.14 MOBI - Mobile Software Systems / Mobility

Prof. Dr. Daniela Nicklas

Chair of Information Systems, esp. Mobile Software Systems / Mobility

Office 05.128

An der Weberei 5

96047 Bamberg

Tel.: +49 /0951 / 863-3670

E-Mail: dnicklas@acm.org

Internet: http://www.uni-bamberg.de

The MOBI group is led by Prof. Dr. Daniela Nicklas and focuses on data management for mobile systems, data stream management/complex event processing and development support for sensor-based applications, in the area of smart cities.

2.15 PSI - Privacy and Security in Information Systems Group

Prof. Dr. Dominik Herrmann

Chair of Information Systems and Applied Computer Sciences,

esp. Privacy and Security Information Systems

Office 05.030

An der Weberei 5

96047 Bamberg

Tel.: +49 /951 / 2661

E-Mail: Dominik.Herrmann@uni-bamberg.de

Internet: https://www.uni-bamberg.de/en/psi/

The focus of the PSI Group is the protection of information systems and the protection of privacy with technical mechanisms. To this end, the PSI Group analyzes and evaluates existing systems and develops protective mechanisms. The PSI Group cooperates with working groups in the fields of machine learning (inference attacks, online tracking), law (data protection, law enforcement) and ethics (value-oriented system design).

2.16 ISM – Information Systems Management

Prof. Dr. Daniel Beimborn

Chair of Information Systems, esp. Information Systems Management

Office 01.029

An der Weberei 5

96047 Bamberg

Tel.: +49 /951 / 2512

E-Mail: Daniel.Beimborn@uni-bamberg.de

Internet: https://www.uni-bamberg.de/en/wi/chair-of-information-systems-especially-information-systems-management/home/

In research and teaching the Chair of ISM deals with questions concerning the management of information systems and technologies as well as with the challenges of digital innovation and transformation. The management of the information systems (IS) of an organization - consisting of those technical and personnel components, which are involved in the production, processing and use of information - is in particular in the 'age of digitization' an elementary component of successful organization management.

3 Module Descriptions

The following appendix titled “Module Handbook – International Studies” describes in detail all modules scheduled to run during 2019-2020.
The module handbook starts with an index of all modules listed by the area of studies. In Section 1 of the list (“International Studies taught in English (on demand)”) you find all modules that are offered in English either regularly or on demand. In the latter case, since the lecture may be in German if all students are German-speaking, you need to tell the lecturer before the semester if you require English tuition. Modules listed in Section 2 of the list (“Exams in English on demand, though course material often in German, may sometimes be available in English”) are delivered in German but (again ``on demand’’) are examined in English if requested. To find out more information please consult the detailed module descriptions or contact the module lecturer. Section 3 (“General Studies in German only, exams in English on request”) lists those modules which are available only in German. Within each Section the modules are organised by subject group (Applied Computer Science, Computer Science, Information Systems) and further by the name of the Teaching and Research Group who are responsible for the offering.

The index of a single module lists its acronym, its title, how many ECTS credit points it comprises, in which semester it is offered and on which page you can find its full description. For example, here is a description of the information related to the module “KogSys-KogMod-M”:

1	2	3	4	5
KogSys-KogMod-M	Cognitive Modeling	6,00 ECTS	every winter semester	page number

1. “KogSys-KogMod-M”:
   a. “KogSys” stands for the research group that provides the module; in this case, this is “Cognitive Systems” (*Kognitive Systeme*)
   b. “KogMod” is the short form of the module title; here, this is Cognitive Modeling
   “M” stands for “Master” which means the module is suggested for graduate students. The ending “B” indicates the recommendation that the module should be attended by undergraduate students.
   NOTE: International Exchange Students may attend any module offered, at undergraduate or graduate level.

2. “Cognitive Modeling”: This is the title of the module
3. “6,00 ECTS”: ECTS indicate the work load for the module (see “Sec. 1.4 Workload”)
4. The module is offered every winter semester
5. The page on which you find a detailed module description.

Otto-Friedrich Universität Bamberg

Module Handbook

International Studies

Valid: 28.07.2019

Modules

Index by areas of study

1) International studies taught in English (on demand) (Bereich)

a) Computer Science (Subject Group)

aa) Privacy and Security in Information Systems Group (Subject)

bb) Communication Services, Telecommunication Systems, and Computer Networks (Subject)

cc) Distributed Systems Group (Subject)

dd) Foundations of Computer Science (Subject)

ee) Mobile Software Systems /Mobility (Subject)

ff) Software Technologies Research Group (Subject)

b) Applied Computer Science (Subject Group)

aa) Smart Environments (Subject)

bb) Cognitive Systems (Subject)

cc) Cultural Computing (Subject)

dd) Human-Computer Interaction (Subject)

a) Applied Computer Science (Subject Group)

b) Computer Science (Subject Group)

Module AI-KI-B Introduction to Artificial Intelligence *Einführung in die Künstliche Intelligenz*	6 ECTS / 180 h 42 h Präsenzzeit 138 h Selbststudium

(since WS19/20)
Person responsible for module: Prof. Dr. Diedrich Wolter
further responsible : Schmid, Ute, Prof. Dr.

Contents:

Dieses Modul bietet Studierenden einen Überblick über das Fachgebiet der Künstlichen Intelligenz (KI) und bietet eine Einführung in elementare Konzepte, Methoden und Algorithmen wie etwa Wissensrepräsentation, Suche, Wahrnehmung und Handlungsplanung. Die vermittelten Inhalte bilden eine Grundlage für kognitive und smarte Systeme sowie für wichtige Teile der Informatik und Wirtschaftsinformatik.

Themen:

- Problemstellungen im Fachgebiet KI
- KI-Programmierung
- intelligente Agenten
- Wissensrepräsentation und Logik
- Suche im Problemraum
- maschinelles Lernen
- Wahrnehmung
- Unsicherheit
- Handlungsplanung

Learning outcomes:

- konkrete Problemstellungen des Faches definieren und erklären können
- Abstraktion von Fakten- bzw. Regelwissen durchführen können
- Grundzüge deklarative Programmiertechniken beherrschen
- Suche als Problemlösungsstrategie anwenden, d.h. implementieren können

Remark:

Veranstaltung Deutsch (im Bedarfsfall Englisch). Die Folien sowie weitere Materialien sind überwiegend in englischer Sprache.

prerequisites for the module:

none

Recommended prior knowledge:	Admission requirements:
Beherrschung grundlegender Programmierkenntnisse (etwa durch Module DSG-EiAPS-B und DSG-JaP-B erworben) sowie Kenntnisse von Basisalgorithmen (etwa durch Modul MI-AuD-B erworben) werden vorausgesetzt, ebenso die Bereitschaft, sich in neue Programmiersprachen und -paradigmen einzuarbeiten	none

Frequency:	Recommended semester:	Minimal Duration of the Module:
every summer semester		1 Semester

Module Units

1. Einführung in Künstliche Intelligenz **Mode of Delivery:** Lectures	2,00 Weekly Contact Hours

Lecturers: Prof. Dr. Ute Schmid, Prof. Dr. Diedrich Wolter **Language:** German/English **Frequency:** every summer semester **Learning outcome:** siehe Modulbeschreibung **Contents:** Präsentation und Diskussion der Inhalte (siehe Modulbeschreibung), insbesondere theoretische und konzeptionelle Aspekte. **Literature:** Stuart Russel und Peter Norvig (2010, 3. Auflage). Artificial Intelligence, a modern approach. Prentice Hall	
2. Einführung Künstliche Intelligenz **Mode of Delivery:** Practicals **Language:** German/English **Frequency:** every summer semester **Learning outcome:** siehe Modulbeschreibung **Contents:** praktische Vertiefungen zu den Inhalten der Vorlesung (siehe Modulbeschreibung)	**2,00 Weekly Contact Hours**

Examination / Duration of Examination: 90 minutes	

<table>
<tr><td colspan="2">Module DSG-AJP-B Advanced Java Programming
Fortgeschrittene Java Programmierung</td><td>3 ECTS / 90 h
23 h Präsenzzeit
67 h Selbststudium</td></tr>
<tr><td colspan="3">(since WS16/17)
Person responsible for module: Prof. Dr. Guido Wirtz</td></tr>
<tr><td colspan="3">Contents:
Aufbauend auf den Grundkenntnissen der objekt-orientierten Programmierung in Java aus DSG-EiAPS-B soll der Umgang mit modernen objekt-orientierten Programmiersprachen durch einen genaueren Blick auf die Möglichkeiten, die eine moderne Programmierumgebung heute liefert, vertieft und gefestigt. Dazu gehören als Themen - jeweils am Beispiel 'Java' praktisch erläutert und geübt - insbesondere:
• Interfaces, abstrakte Klassen und komplexere Vererbungsstrukturen, Nutzung von Package-Strukturen,
• Einsatz und Behandlung von Exceptions,
• Nutzung komplexer Java-APIs, z.B. für Ein- und Ausgabe,
• grundlegende XML Verarbeitung,
• Debugging, Profiling und Testen,
• Überblick über das Programmieren von (grafischen) Benutzerschnittstellen (G)UIs.
Zusätzlich werden die ersten Schritte zur Nutzung komplexer Programmierumgebungen, die über den einfachen Editor-Compiler-Ausführungs-Zyklus hinausgehen, insbesondere der Umgang mit einfachen Testszenarien zur Entwicklung verlässlicher Systeme, eingeübt.</td></tr>
<tr><td colspan="3">Learning outcomes:
Die Studierenden beherrschen die grundlegenden Mechanismen der objekt-orientierten Programmierung vertieft und sind auch in der Lage, einfache Probleme mit Hilfe der über die Standardprogrammiersprachen-Konstrukte hinausgehenden Hilfsmittel einer modernen Programmierumgebung effizient und flexibel zu lösen.</td></tr>
<tr><td colspan="3">Remark:
Der Arbeitsaufwand von 90 Std. gliedert sich in
• 22.5 Std. Teilnahme an der Praktischen Übung
• 55 Std. Bearbeiten der Programmieraufgabe (Assignment)
• 12 Std. Vorbereitung auf das Abschlusskolloquium
• 0.5 Std. Abschlusskolloquium inklusive Warten auf Ergebnis usw.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Programmierkenntnisse in Java sowie Grundkenntnisse aus dem Bereich der Algorithmik und Softwareentwicklung, wie sie z.B. im Modul DSG-EiAPS-B vermittelt werden.
Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every summer semester</td><td>Recommended semester:
2.</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

Module Units	
Fortgeschrittene Java Programmierung **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Guido Wirtz, Scientific Staff Praktische Informatik **Language:** German **Frequency:** every summer semester **Learning outcome:** vgl. Modulbeschreibung **Contents:** vgl. Modulbeschreibung **Literature:** Jedes weiterführende Buch zu Java ist verwendbar.	**2,00 Weekly Contact Hours**
Examination Coursework Assignment and Colloquium / Duration of Examination: 10 minutes Duration of Coursework: 3 months **Description:** Die zu Beginn des Semesters ausgegebene Programmieraufgabe (Assignment) wird als Vorbereitung auf das Abschlusskolloquium von den Studierenden gelöst; zu den Lösungen gibt es inhaltliches Feedback und Hilfestellungen von den betreuenden Mitarbeitern schon während des Semesters. Im Abschlusskolloquium stellen die Studierenden (jeweils einzeln) die von ihnen während des Semesters erarbeiteten Lösungen zu der Programmieraufgabe vor, erläutern diese und beantworten Fragen zu ihrer Lösung und den dabei verwendeten Techniken und Sprachkonstrukten.	

Module DSG-DSAM-M Distributed Systems Architectures and Middleware *Distributed Systems Architecture and Middleware*		6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS19/20) Person responsible for module: Prof. Dr. Guido Wirtz		
Contents: This course introduces students to the ideas, benefits, technologies and issues related to server-centric distributed systems and middleware in general. The core topics are centered around component technologies such as Java EJBs, Business-to-Business technologies like EDI and ebXML, and Cloud Computing facilities like Google App Engine and Windows Azure. Thus the course introduces and discusses in-depth topics concerning distributed middleware and its practical use: • Characteristics and Foundations of Distributed Systems • Classical Middleware and Services • Concurrency and Synchronization • Component Technologies • Cloud Computing, in particular platform as a service • Business-to-Business Technologies The selection of topics and teaching method of this course reflects the Distributed Systems Group's (DSG) dedication to integrate business and IT, theory and practice, research and teaching. You not only will be taught the classical way, but you will have hands-on experience on middleware development and middleware tools. Also, you will get the chance to discuss selected publications with your lecturers.		
Learning outcomes: Students are able to evaluate, plan, design and implement server-centric distributed systems. Students are familiar with recent approaches and standards for building and managing such systems, know about the central problems involved as well as ways to overcome these issues. Students have hands-on experience with up-to-date middleware and tools for building server-centric systems.		
Remark: The main language of instruction in this course is English.		
prerequisites for the module: Basic knowledge in software engineering and in distributed systems as introduced, e.g., in the module DSG-IDistrSys-B (or DSG-DistrSys-M).		
Recommended prior knowledge: Basic knowledge in software engineering and in distributed systems as introduced, e.g., in the module DSG-IDistrSys.		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Distributed Systems Architecture and Middleware **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Guido Wirtz **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**

Learning outcome: c.f. overall module description **Contents:** c.f. overall module description **Literature:** This is a fast emerging field with new insights every year. So, up-to-date literature will be provided at the beginning of each course.	
2. Practicals Distributed Systems Architecture and Middleware **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Praktische Informatik **Language:** English/German **Frequency:** every winter semester **Learning outcome:** c.f. overall module description **Contents:** Introduction to and discussion of tools and practical issues closely related to the topics discussed in the lecture as well as solutions of problems that come up during working on the practical assignment. **Literature:** c.f. overall module description	**2,00 Weekly Contact Hours**
Examination Coursework Assignment and Colloquium / Duration of Examination: 15 minutes Duration of Coursework: 3 months **Description:** Oral examination concerning the topics discussed in the lecture, exercises and assignment. **Students may choose English or German as the language for the oral examination.** Examinations will take place at the end of the winter term or at the begin of the summer term (students may choose one of them). Students are assumed to work on a programming assignment ('schriftliche Hausarbeit') during the semester that is introduced at the beginning of the semester and uses the most important technologies discussed during the semester. **Note:** Without working on the programming assignment over the term students may run into problems during their oral examination (Kolloquium) as we discuss questions concerning topics from the lectures as well as from the assignment; questions about the assignment are based on the assignment solution programmed by the students.	

Module DSG-DistrSys-M Distributed Systems *Distributed Systems*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since SS20) Person responsible for module: Prof. Dr. Guido Wirtz	

Contents:

Nowadays infrastructure and business relies more or less on distributed systems of various flavors. Most of our civilization would not work any more if all distributed systems would fail. So, that should be a good reason for anyone planning to work in the context of IT to learn at least about the characteristics and basic issues of such systems. The course introduces to the different flavors of and issues with distributed systems, discusses the most basic problems arising with this kind of systems and presents solutions and techniques that are essential to make distributed systems work. Additionally, the course also teaches how to build simple distributed systems using Java-based technologies like process interaction, synchronization, remote message invocation and web service infrastructure. Students are required to work (in groups) on assignments in order to combine the theoretical concepts with practical experience and ... Yes, we program!

Learning outcomes:

Students know about the characteristics and different flavors of distributed systems and understand the essential differences compared to monolithic, centralized systems as well as their consequences when designing and building distributed systems. Students are able to apply the basic algorithmic techniques and programming paradigms in order to build simple distributed systems themselves. Students have gained basic experience with practically building and running distributed systems.

Remark:

The language of instruction in this course is English.

The overall workload of 180h for this module consists of:

- weekly classes: 22.5h
- tutorials: 22.5h
- Work on assignment: 75h
- Literature study 30h
- preparation for and time of the final exam: 30h

This course is intended for 2nd/3rd year bachelor students as well as master students which have not enrolled in a similar course during their bachelor studies. In case of questions don't hesitate to contact the person responsible for this module.

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**
Knowledge of the basics of computer science in general, esp. operating systems, as well as practical experience in Java programming, as the subjects taught in DSG-EiAPS-B and DSG-EiRBS-B. Preferable also knowledge about multithreading and synchronization like, e.g., the subject-matters of DSG-PKS-B. Module Introduction to Parallel and Distributed Programming (DSG-PKS-B) - recommended	none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture Distributed Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Guido Wirtz **Language:** English/German **Frequency:** every summer semester **Learning outcome:** c.f. module description **Contents:** c.f. module description **Literature:** • George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair: Distributed Systems - Concepts and Design. Pearson Education UK, 2011 (5. edition); • Andrew Tanenbaum, Marten van Steen: Distributed Systems - Principles and Paradigms, 2017 (3rd edition) • Additional research literature will be provided during the term for selected readings and discussions	**2,00 Weekly Contact Hours**
2. Tutorial Distributed Systems **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Praktische Informatik **Language:** German **Frequency:** every summer semester **Learning outcome:** c.f. module description **Contents:** Introduction to and discussion of tools and practical issues closely related to the topics discussed in the lecture as well as solutions of problems that come up during working on the practical assignment.	**2,00 Weekly Contact Hours**

Examination	
Coursework Assignment and Colloquium / Duration of Examination: 15 minutes Duration of Coursework: 3 months **Description:** Oral examination concerning the topics discussed in the lecture, exercises and assignment. **Students may choose English or German as the language for the oral examination.** Examinations will take place at the end of the summer term or at the begin of the winter term (students may choose one of them). Students are assumed to work on a programming assignment ('schriftliche Hausarbeit') during the semester that is introduced at the beginning of the semester and uses the most important technologies discussed during the semester.	

Note: Without working on the programming assignment over the term students may run into problems during their oral examination (Kolloquium) as we discuss questions concerning topics from the lectures as well as from the assignment; questions about the assignment are based on the assignment solution programmed by the students.	

Module DSG-EiAPS-B Introduction to Algorithms, Programming and Software *Einführung in Algorithmen, Programmierung und Software*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium

(since WS17/18)
Person responsible for module: Prof. Dr. Guido Wirtz

Contents:
Das Modul gibt einen ersten Einblick in die Informatik aus Sicht der Entwicklung von Algorithmen und deren Realisierung durch Programme in imperativen, objekt-orientierten und funktionalen Programmiersprachen (am Beispiel verschiedener Programmiersprachen und Programmierparadigmen) sowie einen Ausblick auf die Problematik der Softwareentwicklung. Behandelt werden die Grundprinzipien der Informatik zu:

- Präsentation, Interpretation und Manipulation von Information,
- Syntax und Semantik von einfachen Sprachen,
- Probleme, Problemklassen und -Instanzen,
- Design, Entwicklung und Implementierung von Algorithmen für einfache Problemklassen,
- einfache Datenstrukturen wie Keller, Warteschlangen, Listen und Bäume,
- Techniken zur Spezifikation, zur Datenabstraktion und funktionalen Abstraktion, z.B. Abstrakte Datentypen, sowie
- einfache Beschreibungsmechanismen für Sprachen wie Grammatiken (Typ 2/3) und Automaten (Endliche Automaten, Kellerautomaten)

All wichtigen Begriffe werden am Beispiel von konkreten Programmiersprachen veranschaulicht, so dass damit auch die Grundlagen imperativer, funktionaler sowie objektorientierter Programmiersprachen eingeführt werden. Dazu gehören insbesondere die für alle Programmiersprachen wesentlichen Konzepte wie

- Wertebereiche, Namensräume und deren Realisierung durch Speichermodelle,
- Seiteneffekte durch Zuweisungen vs. Berechnung von Funktionen (Parameter, Resultate),
- Kontroll- und Datenfluss in einem Programm, bei Funktionsaufrufen usw.,
- Iteration vs. Rekursion, sowie
- Konzepte zur Strukturierung von Programmen.

Neben der Diskussion der verschiedenen Konzepte werden auch die wichtigsten Aspekte durch praktisches Programmieren eingeübt.

Learning outcomes:
Studierende haben einen ersten Überblick über das Fach 'Informatik' mit seinen verschiedenen Gebieten und kennen die grundlegenden Begriffe, Methoden und Techniken der Informatik aus Sicht von Algorithmen, Programmiersprachen und Softwareentwicklung. Studierende sind in der Lage, aus einem Basisrepertoire an Möglichkeiten jeweils geeignete Abstraktions- und Repräsentationsmethoden zur maschinellen Bearbeitung auszuwählen und Methoden zur Beschreibung von Syntax und Semantik einfacher Sprachen anzuwenden. Sie verstehen die Zusammenhänge zwischen Spezifikation und Implementierung wie auch die grundsätzliche Arbeitsweise von Programmiersprachen und können die wesentlichen Schritte der Softwareentwicklung nachvollziehen. Studierende können einfache Problemstellungen beschreiben, algorithmische Lösungen dazu entwickeln und diese auch mittels einfacher Datenstrukturen in konkreten imperativen und funktionalen Programmiersprachen umsetzen.

Remark:
Auch wenn das Modul organisatorisch unabhängig von der Einführung in Java durch das ebenfalls jeweils im Wintersemester angebotene Modul DSG-JaP-B ist und beide Module auch bei entsprechenden Vorkenntnissen unabhängig voneinander absolviert werden können, **wird Studienanfängerinnen und -anfängern dringend empfohlen, beide Module im gleichen Semester zu bearbeiten, d.h. bei Studienbeginn zum Wintersemester im 1. Fachsemester und bei Studienbeginn zum Sommersemester jeweils im 2. Fachsemester.**

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
Die Veranstaltung hat als grundlegende Einführungsveranstaltung in das Gebiet der Informatik weder Inhalte anderer Lehrveranstaltungen noch Informatikkenntnisse oder Programmierkenntnisse zur Voraussetzung. *Insbesondere ist das Modul PSI-EiRBS-B (vormals DSG-EiRBS-B), das regelmäßig im Sommersemester angeboten wird,* ***keine*** *Voraussetzung für DSG-EiAPS-B.*	none

Frequency: every winter semester	**Recommended semester:** from 1.	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Einführung in Algorithmen, Programmierung und Software — **2,00 Weekly Contact Hours**

Mode of Delivery: Lectures
Lecturers: Prof. Dr. Guido Wirtz
Language: German
Frequency: every winter semester

Learning outcome:
vgl. Modulbeschreibung

Contents:
vgl. Modulbeschreibung

Literature:
Jede Einführung in die Informatik kann als Ergänzung zur Veranstaltung genutzt

werden, allerdings orientiert sich die Vorlesung nicht an einem Buch; deshalb ist die Liste hier nur als Auswahl "nützlicher" Bücher zu verstehen, die zum Teil andere Schwerpunkte setzen, nicht unbedingt die gleichen Themen behandeln, bei gleichen Themen andere Herangehensweisen an das jeweilige Thema wählen und natürlich zum Teil andere Schreibweisen usw. benutzen:

- Heinz-Peter Gumm, Manfred Sommer: Einführung in die Informatik. Oldenbourg Verlag, 2013 (10th)
- Herbert Klaeren, Michael Sperber: Die Macht der Abstraktion - Einführung in die Programmierung. Teubner, 2007 (1th)
- Matthias Felleisen, Robert Bruce Findler, Matthew Flatt, Shriram Krishnamurthi: How to Design Programs - An Introduction to Computing and Programming. The MIT Press 2001 (online verfügbar)

- Helmut Herold, Bruno Lurz, Jürgen Wohlrab: Grundlagen der Informatik. Pearson Higher Education, 2012 (2nd)
- Barbara Liskov with John Guttag: Program Development in Java. Addison-Wesley, 2001

2. Einführung in Algorithmen, Programmierung und Software **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Praktische Informatik **Language:** German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Learning outcome: vgl. Vorlesung	
Contents: In der Übung werden die wichtigsten Konzepte der gleichnamigen Vorlesung an einfachen Beispielen praktisch umgesetzt und durch die Besprechung von typischen Aufgaben zum jeweiligen Thema, die den Studierenden regelmäßig zum freiwilligen Üben angeboten werden, vertieft. Dabei wird insbesondere Wert auf die Vorstellung von Lösungen durch die Studierenden und deren Diskussion in der Übungsgruppe gelegt.	
Literature: vgl. Vorlesung	

Examination Written examination / Duration of Examination: 90 minutes **Description:** Klausur zum Stoff des gesamten Moduls, also der Vorlesung und Übung zur DSG-EiAPS-B. Bestehen der Klausur durch Erreichen von 50% der maximal erreichbaren Punkte.	

Module DSG-IDistrSys-B Introduction to Distributed Systems *Introduction to Distributed Systems*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since SS20) Person responsible for module: Prof. Dr. Guido Wirtz	

Contents:

Nowadays infrastructure and business relies more or less on distributed systems of various flavors. Most of our civilization would not work any more if all distributed systems would fail. So, that should be a good reason for anyone planning to work in the context of IT to learn at least about the characteristics and basic issues of such systems. The course introduces to the different flavors of and issues with distributed systems, discusses the most basic problems arising with this kind of systems and presents solutions and techniques that are essential to make distributed systems work. Additionally, the course also teaches how to build simple distributed systems using Java-based technologies like process interaction, synchronization, remote message invocation and web service infrastructure. Students are required to work (in groups) on assignments in order to combine the theoretical concepts with practical experience and ... Yes, we program!

Learning outcomes:

Students know about the characteristics and different flavors of distributed systems and understand the essential differences compared to monolithic, centralized systems as well as their consequences when designing and building distributed systems. Students are able to apply the basic algorithmic techniques and programming paradigms in order to build simple distributed systems themselves. Students have gained basic experience with practically building and running distributed systems.

Remark:

The language of instruction in this course is English.

The overall workload of 180h for this module consists of:

- weekly classes: 22.5h
- tutorials: 22.5h
- Work on assignment: 75h
- Literature study 30h
- preparation for and time of the final exam: 30h

This course is intended for 2nd/3rd year bachelor students as well as master students which have not enrolled in a similar course during their bachelor studies. In case of questions don't hesitate to contact the person responsible for this module.

prerequisites for the module:

none

Recommended prior knowledge:	Admission requirements:
Knowledge of the basics of computer science in general, esp. operating systems, as well as practical experience in Java programming, as the subjects taught in DSG-EiAPS-B and DSG-EiRBS-B. Preferable also knowledge about multithreading and synchronization like, e.g., the subject-matters of DSG-PKS-B. Module Introduction to Parallel and Distributed Programming (DSG-PKS-B) - recommended	none

Frequency: every summer semester	**Recommended semester:** from 4.	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Introduction to Distributed Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Guido Wirtz **Language:** English/German **Frequency:** every summer semester **Learning outcome:** c.f. overall module description **Contents:** c.f. overall module description **Literature:** • George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair: Distributed Systems. Pearson Education UK, 2011 (5. Auflage); ISBN: 9780273760597 • Kenneth P. Birman: Guide to Reliable Distributed Systems. Springer Texts in CS, Springer Verlag, 2012, ISBN 978-1-4471-2415-3	**2,00 Weekly Contact Hours**
2. Tutorials Introduction to Distributed Systems **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Praktische Informatik **Language:** English/German **Frequency:** every summer semester **Learning outcome:** c.f. overall module description **Contents:** Introduction to and discussion of tools and practical issues closely related to the topics discussed in the lecture as well as solutions of problems that come up during working on the practical assignment. **Literature:** c.f. overall module description	**2,00 Weekly Contact Hours**

Examination	
Coursework Assignment and Colloquium / Duration of Examination: 10 minutes Duration of Coursework: 3 months **Description:** Oral examination concerning the topics discussed in the lecture, exercises and assignment. **Students may choose English or German as the language for the oral examination.** Examinations will take place at the end of the summer term or at the begin of the winter term (students may choose one of them). Students are assumed to work on a programming assignment ('schriftliche Hausarbeit') during the semester that is introduced at the beginning of the	

semester and uses the most important technologies discussed during the semester. **Note:** Without working on the programming assignment over the term students may run into problems during their oral examination (Kolloquium) as we discuss questions concerning topics from the lectures as well as from the assignment; questions about the assignment are based on the assignment solution programmed by the students.	

Module DSG-JaP-B Programming in Java *Java Programmierung*	3 ECTS / 90 h 30 h Präsenzzeit 60 h Selbststudium
(since WS17/18) Person responsible for module: Prof. Dr. Guido Wirtz	

Contents:

Die Programmiersprache Java wird als imperative und auch objektorientierte Sprache in ihren wichtigsten Konzepten und Bestandteilen eingeführt. Der Schwerpunkt liegt dabei auf dem Kern der Sprache und der praktischen Anwendung der Sprache zur Erstellung einfacher Programme, dem sog. Programmieren im Kleinen. Dazu werden die relevanten Konzepte zur Erstellung einfacher Programme (Schnittstellen, Klassen und Testklassen) zur Manipulation von grundlegenden Datentypen und einfachen Datenstrukturen (Felder, einfache Listen) eingeführt und anhand von Beispielen und durch einfache Programmieraufgaben erläutert. Zudem wird die Verwendung der in Java vorhandenen Techniken zur Umsetzung objektorientierten Programmierens wie z.B. Typisierung und Vererbung sowie Mechanismen zur Abstraktion und Strukturierung wie z.B. Schnittstellen und Paket-Strukturen und einfache Fehlerbehandlung (Exceptions) diskutiert.

Learning outcomes:

Studierende sollen mit der Programmiersprache Java und einer einfachen Programmierumgebung (Editor, Compiler, Dokumentations-Werkzeug) soweit praktisch umgehen können, dass sie aus der Beschreibung einfacher Probleme selbständig ein Lösungsverfahren entwickeln und durch Wahl geeigneter Daten- und Kontrollstrukturen in ein funktionsfähiges Java-Programm umsetzen, übersetzen und nach Auswahl geeigneter Testdaten testen können. Zusätzlich sollen die von Java angebotenen - für objektorientierte Sprachen typische - Strukturierungs- und Abstraktionstechniken wie Sichtbarkeitsbereiche, Schnittstellen und implementierende Klassen, einfache Vererbung, Programme bestehend aus mehreren Klassen sowie Verwendung eigener und vorgegebener Paketstrukturen sinnvoll eingesetzt werden können.

Remark:

Auch wenn das Modul organisatorisch unabhängig von der grundlegenden Einführung in die Informatik durch das Modul DSG-EiAPS-B ist und bei entsprechenden Vorkenntnissen auch ohne die DSG-EiAPS-B absolviert werden kann, wird Studienanfängerinnen und -anfängern **dringend empfohlen, beide Module im gleichen Semester zu bearbeiten**, d.h. bei Studienbeginn zum Wintersemester im 1. Fachsemester und bei Studienbeginn zum Sommersemester jeweils im 2. Fachsemester.

prerequisites for the module:

none

Recommended prior knowledge: Grundlagende Kenntnisse in einfachen Algorithmen und Kontrollstrukturen sowie den Grundprinzipien der Informatik, wie sie z.B. in den ersten Sitzungen der Vorlesung zum Modul DSG-EiAPS-B vermittelt werden, werden vorausgesetzt.		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:** from 1.	**Minimal Duration of the Module:** 1 Semester

Module Units	
Java Programmierung **Mode of Delivery:** Lectures and Practicals	**2,00 Weekly Contact Hours**

Lecturers: Prof. Dr. Guido Wirtz
Language: German
Frequency: every winter semester

Learning outcome:

Studierende sollen mit der Programmiersprache Java und einer einfachen

Programmierumgebung (Editor, Compiler, Dokumentations-Werkzeug) soweit praktisch umgehen können, dass sie aus der Beschreibung einfacher Probleme selbständig ein Lösungsverfahren entwickeln und durch Wahl geeigneter Daten- und Kontrollstrukturen in ein funktionsfähiges Java-Programm umsetzen, übersetzen und nach Auswahl geeigneter Testdaten testen können. Zusätzlich sollen die von Java angebotenen - für objektorientierte Sprachen typische - Strukturierungs- und Abstraktionstechniken wie Sichtbarkeitsbereiche, Schnittstellen und implementierende Klassen, einfache Vererbung, Programme bestehend aus mehreren Klassen sowie Verwendung eigener und vorgegebener Paketstrukturen sinnvoll eingesetzt werden können.

Contents:

Die Programmiersprache Java wird als imperative und auch objektorientierte Sprache in ihren wichtigsten Konzepten und Bestandteilen eingeführt. Der Schwerpunkt liegt dabei auf dem Kern der Sprache und der praktischen Anwendung der Sprache zur Erstellung einfacher Programme, dem sog. Programmieren im Kleinen. Dazu werden die relevanten Konzepte zur Erstellung einfacher Programme (Schnittstellen, Klassen und Testklassen) zur Manipulation von grundlegenden Datentypen und einfachen Datenstrukturen (Felder, einfache Listen) eingeführt und anhand von Beispielen und durch einfache Programmieraufgaben erläutert. Zudem wird die Verwendung der in Java vorhandenen Techniken zur Umsetzung objektorientierten Programmierens wie z.B. Typisierung und Vererbung sowie Mechanismen zur Abstraktion und Strukturierung wie z.B. Schnittstellen und Paket-Strukturen und einfache Fehlerbehandlung (Exceptions) diskutiert.

Examination

Written examination / Duration of Examination: 90 minutes

Description:

Klausur zum Stoff des gesamten Moduls, insbesondere in Form von Programmieraufgaben. Bestehen der Klausur durch Erreichen von 50% der maximal erreichbaren Punkte.

<table>
<tr><td colspan="2">Module DSG-PKS-B Introduction to Parallel and Distributed Programming
Programmierung komplexer interagierender Systeme</td><td>3 ECTS / 90 h
23 h Präsenzzeit
67 h Selbststudium</td></tr>
<tr><td colspan="3">(since WS17/18)
Person responsible for module: Prof. Dr. Guido Wirtz</td></tr>
<tr><td colspan="3">Contents:
Die Veranstaltung erläutert und übt den Umgang mit (explizit) parallelen Programmen und schafft damit auch ein vertieftes Verständnis für die Arbeitsweise heutiger Mehrkernprozessoren und Multiprozessoren. Dabei wird sowohl auf die grundlegenden Probleme und Techniken eingegangen als auch das praktische Entwerfen und Programmieren solcher Systeme (derzeit auf der Grundlage von Java) eingeübt. Dabei geht es um
• Prozesse und Threads,
• Prozesskommunikation,
• Synchronisation bei Shared Memory,
• einfache C/S-Systeme mit TCP sockets,
• Message-Passing im Aktor-Modell.
Zusätzlich wird die Problematik robuster verteilter Systeme diskutiert und ein Ausblick auf alternative Interaktionsparadigmen gegeben.</td></tr>
<tr><td colspan="3">Learning outcomes:
Die Studierenden kennen die gebräuchlichen Prozessbegriffe, die grundsätzlichen Probleme der Programmierung echt- und pseudo-paralleler Prozesssysteme sowie die grundlegenden Mechanismen zur Inter-Prozess-Kommunikation. Die Studierenden sind in der Lage, einfache parallele Programme mittels Threads zu schreiben, diese über Synchronisationsverfahren zu koordinieren sowie durch Kommunikationsmechanismen kooperativ und verlässlich zusammen arbeiten zu lassen.</td></tr>
<tr><td colspan="3">Remark:
Der Arbeitsaufwand von 90 Std. gliedert sich in
• 22.5 Std. Teilnahme an der Praktischen Übung
• 55 Std. Bearbeiten der Programmieraufgabe (Assignment)
• 12 Std. Vorbereitung auf das Abschlusskolloquium
• 0.5 Std. Abschlusskolloquium inklusive Warten auf Ergebnis usw.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Programmierkenntnisse in Java sowie Grundkenntnisse aus dem Bereich der Betriebssysteme, wie sie z.B. im Modul PSI-EiRBS-B (vormals DSG-EiRBS-B) vermittelt werden.
Modul Einführung in Algorithmen, Programmierung und Software (DSG-EiAPS-B) - empfohlen
Modul Einführung in Rechner- und Betriebssysteme (PSI-EiRBS-B, vormals DSG-EiRBS-B) - empfohlen</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

Module Units	
Programmierung komplexer interagierender Systeme **Mode of Delivery:** Lectures and Practicals **Lecturers:** Scientific Staff Praktische Informatik **Language:** German **Frequency:** every winter semester **Learning outcome:** vgl. Modulbeschreibung **Contents:** vgl. Modulbeschreibung **Literature:** - wird jeweils aktuell zur Veranstaltung angegeben -	**2,00 Weekly Contact Hours**
Examination Coursework Assignment and Colloquium / Duration of Examination: 10 minutes Duration of Coursework: 3 months **Description:** Die zu Beginn des Semesters ausgegebene Programmieraufgabe (Assignment) wird als Vorbereitung auf das Abschlusskolloquium von den Studierenden gelöst; zu den Lösungen gibt es inhaltliches Feedback und Hilfestellungen von den betreuenden Mitarbeitern schon während des Semesters. Im Abschlusskolloquium stellen die Studierenden (jeweils einzeln) die von ihnen während des Semesters erarbeiteten Lösungen zu der Programmieraufgabe vor, erläutern diese und beantworten Fragen zu ihrer Lösung und den dabei verwendeten Techniken und Sprachkonstrukten.	

Module DSG-Project-2-SoSySc-B DSG Bachelorproject Software Systems Science *DSG Bachelorprojekt Software Systems Science*	12 ECTS / 360 h 220 h Präsenzzeit 140 h Selbststudium
(since WS18/19) Person responsible for module: Prof. Dr. Guido Wirtz	

Contents:

Überschaubare Themen aus der aktuellen Forschungsarbeit der Arbeitsgruppe Verteilte Systeme (DSG), die aber eine umfangreiche Einarbeitung erfordern können, werden in einer zum Teil gemeinsam, zum Teil arbeitsteilig, arbeitenden Gruppe von Studierenden von der Konzeption bis zur praktischen Umsetzung im Rahmen des zweisemestrigen Projekts durchgeführt. Dabei geht es nicht nur um die programmiertechnische Umsetzung, sondern insbesondere auch um die Entwicklung tragfähiger und mit den vorgegebenen Rahmenbedingungen kompatibler Konzepte zur Lösung der gestellten Aufgabe, sowie um die Sicherstellung der robusten und verlässlichen Funktion der entwickelten Systeme. In der Regel wird dazu das Studium aktueller Literatur und die Auswahl, Umsetzung und/oder Adaption zum Thema vorgeschlagener Ansätze notwendig sein. Typische Themen - die sich jeweils den aktuellen Arbeiten der DSG anpassen - sind z.B. die Untersuchung von BPMN- oder BPEL basierten Standards und Ansätzen im Bereich von dienst-orientierten Systemen oder aber die Erstellung eines Prototyps zum Monitoring oder der Visualisierung verteilter Software-Systeme.

Learning outcomes:

Studierende sollen ein vertieftes Verständnis der bei der Durchführung von praktischen, arbeitsteilig organisierten, Softwareprojekten auftretenden Probleme wie auch von erfolgversprechenden Lösungsansätzen zu diesen Problemen erhalten. Da dies anhand der intensiven Bearbeitung eines Themas aus dem Forschungsbreich der Verteilten Systeme geschieht, gewinnen die TeilnehmerInnen wichtige Erfahrungen mit der Durchführung kleinerer, forschungsorientierter Projekte von der Grobkonzeption über die Detailplanung bis hin zur Umsetzung und Dokumentation der Ergebnisse in einem wissenschaftlich ausgerichteten Arbeitsbericht sowie einer Posterpräsentation.

Remark:

Dieses Modul erstreckt sich über 2 Semester (Start im Wintersemester):
2x6=12 ECTS, 2x4=8 SWS.

Der Arbeitsaufwand beträgt insgesamt 360 Std., welche sich grob wie folgt gliedern:
- 60 Std. Recherche, Planung und Teilnahme am Planungsworkshop
- 40 Std. Teilnahme an Projekttreffen, einschließlich Tutorien
- 180 Std. Durchführung des Projekts (Projektarbeit)
- 20 Std. Erstellung des Zwischenberichts (Hausarbeit)
- 60 Std. Erstellung des Abschlussberichts, sowie Erstellung und Präsentation des Projektposters (Hausarbeit und Kolloquium)

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**
Grundlegende methodische Kenntnisse zur Planung und Durchführung von Softwareprojekten und zum wissenschaftlichen Arbeiten, sowie Grundkenntnisse in der Programming paralleler und verteilter Systeme	none

wie sie z.B. durch DSG-PKS-B und/oder DSG-IDistrSys vermittelt werden.		
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 2 Semester

Module Units	
DSG Bachelorprojekt Software Systems Science **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Guido Wirtz, Scientific Staff Praktische Informatik **Language:** German/English **Frequency:** every semester **Learning outcome:** siehe Modulbeschreibung **Contents:** vgl. Modulbeschreibung **Literature:** Je nach Projektthematik; wird zu Beginn des Projekts bekannt gegeben.	**8,00 Weekly Contact Hours**

Examination Coursework Assignment / Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Anfertigen eines schriftlichen Zwischenberichts zum Projekt in Deutsch oder Englisch nach etwa 80 Std. geleisteter Projektarbeit, spätestens am Ende des Semesters, in dem das Projekt begonnen wurde. Die Gewichtung der Prüfungsleistungen wird zu Beginn des Semesters bekannt gegeben.	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** **Kolloquium:** Fachliche Diskussion auf der Grundlage des im Projekt bearbeiteten Themas im Rahmen einer Abschlussveranstaltung, auf der zunächst das zum Projekt angefertigte Poster erläutert wird; hier können auch praktische Projektergebnisse (z. B. lauffähige Software) demonstriert werden. **Hausarbeit:** Anfertigen eines schriftlichen Abschlussberichts in Deutsch oder Englisch nach abgeschlossener Projektarbeit. Die Gewichtung der Prüfungsleistungen wird zu Beginn des Semesters bekannt gegeben.	

Module DSG-Project-B Bachelor Project in Distributed Systems *Bachelorprojekt zur Praktischen Informatik*	6 ECTS / 180 h 130 h Präsenzzeit 50 h Selbststudium
(since WS18/19) Person responsible for module: Prof. Dr. Guido Wirtz	
Contents: Überschaubare Themen aus der aktuellen Forschungsarbeit der Arbeitsgruppe Verteilte Systeme (DSG), die ohne umfangreiche Einarbeitung zu bearbeiten sind, werden in einer zum Teil gemeinsam, zum Teil arbeitsteilig, arbeitenden Gruppe von Studierenden von der Konzeption bis zur praktischen Umsetzung im Rahmen eines 6-wöchigen Projekts durchgeführt. Dabei geht es nicht nur um die programmiertechnische Umsetzung, sondern insbesondere auch um die Entwicklung tragfähiger und mit den vorgegebenen Rahmenbedingungen kompatibler Konzepte zur Lösung der gestellten Aufgabe. In der Regel wird dazu das Studium aktueller Literatur und die Auswahl, Umsetzung und/oder Adaption zum Thema vorgeschlagener Ansätze notwendig sein. Typische Themen - die sich jeweils den aktuellen Arbeiten der DSG anpassen - sind z.B. Transformationen zwischen verschiedenen Prozesssprachen oder XML-Darstellungen, die Erstellung einfacher, neuer Werkzeuge im Kontext der Beschreibung und Analyse verteilter Systeme oder aber die Erweiterung von Werkzeugen um neue Funktionalitäten inklusive Einarbeitung in schon vorhandene Programmsysteme usw. Dabei wird sowohl durch die konkrete Themenstellung als auch die enge betreuung und Unterstützung des Projekts darauf geachtet, dass die gestellten Aufgaben auch im (fortgeschrittenen) Bachelorstudium sinnvoll zu bearbeiten sind.	
Learning outcomes: Studierende sollen ein vertieftes Verständnis der bei der Durchführung von praktischen, arbeitsteilig organisierten, Softwareprojekten auftretenden Probleme wie auch von erfolgversprechenden Lösungsansätzen zu diesen Problemen erhalten. Da dies anhand der intensiven Bearbeitung eines Themas aus dem Forschungsbreich der praktischen Informatik geschieht, gewinnen die TeilnehmerInnen wichtige Erfahrungen mit der Durchführung kleinerer, forschungsorientierter Projekte von der Grobkonzeption über die Detailplanung bis hin zur Umsetzung und Dokumentation der Ergebnisse in einem wissenschaftlich ausgerichteten Arbeitsbericht.	
Remark: Der Arbeitsaufwand von insgesamt 180 Std. gliedert sich in etwa in: • 50 Std. Einführung, Vorstellen von Werkzeugen, Vorträge zum Projektstand • 30 Std. Recherchen zu und Einarbeitung in Thematik des Praktikums inkl. Vorbereitung von Kurzvorträgen • 80 Std. praktische Projektarbeit (Softwareentwicklung) • 10 Std. Abfassen des Projektberichts • 10 Std. Vorbereitung auf und Zeit für das Kolloquium (unter o.g. schon erbrachten Aufwänden)	
prerequisites for the module: none	
Recommended prior knowledge: Programmierkenntnisse sowie Kenntnisse in den Grundlagen des im Projekt behandelten Themengebiets. Modul Einführung in Algorithmen, Programmierung und Software (DSG-EiAPS-B) - empfohlen	**Admission requirements:** none

Modul Einführung in Rechner- und Betriebssysteme (PSI-EiRBS-B, vormals DSG-EiRBS-B) - empfohlen	

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Projektübung zur Praktischen Informatik **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Guido Wirtz, Scientific Staff Praktische Informatik **Language:** German **Frequency:** every summer semester **Contents:** vgl. Modulbeschreibung **Literature:** - je nach Projektthematik -	**4,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium / Duration of Examination: 15 minutes Duration of Coursework: 2 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Anfertigen eines schriftlichen Berichts über das im Projekt durchgeführte Softwareprojekt. Diskussion des vorliegenden Projektberichts sowie der erstellten Artefakte vor dem Hintergrund des allgemeinen Themas der Projektarbeit.	

<table>
<tr><td colspan="2">Module DSG-Project-M Master Project Distributed Systems
Masterprojekt Verteilte Systeme</td><td>9 ECTS / 270 h</td></tr>
<tr><td colspan="3">(since SS19)
Person responsible for module: Prof. Dr. Guido Wirtz</td></tr>
<tr><td colspan="3">Contents:
Im Rahmen des Projekts wird ein umfangreiches Thema im Bereich der Systementwicklung in Gruppenarbeit bearbeitet. Studierende arbeiten dabei an auch in der Praxis auftretenden Problematiken, die mit der möglichst selbständigen Lösung einer größeren, nur noch bedingt von einem Einzelnen lösbaren Aufgabe in zum Teil konkret vorgegebenen Rahmenbedingungen verbunden sind. Das Master-Projekt unterscheidet sich dabei von der Projektarbeit im Bachelorstudiengang durch die Komplexität der Aufgabe und den direkten Bezug zu aktuellen wissenschaftlichen Arbeiten des Lehrstuhls.</td></tr>
<tr><td colspan="3">Learning outcomes:
Fähigkeit zur selbständigen Erarbeitung von Problemlösungen auf der Basis des erlernten Wissens und der angeeigneten Fähigkeiten aus dem Studium als auch der aktuellen wissenschaftlichen Literatur; Fähigkeit, komplexe Problemlösungsansätze im Rahmen eines systematischen ingenieurtechnischen Entwicklungsprozesses in Software umzusetzen und professionell zu dokumentieren; Fähigkeit zur Teamarbeit; Wissenschaftliche Neugier und die Ausbildung einer selbstbewussten und forschenden Einstellung zur Technik.</td></tr>
<tr><td colspan="3">Remark:
Verfassen eines schriftlichen Projektberichts, eines Posters zum Projektergebnis sowie Bestehen des mündlichen Testats zum Projektergebnis.

Der Arbeitsaufwand von insgesamt 270 Std. (als Block nach dem jeweiligen SoSe) gliedert sich in etwa in:
• 35 Std. Einführung, Vorstellen von Werkzeugen, Kurzvorträge
• 30 Std. Recherchen zu und Einarbeitung in Thematik des Projekts inkl. Vorbereiten von Kurzvorträgen
• 180 Std. praktische Projektarbeit (Softwareentwicklung)
• 15 Std. Abfassen des Projektberichts und Erstellen des gemeinsamen Posters
• 10 Std. Vorbereitung auf dasTestat (unter o.g. schon erbrachten Aufwänden)</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Die Veranstaltung baut auf der Veranstaltung DSG-EiDistrSys 'Einführung in verteilte Systeme' auf. Je nach Themenstellung ist auch der vorherige Besuch einer der Veranstaltungen DSG-SOA-M oder DSG-DSAM-M zu empfehlen (Bekanntgabe jeweils bei Themenankündigung).

Von den Studierenden des Faches wird die Beherrschung einer höheren (objektorientierten) Programmiersprache sowie die Bereitschaft zur praktischen Arbeit am Rechner erwartet.

Module Einführung in Verteilte Systeme (DSG-EiDistrSys) -</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

Module Units	
Verteilte Systeme **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Guido Wirtz, Scientific Staff Praktische Informatik **Language:** German/English **Frequency:** every semester **Contents:** Aufbauend auf den in den Vorlesungen und Übungen im Bereich Verteilte Systeme erworbenen Kenntnissen und Fertigkeiten wird in dieser Veranstaltung ein kleineres Projekt mit wissenschaftlichem Bezug in einer Gruppe umgesetzt. Nach einer kurzen Einführung in die jeweils verwendeten Technologien und Werkzeuge wird in einer als Projekt mit verschiedenen Arbeitsgruppen/paketen organisierten Form ein zusammenhängendes Problem aus dem Bereich der verteilten und mobilen Systeme praktisch bearbeitet. In der Regel wird dabei ein Prototyp eines komplexen verteilten Softwaresystems oder Werkzeugs aus diesem Bereich erstellt. **Literature:** - je nach Projektthema -	**6,00 Weekly Contact Hours**
Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 3 months **prerequisites for module examination:** regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Bericht über den im Projekt erbrachten Eigenanteil als klar gekennzeichneter Teil des Gesamtberichts der Projektgruppe; Mitarbeit bei der Erstellung einer Posterdemonstration zu den Projektsergebnisen. Mündliches Prüfungsgespräch über die Inhalte des Projekts, insbesondere die vom jeweiligen Studierenden erbrachten konzeptionellen und praktischen Leistungen.	

Module DSG-SOA-M Service-Oriented Architecture and Web Services *Service-Oriented Architecture and Web Services*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since SS20) Person responsible for module: Prof. Dr. Guido Wirtz	

Contents:

Building enterprise-scale IT systems requires sound concepts for integrating software. **Service-oriented architectures (SOAs)** have been the number one answer to this integration challenge for years. Indeed, service orientation is and will be a cornerstone in modularizing large IT landscapes and alignment with business needs is the driving factor for service engineering. A SOA composes an IT system from services in a loosely-coupled manner. Each service implements a business task and therefore have a clear value attribution. When business needs change, the loose coupling of services allows for quick adjustment of the SOA. In recent years, Microservices have been put forward as a new paradigm for organizing software-intensive systems as a set of small services that communicate using lightweight communication technologies and are *independently deployable by fully automated deployment machinery*. Conceptually, Microservices and SOA share a lot, but the Microservices paradigm puts a lot more emphasis on automation in development and therefore is a better fit for modern development practices.

When moving beyond company boundaries and opening up the solution space is necessary, **software ecosystems (SECOs)**come into play. Software ecosystems integrate software contributions from independent organizational entities and enable software products and solutions that a single company cannot realize alone. Prominent representatives of software ecosystems are Android and the Playstore or iOS and the AppStore. But the paradigm of software ecosystems goes far beyond mobile platforms and also covers application areas in the cloud domain or the embedded domain.

Skilled software architects therefore reconcile the business views and technical views for the benefit of the enterprise and therefore need both, advanced knowledge in business process and workflow management as well as a rock-solid understanding of service engineering and distributed computing.

This course will introduce you to the world of architectures for large-scale software by giving a brief overview on distributed systems and software architecture in general. Then SOAs as an architectural paradigm and Web Services (WSDL + REST) as SOA implementation technology will be treated in detail. SOA will be contrasted to Microservices and the development aspects that Microservices focuses on will be discussed. Software ecosystems then will be introduced as a paradigm for organizing software systems and container technology (Linux Containers (LXC) and Docker) as a frequent implementation means for software ecosystems will be introduced. In particular, we will investigate what building industry-grade ecosystems based on container technology means in practice.

- Conceptual Foundations of SOA
- SOA Characterisitics
- Microservices
- WSDL and Basic Web Services
- REST-ful Services
- Software Ecosystems
- Container technology

The selection of topics and teaching method of this course reflects the Distributed Systems Group's (DSG) dedication to integrate business and IT, theory and practice, research and teaching. You not only will be taught the classical way, but you will have hands-on experience on service development and SOA tools.

Also, you will get a grasp of current services research and you will get the chance to discuss selected publications with your lecturers.

Learning outcomes:
Students know about the different aspects of service-oriented architectures and their practical use.
Students

- Understand the characteristics of SOAs, Microservices and SECOs and its implications on IT systems.
- Know relevant technologies and standards in the field and being able to combine some of these to develop basic Web Services and service compositions
- Being able to compare WSDL Web Services to REST Web Services
- Being able to use container technology for integrating software
- Being able to judge IT architectures from a SOA/Microservices/SECO perspective.
- Being able to understand and discuss scientific work in the area

Remark:
The main language of instruction in this course is English.

The overall workload of 180h for this module consists of:

- weekly classes: 22.5h
- tutorials: 22.5h
- Work on assignment: 75h
- Literature study 30h
- preparation for and time of final exam: 30h

prerequisites for the module:
Basic knowledge in software engineering and in distributed systems as introduced, e.g., in the modules DSG-IDistrSys-B or DSG-DistrSys-M.

Recommended prior knowledge: Basic knowledge in software engineering and distributed systems. Module Introduction to Distributed Systems (DSG-IDistrSys) - recommended		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Service-Oriented Architecture and Web Services **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Guido Wirtz, Scientific Staff Praktische Informatik **Language:** English **Frequency:** every summer semester **Learning outcome:** c.f. overall module description **Contents:** c.f. overall module description **Literature:**	**2,00 Weekly Contact Hours**

SOA is still a fast emerging field - most recent version of standards and up-to-date literature will be provided at the beginning of each course.	
2. Practicals Service-Oriented Architecture and Web Services **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Praktische Informatik **Language:** English/German **Frequency:** every summer semester **Learning outcome:** c.f. overall module description **Contents:** Introduction to and discussion of tools and practical issues closely related to the topics discussed in the lecture as well as solutions of problems that come up during working on the practical assignment. **Literature:** c.f. overall module description	**2,00 Weekly Contact Hours**
Examination Coursework Assignment and Colloquium / Duration of Examination: 15 minutes Duration of Coursework: 3 months **Description:** Oral examination concerning the topics discussed in the lecture, exercises and assignment. S**tudents may choose English or German as the language for the oral examination.** Examinations will take place at the end of the summer term or at the begin of the winter term (students may choose one of them). Students are assumed to work on a programming assignment ('schriftliche Hausarbeit') during the semester that is introduced at the beginning of the semester and uses the most important technologies discussed during the semester. **Note:** Without working on the programming assignment over the term students may run into problems during their oral examination (Kolloquium) as we discuss questions concerning topics from the lectures as well as from the assignment; questions about the assignment are based on the assignment solution programmed by the students.	

Module DSG-Sem-B Bachelor Seminar in Practical Computer Science *Bachelorseminar zur Praktischen Informatik*		3 ECTS / 90 h
(since WS12/13) Person responsible for module: Prof. Dr. Guido Wirtz		
Contents: Verschiedene Themen aus dem Bereich der praktischen Informatik, die einen der fachlichen oder methodischen Aspekte aus den grundlegenden Informatik-Modulen DSG-EidAPS-B oder DSG-EiRBS-B anhand aktueller Literatur vertiefen und/oder ergänzen.		
Learning outcomes: Studierende sollen überschaubare aktuelle Themen der praktischen Informatik anhand eigener Literaturrecherchen unter Anleitung erarbeiten und in einer dem Thema angemessenen und für alle SeminarteilnehmerInnen verständlichen Form aufbereiten und präsentieren können.		
prerequisites for the module: none		
Recommended prior knowledge: Grundlegende Kenntnisse im jeweils im Seminar behandelten Gebiet der Praktischen Informatik, also mindestens eines der beiden Module DSG-EiAPS-B oder DSG-EiRBS-B. Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended Module Introduction to Computer Architecture and Operating Systems (DSG-EiRBS-B) - recommended		**Admission requirements:** none
Frequency: every semester	**Recommended semester:** 2.	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelorseminar zur Praktischen Informatik **Mode of Delivery:** Introductory seminar **Lecturers:** Prof. Dr. Guido Wirtz, Scientific Staff Praktische Informatik **Language:** German **Frequency:** every semester **Contents:** vgl. Modulbeschreibung **Literature:** - wird jeweils nach Seminarthemen vergeben -	**2,00 Weekly Contact Hours**
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 3 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:**	

Begutachtung einer schriftlichen Ausarbeitung zu den wichtigsten Aspekten des erarbeiteten Themas mit formgerechter Liste der verwendeten Literatur. Freies Halten eines Referats auf der Grundlage der von dem/der Vortragenden erstellten Folien oder elektronischen Präsentationsunterlagen inklusive Diskussion der Inhalte mit den Seminarteilnehmerinnen und Seminarteilnehmern.	

Module DSG-Sem-M Master Seminar in Distributed Systems *Masterseminar zu Verteilten Systemen*	3 ECTS / 90 h
(since WS12/13) Person responsible for module: Prof. Dr. Guido Wirtz	

Contents:

This module is intended to offer an in-depth study of specific topics in distributed systems that go well beyond the topics discussed in DSG-IDistrSys, DSG-SOA-M or DSG-DSM-M. We try to close the gap between 'standard' lecture topics often dealing with the (required) basics and the state-of-the-art related to a specific research question regarding distributed systems in general, SOC and SOA, server-side middleware, process languages, as well as questions w.r.t. standard conformance, interoperability and correctness based on 'ground-breaking' as well as up-to-date research papers from international journals and/or conferences.

Learning outcomes:

Students will learn how to read and work on research papers, how to present their essence as an outline talk to colleguages (students)and how to guide discussion sessions based on scientific talks. Students will be able to classify and compare results from papers in the context of a specific research question. Moreover, students will become proficient in the developments of the specialized research area that is the topic of the particular course.

Remark:

The main language of instruction in this course is English.

prerequisites for the module:

none

Recommended prior knowledge: Basic knowledge about distributed systems as offered, e.g., by the course DSG-IDistrSys or similar knowledge. Dependend on the topic of the specific seminar, additional knowledge as discussed in DSG-SOA-M or DSG-DSAM-M may be helpful (ask if in doubt before enrolling in the course)	**Admission requirements:** none

Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Master Seminar in Distributed Systems **Mode of Delivery:** Key competence **Lecturers:** Prof. Dr. Guido Wirtz **Language:** English/German	**2,00 Weekly Contact Hours**

Frequency: every semester **Learning outcome:** see module description **Contents:** see module description **Literature:** depends on specific topics of each seminar and will be given in the introductionary meeting	
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 3 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Written and oral presentation of the essence of a set of related research papers and moderated discussion of the presentations of all students participating in the seminar.	

Module EESYS-BIA-M Business Intelligence & Analytics *Business Intelligence & Analytics*	6 ECTS / 180 h

(since SS19)
Person responsible for module: Prof. Dr. Thorsten Staake
further responsible : Konstantin Hopf

Contents:

This module covers topics from the field of Business Intelligence, Data Science, and Business Analytics and introduces data-driven decision support. The main topics include

- the role of Business Intelligence in organizations,
- the data analytics process using the CRISP-DM process model,
- data sources in organizations and publicly available data sources,
- an introduction to Data Science and the basics of data analytics including a repetition of the fundamentals of descriptive statistics and data visualization,
- fundamentals of spatio-temporal data analysis,
- advanced analytics methods including unsupervised and supervised machine learning, optimization and simulation, and
- legal and ethical aspects of data analytics (in particular privacy, data security and copyright).

Students approach the topics by means of concrete data analytics examples and case studies in the programming environment GNU R. The course covers the most important steps of the data analytics process (business understanding, data understanding, data preparation, modeling, evaluation and deployment).

Learning outcomes:

Students will be able to

- describe the role of business intelligence and data analyses in organizations,
- identify available internal and publicly available data sources, make them usable and describe the data,
- apply advanced analytics methods (especially: k nearest neighbor, Decision Trees, Support Vector Machines, Random Forest) in the software R on their own and create analyses for business-relevant questions, which can be used as a basis for decision-making,
- visualize the results of the analyses in a meaningful way, and
- describe selected ethical and legal aspects of data analytics.

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**
This course requires a basic understanding of statistics (e.g., from a bachelor-level course). A statistics repetition is part of the course and should be complemented in self-study if necessary. Basic familiarity with a programming language.	none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Business Intelligence & Analytics **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Thorsten Staake **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: The lecture covers the topics mentioned in “Module EESYS-BIA-M”, subsection “Contents”. Traditional lecture elements, case studies, discussions, exercises, and group work are used to support participants in reaching the learning objectives. Methods, tools, and theories are introduced with references to practical challenges and applied to exemplary problems. For selected topics, the lectures rely on flipped classroom elements for which participants need to acquire knowledge in advance (e.g., through reading tasks), which is then critically reflected and extended in the classroom lecture. The course materials are in English, the language of instruction is agreed upon in the first course together with the course participants.	
Literature: Reading material will be announced in class.	
2. Practicals Business Intelligence & Analytics **Mode of Delivery:** Practicals **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: In the classroom tutorial, participants apply the methods, tools, and theories conveyed in the lecture to exemplary problems and to new challenges. This includes solving smaller tasks (e.g., acing case studies, working on concrete data problems) on paper and using the statistics software GNU R. Tasks are addressed in small teams or individually. The tutorials can also cover new content, especially when its immediate application supports the learning process. Selected tutorials contain a self-assessment of the learning progress. An introduction to GNU R is given in the first sessions.	
Examination Written examination / Duration of Examination: 90 minutes **Description:** The examination covers subject matter taught in the lectures and tutorials. The examination can also cover transfers of the subject matter to new problems and settings. Students can achieve up to 90 points. Through the voluntary completion of coursework (“bonus exercises”) during the semester, participants can collect up to 12 additional points that are counted towards the exam, given that the exam is passed also without points from bonus exercises. Bonus exercises can take the form of written assignments, presentations, or smaller software projects. Points from bonus exercises are	

only valid in the semester they have been earned in and in the immediately following semester. In the first week of the course, the publishing dates of bonus exercise tasks, the submission deadlines, and the points per bonus exercise will be announced. It is possible to pass the exam with a grade of 1.0 also without points from bonus exercises. Exam questions are stated in English, answers can be given in German or English.	

Module EESYS-DAE-M Data Analytics in Energy Informatics *Data Analytics in der Energieinformatik*	6 ECTS / 180 h
(since SS19) Person responsible for module: Prof. Dr. Thorsten Staake	

Contents:

This course provides the theoretical foundation and conveys hands-on skills in the fields of data analytics and machine learning using the statistics software GNU R. It uses real-word datasets from the realm of energy efficiency and consumer behavior and conveys the subject matter through real-world examples and practical challenges.

Following a refresher in descriptive statistic, the course covers

- an introduction to the statistics software GNU R,
- the design of field experiments and the use of Information Systems to collect behavioral data,
- techniques to formulate, solve, and interpret linear and logistic regression analyses,
- techniques to formulate, solve, and interpret clustering analyses,
- setting up, training, and evaluating machine learning algorithms, including KNN, regression, and support vector machines, and
- ethical issues and data privacy regulations.

Learning outcomes:

After a successful participation in this course, participants can

- translate new business and research questions that can be answered using empirical methods into suitable experimental designs,
- plan and conduct corresponding experiments,
- choose suitable methods from the set of methods presented in class to analyze the data,
- explain their design choices, the choice of methods, and the steps of the analyses,
- apply the methods correctly and efficiently using the statics software R,
- adjust the methods if needed to solve new and specific problems based on an understanding of the necessary theories,
- interpret the outcome of such analyses and identify the strengths and limitations of the approaches, and
- reflect upon data protection, privacy and ethical issues related to powerful techniques for data acquisition and analytics.

Remark:

The lecture will be held as a self-paced, video-based online lecture.

The tutorials take place once per week as in-classroom events.

The online lecture includes instructional videos (scripted, i.e., with subtitles), reading material, exemplary data sets, and a multitude of online and offline tasks. It also includes an online discussion forum.

The online lecture is supported by three classroom lectures (in addition to the classroom tutorials):

1. Classroom lecture: The introductory event includes a course overview and motivation. Moreover, credentials to access the online resources will be announced. Date: First week of the semester.

2. Classroom lecture: This intermediate session includes a review of the concepts covered so far. It should help participants to self-assess their learning progress. Date: Announced in the first week of the semester.
3. Classroom lecture: Exam preparation and Q&A. Date: Last week of the semester.

An introduction to the statistics software GNU R will be given as in-classroom event during the tutorials at the beginning of the semester.

prerequisites for the module: none		
Recommended prior knowledge: This course requires a basic understanding of statistics (e.g., from a bachelor-level course). A statistics repetition and is part of the online material of the course and the of the first tutorials and should be complemented in self-study if necessary. Basic familiarity with a programming language.		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Data Analytics in Energy Informatics **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Thorsten Staake **Language:** German/English **Frequency:** every winter semester **Contents:** The video-based online lecture is divided into two parts. Part 1 conveys the statistical basics required for the module, including, for example, properties of random distributions and descriptive and injunctive statistics. This part serves as refresher of bachelor-level statistics and thereby enables students with no statistics-knowledge beyond a basic introductory course to participate. Part 2 covers the methods outlined in “Module EESYS-DAE-M” subsection “Contents”. It includes both, the theory behind the concepts and their application using R. Both, Part 1 and Part 2 use datasets and examples from industry and research and provides many hands-on examples. In order to deepen the understanding and to ease the transfer of the methods to new problems and settings, mini-tasks and small exercises are part of the online lecture. **Literature:** Reading material will be announced in class.	**2,00 Weekly Contact Hours**
2. Practicals Data Analytics in Energy Informatics **Mode of Delivery:** Practicals **Language:** German/English **Frequency:** every winter semester **Contents:** In the classroom tutorial, participants apply the methods, tools, and theories conveyed in the lecture to exemplary problems and to new challenges. This includes solving smaller tasks (e.g., acing case studies, working on concrete	**2,00 Weekly Contact Hours**

data problems) on paper and using the statistics software GNU R. Tasks are addressed individually or in small teams. The tutorials can also cover new content, especially when its immediate application supports the learning process. Selected tutorials contain a self-assessment of the learning progress. An introduction to GNU R is given in the first sessions.	

Examination Written examination / Duration of Examination: 90 minutes **Description:** The examination covers subject matter taught in the lectures and tutorials. The examination can also cover transfers of the subject matter to new problems and settings. Students can achieve up to 90 points. Through the voluntary completion of coursework ("bonus exercises") during the semester, participants can collect up to 12 additional points that are counted towards the exam, given that the exam is passed also without points from bonus exercises. Bonus exercises can take the form of written assignments, presentations, or smaller software projects. Points from bonus exercises are only valid in the semester they have been earned in and in the immediately following semester. In the first week of the course, the publishing dates of bonus exercise tasks, the submission deadlines, and the points per bonus exercise will be announced. It is possible to pass the exam with a grade of 1.0 also without points from bonus exercises. Exam questions are stated in English, answers can be given in German or English.	

Module EESYS-ES-M Energy Efficient Systems *Energieeffiziente Systeme*		6 ECTS / 180 h
(since SS19) Person responsible for module: Prof. Dr. Thorsten Staake		

Contents:

The course covers the design and application of Information Systems that help increase energy efficiency and reduce greenhouse gas emissions. It is directed to computer science and Information Systems students that want to apply their skills to challenges in the fields of energy, mobility, production, and sustainable consumption/consumer behavior.

The course introduces methods and theories from behavioral economics, operations management, and simulation analysis that help to understand, analyze, and shape both, industry processes and consumer behavior in the field of sustainability. Also covered are cost/benefit considerations on a micro- and macro-level (including, for example, rebound effects) and a discussion on the economic and societal implications of the subject matter.

The course includes an introduction to physics and energy engineering to allow students with very limited knowledge in these fields to participate successfully.

Learning outcomes:

Successful participants of this course shall acquire the skills to

- explain the physical and technical principals covered in this course and apply them to new problems,
- explain the components, influencing factors, requirements and challenges related to electric mobility and describe the contribution that Information Systems can make to solve the challenges; moreover, successful participants shall be able to set up data-based simulations to derive important characteristic variables related to electric vehicles, such as electric reachability, peak loads to electric grids, etc.,
- outline, assess, and conceptually model the potential of Information Systems and the effects to heating and room climate applications,
- explain in detail the characteristics of and implications from environmental business Information Systems,
- explain the discussed behavioral theories (e.g., the prospect theory), make use of them when building Information Systems that support decision making and behavioral change, and be able to evaluate the effectiveness of such systems, and
- evaluate the effects of the tools and methods introduced, including their micro- and macro-economic effects, and critically assess the techniques used to perform such evaluations.

Moreover, successful participants shall be able to apply the acquired skills to new challenges and adjust and extend them as needed.

Finally, the participants shall realize the scope for design and the potential that results from their IT studies to favorably shape a sustainable and socially desirable development of our society.

prerequisites for the module:

none

Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Energy Efficient Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Thorsten Staake **Language:** German/English **Frequency:** every summer semester **Contents:** The lecture covers the topics mentioned in “Module EESYS-ES-M”, subsection “Contents”. It uses traditional lecture elements, discussions, exercises, and group work to support participants in reaching the learning objectives. Special emphasis is placed on working on cases and on discussions of studies and scientific publications. Methods, tools, and theories are introduced with references to practical challenges and are applied to exemplary problems. For selected topics, the lecture relies on flipped classroom elements for which participants need to acquire knowledge in advance (e.g., through reading tasks), which is then critically reflected and extended in the classroom sessions. **Literature:** Weiterführende Unterlagen werden in der Veranstaltung bekanntgegeben.	**2,00 Weekly Contact Hours**
2. Practicals Energy Efficient Systems **Mode of Delivery:** Practicals **Language:** German/English **Frequency:** every summer semester **Contents:** The first tutorials convey basics in physics and electrical engineering in order to also allow students who did not take related modules to participate in this course. Subsequently, participants apply the methods, tools, and theories conveyed in the lecture to exemplary problems and to new challenges. Tutorials include small tasks, case studies, and reviews of scientific publications that are addressed individually or in small teams. The tutorials can also cover new content, especially when its immediate application supports the learning process. Selected tutorials contain a self-assessment of the learning progress. **Literature:** Reading material will be announced in class.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** The examination covers subject matter taught in the lectures and tutorials. The examination can also cover transfers of the subject matter to new problems and settings. Students can achieve up to 90 points. Through the voluntary completion of coursework (“bonus exercises”) during the semester, participants can collect up to 12 additional points that are counted	

towards the exam, given that the exam is passed also without points from bonus exercises. Bonus exercises can take the form of written assignments, presentations, or smaller software projects. Points from bonus exercises are only valid in the semester they have been earned in and in the immediately following semester. In the first week of the course, the publishing dates of bonus exercise tasks, the submission deadlines, and the points per bonus exercise will be announced. It is possible to pass the exam with a grade of 1.0 also without points from bonus exercises. Exam questions are stated in English, answers can be given in German or English.	

Module EESYS-GEI-B Fundamentals of Energy Informatics *Grundlagen der Energieinformatik*		6 ECTS / 180 h
(since SS19) Person responsible for module: Prof. Dr. Thorsten Staake		

Contents:

The course covers the design and application of Information Systems that aim to increase energy efficiency and support the integration of renewable electricity sources into our energy system. It focuses on electricity supply, including conventional and distributed generation, distribution ("smart grids"), and energy markets. The course conveys physical and technical foundations, important market mechanisms, and IT-supported control and management approaches. It also covers the organization of energy markets and the role of the actors with a focus on aspects relevant to IT-based solutions.

Additional topics include the energy and resource consumption of IT, aspects related to safety and security of the IT infrastructure in the context of smart grids, side effects of the technical and organizational development, and the role of energy policy and market forces.

Learning outcomes:

Successful participants of this course shall acquire the skills to

- explain the physical and technical principals related to electricity generation, distribution, and use and apply the principals to perform new analyses,
- derive, adjust, and extend models of electricity sources and consumers for simple topologies and calculate characteristic values, such as voltage drops or efficiency ratings,
- name the challenges that occur with respect to electricity generation and distribution, explain why they occur, and assess their implications,
- name the introduced components of a smart grid and explain how they work in principal,
- name and explain the basic pillars of energy markets, including the important market mechanisms and regulatory measures,
- explain the role of the major actors in an electricity market and their interests, and
- sketch and explain the costs, benefits, and risks of the technical components and market mechanisms related to a smart grid.

Moreover, successful participants shall be able to apply the acquired skills to new challenges and adjust and extend them as needed.

Finally, the participants shall realize the scope for design and the potential that results from their IT studies to contribute to a sustainable, commercially attractive provisioning and usage of electricity.

prerequisites for the module:

none

Recommended prior knowledge:		Admission requirements:
none		none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Grundlagen der Energieinformatik **Mode of Delivery:** Lectures	**2,00 Weekly Contact Hours**

Lecturers: Prof. Dr. Thorsten Staake **Language:** German **Frequency:** every winter semester **Contents:** The lecture covers the topics mentioned in “Module EESYS-GEI-B”, subsection "Contents". It uses traditional lecture elements, discussions, exercises, and group work to support participants in reaching the learning objectives. Special emphasis is placed on working on cases and on solving small practical problems. Methods, tools, and theories are introduced with references to practical challenges and applied to exemplary problems. For selected topics, the lectures rely on flipped classroom elements for which participants need to acquire knowledge in advance (e.g., through reading tasks), which is then critically reflected and extended in the classroom lecture. **Literature:** Reading material will be announced in class.	
2. Practicals Grundlagen der Energieinformatik **Mode of Delivery:** Practicals **Language:** German **Frequency:** every winter semester **Contents:** The first tutorials convey basics in physics and electrical engineering in order to also allow students who did not take related modules to participate in this course. Subsequently, participants apply the methods, tools, and theories conveyed in the lecture to exemplary problems and to new challenges. Tutorials include case studies and reviews of scientific publications that are addressed individually or in small teams. The tutorials can also cover new content, especially when its immediate application supports the learning process. Selected tutorials contain a self-assessment of the learning progress.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** The examination covers subject matter taught in the lectures and tutorials. The examination can also cover transfers of the subject matter to new problems and settings. Students can achieve up to 90 points. Through the voluntary completion of coursework (“bonus exercises”) during the semester, participants can collect up to 12 additional points that are counted towards the exam, given that the exam is passed also without points from bonus exercises. Bonus exercises can take the form of written assignments, presentations, or smaller software projects. Points from bonus exercises are only valid in the semester they have been earned in and in the immediately following semester. In the first week of the course, the publishing dates of bonus exercise tasks, the submission deadlines, and the points per bonus exercise will	

be announced. It is possible to pass the exam with a grade of 1.0 also without points from bonus exercises. Exam questions are stated in German, answers can be given in German or English.	

Module EESYS-IITP-B International IT Project Management *Internationales IT-Projektmanagement*		6 ECTS / 180 h
(since SS19) Person responsible for module: Prof. Dr. Thorsten Staake		
Contents: This course provides its participants with the knowledge they need to manage and support IT projects. It covers the entire project lifecycle from scoping to planning, executing, controlling, and closing projects and discusses both, traditional (e.g., waterfall- and V-models) and agile (e.g., Scrum) management techniques. The course addresses issues that are relevant for small, agile companies in unstable environments as well as for multinationals with well-established processes. Special attention is paid to the management of international projects and international teams. Throughout the course, care is taken to combine hands-on advice about tools, techniques, and management practices with insights about the concepts' theoretical foundations, strengths, and limitations.		
Learning outcomes: After successfully completing this course, students are well-equipped with sound methods to plan, execute, and manage IT projects in small and large organizations. They are also able to support local and international teams. Moreover, based on a solid theoretical background, successful participants are able to apply the methods and tools to new settings and problems and develop them further if it is required.		
Remark: The course is organized as classroom lecture with the exception that three to four lecture units are available exclusively online. The online lectures include scripted videos, references to literature and tasks that can be completed online. The tutorial will be held as classroom event.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Internationales IT-Projektmanagement **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Thorsten Staake **Language:** German/English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: The lecture covers the topics mentioned in "Module EESYS-IITP-B", subsection "Contents". It uses traditional lecture elements, case studies, discussions, exercises and group work to support participants in reaching the learning	

objectives. Methods, tools, and theories are introduced with references to practical challenges and applied to exemplary problems. For selected topics, the lectures rely on flipped classroom elements for which participants need to acquire knowledge in advance (e.g., through reading tasks), which is then critically reflected and extended in the classroom lecture. **Literature:** Reading material will be announced in class.	
2. Practicals Internationales IT-Projektmanagement **Mode of Delivery:** Practicals **Language:** German/English **Frequency:** every summer semester **Contents:** In the tutorial, participants apply the methods, tools, and theories conveyed in the lecture to exemplary problems and to new challenges. Tutorials include small tasks, case studies, and reviews of management guidelines and scientific publications that are addressed individually or in small teams. The tutorials can also cover new content, especially when its immediate application supports the learning process. Selected tutorials contain a self-assessment of the learning progress.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** The examination covers subject matter taught in the lectures and tutorials. The examination can also cover transfers of the subject matter to new problems and settings. Students can achieve up to 90 points. Through the voluntary completion of coursework (“bonus exercises”) during the semester, participants can collect up to 12 additional points that are counted towards the exam, given that the exam is passed also without points from bonus exercises. Bonus exercises can take the form of written assignments, presentations, or smaller software projects. Points from bonus exercises are only valid in the semester they have been earned in and in the immediately following semester. In the first week of the course, the publishing dates of bonus exercise tasks, the submission deadlines, and the points per bonus exercise will be announced. It is possible to pass the exam with a grade of 1.0 also without points from bonus exercises. Exam questions are stated in English, answers can be given in German or English.	

Module EESYS-P-BIRES-M Project Business Intelligence for Renewable Energy Systems *Projekt Business Intelligence for Renewable Energy Systems*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Thorsten Staake		
Contents: The students carry out a comprehensive IT project in the field of business intelligence and data analytics. The application domain relates to energy and sustainability. The topic will be announced in the first session. The organization of the project work includes all phases of a project's lifecycle with a focus on scoping, planning, execution, and monitoring, including, of course, also the development tasks. The participants apply agile project management methods ("scrum") and work autonomously towards their goal. The course advisor serves as project owner. The technical content of the project typically includes machine learning, further data analytics tasks, data visualization, and the design of dashboards. Tasks can also include establishing interfaces to databases and programming for mobile devices. The project goal is defined in a way such that participants may have to independently acquire and extend their skills both regarding project management tasks and regarding the technical execution. The language of instruction is agreed upon in the first course together with the course participants.		
Learning outcomes: Students will have developed a state-of-the-art IT tool or have worked on an extensive problem to support organizations in their decision-making. After completing this module, students are able to • capture and analyze requirements of an IT project and to work out implementations, • collect and process suitable data for the given problem, • work in an agile project team and apply agile project management methods, and • prepare and hold project interim and final presentations appropriate to the target group.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Project Business Intelligence for Renewable Energy Systems **Mode of Delivery:** **Lecturers:** Prof. Dr. Thorsten Staake **Language:** German/English **Frequency:** every winter semester	**4,00 Weekly Contact Hours**
Learning outcome: Students will have developed a state-of-the-art IT tool or have worked on an extensive problem to support organizations in their decision-making. After completing this module, students are able to	

- capture and analyze requirements of an IT project and to work out implementations,
- collect and process suitable data for the given problem,
- work in an agile project team and apply agile project management methods, and
- prepare and hold project interim and final presentations appropriate to the target group.

Contents:

The students carry out a comprehensive IT project in the field of business intelligence and data analytics. The application domain relates to energy and sustainability. The topic will be announced in the first session.

The organization of the project work includes all phases of a project's lifecycle with a focus on scoping, planning, execution, and monitoring, including, of course, also the development tasks. The participants apply agile project management methods ("scrum") and work autonomously towards their goal. The course advisor serves as project owner.

The technical content of the project typically includes machine learning, further data analytics tasks, data visualization, and the design of dashboards. Tasks can also include establishing interfaces to databases and programming for mobile devices. The project goal is defined in a way such that participants may have to independently acquire and extend their skills both regarding project management tasks and regarding the technical execution.

The language of instruction is agreed upon in the first course together with the course participants.

Literature:

Reading material will be announced in class.

Examination

Coursework Assignment with presentation / Duration of Examination: 20 minutes

Duration of Coursework: 4 months

prerequisites for module examination:

Regelmäßige Teilnahme an der Lehrveranstaltung

Description:

Project and coursework assignment with presentation

Duration of project coursework assignment: 4 months, duration of oral examination: 20 minutes

Students work on a topic that will be announced in the first session. They create artifacts (e.g., source code, posters, documents), prepare a report and defend their results at the end of the semester in the form of a presentation. The artifact, the report, and the presentation are included in the evaluation. The work is carried out in groups, yet the contribution of each student is evaluated individually.

The examination language will be announced in the first session.

<table>
<tr><td colspan="2">Module EESYS-P-SGDA-M Project Smart Grid Data Analytics
Projekt Smart Grid Data Analytics</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS19/20)
Person responsible for module: Prof. Dr. Thorsten Staake</td></tr>
<tr><td colspan="3">Contents:
The students carry out a comprehensive IT project in the field of electricity grids, energy conservation or internet of things. The topic will be announced in the first session.

The organization of the project work includes all phases of a project’s lifecycle with a focus on scoping, planning, execution, and monitoring. The participants apply agile project management methods (“scrum”) and work autonomously towards their goal. The course advisor serves as scrum project owner.

The technical content of the project typically includes machine learning, further data analytics tasks, systems for decision support, and work that relates to networked sensors and actuators. Tasks can also include programming for mobile devices. The project goal is defined in a way that participants may have to acquire and extend their skills both regarding project management tasks and regarding the technical execution by means of independent studies.

The language of instruction is agreed upon in the first course together with the course participants.</td></tr>
<tr><td colspan="3">Learning outcomes:
Students will have developed a state-of-the-art tool for the energy industry or have worked on an extensive problem to support organizations in their decision-making. After completing this module, students are able to
• capture and analyze requirements of an IT project and to work out implementations,
• collect and process suitable data for the given problem,
• work in an agile project team and apply agile project management methods, and
• prepare and hold project interim and final presentations appropriate to the target group.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
none</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every summer semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>Project Smart Grid Data Analytics
Mode of Delivery:
Lecturers: Prof. Dr. Thorsten Staake
Language: German/English
Frequency: every summer semester

Learning outcome:
Students will have developed a state-of-the-art tool for the energy industry or have worked on an extensive problem to support organizations in their decision-making. After completing this module, students are able to</td><td>4,00 Weekly Contact Hours</td></tr>
</table>

- capture and analyze requirements of an IT project and to work out implementations,
- collect and process suitable data for the given problem,
- work in an agile project team and apply agile project management methods, and
- prepare and hold project interim and final presentations appropriate to the target group.

Contents:

The students carry out a comprehensive IT project in the field of electricity grids, energy conservation or internet of things. The topic will be announced in the first session.
The organization of the project work includes all phases of a project’s lifecycle with a focus on scoping, planning, execution, and monitoring. The participants apply agile project management methods (“scrum”) and work autonomously towards their goal. The course advisor serves as scrum project owner.
The technical content of the project typically includes machine learning, further data analytics tasks, systems for decision support, and work that relates to networked sensors and actuators. Tasks can also include programming for mobile devices. The project goal is defined in a way that participants may have to acquire and extend their skills both regarding project management tasks and regarding the technical execution by means of independent studies.
The language of instruction is agreed upon in the first course together with the course participants.

Literature:

Reading material will be announced in class.

Examination

Coursework Assignment with presentation / Duration of Examination: 20 minutes
Duration of Coursework: 4 months

prerequisites for module examination:

Regelmäßige Teilnahme an der Lehrveranstaltung

Description:

Project and coursework assignment with presentation

Duration of project coursework assignment: 4 months, duration of oral examination: 20 minutes

Students work on a topic that will be announced in the first session. They create artifacts (e.g., source code, posters, documents), prepare a report and defend their results at the end of the semester in the form of a presentation. The artifact, the report, and the presentation are included in the evaluation. The work is carried out in groups, yet the contribution of each student is evaluated individually.

The examination language will be announced in the first session.

Module GdI-AFP-M Advanced Functional Programming *Advanced Functional Programming*	6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Ph.D. Michael Mendler	

Contents:

Based on an existing basic knowledge of functional programming (FP), the aim of this module is to develop advanced skills in the use of FP languages to structure and solve algorithmic problems. We will study advanced programming abstractions specifically developed for the functional context as they are available as packages and frameworks in the toolbox of professional FP programmers. Following the methodological structure of the introductory course GDI-IFP, this advanced course, too, combines both practical programming with a focused discussion of pertinent underlying mathematical concepts.

Specifically, as our main algorithmic application domain, we will look at concurrent programming with shared memory model and introduce the synchronous model (control-flow and data-flow) of functional programming to guarantee value determinism, deadlock-freedom and absence of memory overflows. We use Haskell as our main language but also also look at other FP languages such as F#, ML or OCAML where appropriate.

Learning outcomes:

At the end of this course students should

- be familiar with advanced FP programming concepts and their application (e.g., class mechanism, type families, higher-rank polymorphism, monad and arrow abstractions, lenses, continuation-style programming, stream programming, concurrency abstractions)
- be able to use these advanced language concepts to solve complex algorithmic problems efficiently, in particular involving the use of memory, concurrency and interaction
- be able use the Haskell stack build tool and understand the mechanisms of package management
- appreciate the importance of functional abstraction for conciseness and efficiency of programming complex applications
- be familiar with the second-order polymorphic lambda calculus (System F) as an operational semantics behind (lazy) functional programming
- be able to explain the encoding of data structures in System F
- have an elementary understanding of the execution model of functional languages and transformation to operational code through defunctionalisation and abstract machines.

Remark:

The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German.

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**
Elementary programming skills in a functional programming language, such as from module GdI-IFP-B; English language skills at Level B2 (UniCert II) or above. Module Introduction to Functional Programming (GdI-IFP) - recommended	none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Advanced Functional Programming **Mode of Delivery:** Lectures **Lecturers:** Prof. Ph.D. Michael Mendler **Language:** English/German **Frequency:** every summer semester **Contents:** Through class presentations and direct interactions with the students the lecturer introduces the topics of the course in detail, poses exercises and suggests literature for self-study. **Literature:** ...	**2,00 Weekly Contact Hours**
2. Advanced Functional Programming **Mode of Delivery:** Practicals **Lecturers:** Prof. Ph.D. Michael Mendler **Language:** English/German **Frequency:** every summer semester **Contents:** The tutorials deepen the students' understanding of the theoretical concepts and constructions covered in the lectures through practical exercises. Participants are given the opportunity to discuss their solutions to homework question sheets and sample solutions are presented by the tutors or lecturer for selected exercises. The tutorials also provide exam preparation. **Literature:** The literature will be announced in class. Here are some general pointers on FP languages and synchronous programming. • S. Marlow: The Haskell 2010 Language Report. https://www.haskell.org/onlinereport/haskell2010/ • V. Zsók, Z. Horváth, R. Plasmeijer: Central European Functional Programming School. Springer 2012. • S. Marlow: Parallel and Concurrent Programming in Haskell: Techniques for Multicore and Multithreaded Programming, O'Reilly 2013. • D. Syme, A. Granicz, A. Cisternino: Expert F#4.0, Apress 2015. • H. Barendregt, W. Dekkers, R. Statman: Lambda Calculus with Types. CUP 2013. • Benveniste, A. et al: The Synchronous Languages 12 years later. Proc. IEEE, Vol 91(1), January 2003. • Berry, G.: SCADE: Synchronous design and validation of embedded control software. In: Next Generation Design and Verification Methodologies for Distributed Embedded Control Systems. Proc. GM R&D Workshop, Bangalore, January 2007. pp. 19-33.	**2,00 Weekly Contact Hours**

• Potop-Butucaru et. al: The Synchronous Hypothesis and Synchronous Languages. In Richard Zurawski. *Embedded Systems Design and Verification*, CRC Press, pp.6-1-6-27, 2009.	
Examination Written examination / Duration of Examination: 90 minutes **Description:** 90 min written examination. The exam takes place during the regular exam period after the end of the semester.	

Module GdI-GTI-B Machines and Languages *Grundlagen der Theoretischen Informatik*		6 ECTS / 180 h
(since WS18/19) Person responsible for module: Prof. Ph.D. Michael Mendler		
Contents: This course addresses the questions "what is a computation?" and "what is an algorithm?" and explores the capabilities and limitations of computers and programming languages as well as the implication of these for a practical computer scientist. It introduces the basic concepts and methods that underlie the mathematical study of computing machines and formal languages.		
Learning outcomes: At the end of this course the students should be able to distinguish finite automata, pushdown automata, Turing machines, and know the difference between the deterministic and non-deterministic versions in each case; be able to distinguish regular, context-free, context-sensitive and general phrase structure grammars in the Chomsky Hierarchy; understand the relations between language classes and machine classes; have developed elementary automata and Turing machine programming skills; know the basic concepts of algorithmic complexity theory such as the big-O notation and key complexity classes such as N and NP as well as their relationship.		
Remark: The language of instruction in this course is German. However, all course materials (lecture slides and tutorial notes) as well as the exam are available in English.		
prerequisites for the module: None.		
Recommended prior knowledge: Elementary concepts in logic and discrete mathematics for computer scientists; Basic programming skills; English language skills at Level B2 (UniCert II) or above. Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - Module Propositional and Predicate Logic (GdI-MfI-1) - recommended		**Admission requirements:** None.
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Machines and Languages **Mode of Delivery:** Lectures **Lecturers:** Prof. Ph.D. Michael Mendler **Language:** German/English **Frequency:** every summer semester **Contents:** Through prepared class presentations and direct interactions with the students the lecturer introduces the topics of the course in detail, poses exercises and suggests literature for self-study.	**2,00 Weekly Contact Hours**

Literature: • Hopcroft, J. E., Motwani, R., Ullman, J. D.: Introduction to Automata Theory, Languages, and Computation. Addison Wesley, 2001. • Martin, J. C.: Introduction to Languages and the Theory of Computation, McGraw Hill, (2nd ed.), 1997. • Sudkamp, Th. A.: Languages and Machines. An Introduction to the Theory of Computer Science. Addison Wesley, (2nd ed.) 1997.	
2. Machines and Languages **Mode of Delivery:** Practicals **Lecturers:** Prof. Ph.D. Michael Mendler, N.N. **Language:** English/German **Frequency:** every summer semester **Contents:** The tutorials deepen the students' understanding of the theoretical concepts and constructions covered in the lectures through practical exercises. Participants are given the opportunity to present their solutions to homework question sheets and sample solutions are given by the lecturer for selected exercises. The tutorials also provide exam preparation.	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** 90 min written examination. The exam takes place during the regular exam period after the end of the semester. An alternative oral exam may be negotiable for guest students only.	

<table>
<tr><td colspan="2">Module GdI-IFP-B Introduction to Functional Programming
Introduction to Functional Programming</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS19/20)
Person responsible for module: Prof. Ph.D. Michael Mendler</td></tr>
<tr><td colspan="3">Contents:
The aim of this module is to provide an introduction to functional programming using Haskell. This course develops both elementary practical programming skills and discusses the typed lambda calculus and its role as an operational semantics for functional programming, stressing the importance of types and type checking for static program analysis.</td></tr>
<tr><td colspan="3">Learning outcomes:
At the end of this course students should be familiar with important language constructs of Haskell and their semantics (e.g., expressions, local declarations, higher-order function abstraction, recursion, lazy and eager evaluation, referential transparency, algebraic data types, monads); be able to use these language concepts to solve algorithmic problems; be familiar with the lambda calculus as an operational semantics behind functional programming; understand the difference between imperative and declarative programming styles; have an appreciation of the close relationship between programming language types and specification and the role of type checking as a static program analysis method; be familiar with polymorphic Hindley-Milner style type systems.</td></tr>
<tr><td colspan="3">Remark:
The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Elementary concepts in logic and discrete mathematics for computer scientists; Basic
programming skills; English language skills at Level B2 (UniCert II) or above.

Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended
Module Propositional and Predicate Logic (GdI-MfI-1) - recommended</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>1. Introduction to Functional Programming
Mode of Delivery: Lectures
Lecturers: Prof. Ph.D. Michael Mendler
Language: English/German
Frequency: every winter semester
Contents:</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

Through prepared class presentations and direct interactions with the students the lecturer introduces the topics of the course in detail, poses exercises and suggests literature for self-study. **Literature:** • Pierce, B. C.: Types and Programming Languages, MIT Press, 2002 • Thompson, S.: Haskell – The Craft of Functional Programming, Addison-Wesley 1999.	
2. Introduction to Functional Programming **Mode of Delivery:** Practicals **Lecturers:** Prof. Ph.D. Michael Mendler **Language:** English/German **Frequency:** every winter semester **Contents:** The tutorials deepen the students' understanding of the theoretical concepts and constructions covered in the lectures through practical exercises. Participants are given the opportunity to discuss their solutions to homework question sheets and sample solutions are presented by the tutors or lecturer for selected exercises. The tutorials also provide exam preparation.	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** 90 min written examination. The exam takes place during the regular exam period after the end of the semester.	

<table>
<tr><td colspan="2">Module GdI-MTL Modal and Temporal Logic
Modal and Temporal Logic</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS17/18)
Person responsible for module: Prof. Ph.D. Michael Mendler</td></tr>
<tr><td colspan="3">Contents:
This advanced module aims to give a thorough introduction to a selection of modal logics with strong applications in Computer Science. Basic knowledge of classical propositional logic and predicate logic and associated calculi is assumed as a prerequisite. Among the logics covered are modal and temporal logics for the analysis of distributed systems or semantic information processing. Depending on the time available, the module also covers belief logics and other specialised logics for security protocols and distributed algorithms. The course addresses theoretical foundations (models and proof systems) but also discusses applications and offers practical experience through hands-on experimentation with automatic and interactive verification tools.</td></tr>
<tr><td colspan="3">Learning outcomes:
At the end of the course students should understand the commonalities and differences between propositional and predicate logics on the one hand and modal logics on the other for system specification and modelling; be aware of the important role played by modal logics for the trade-off between expressiveness and automation; know the semantical foundations of modal logics based on Kripke structures; understand the difference between epistemic, temporal, deontic modalities; be familiar with basic results from modal correpondence theory with modal theories such as K, S4, S5; know the Hennessy-Milner Theorem, model filtration and minimzation techniques; apply standard reasoning procedures based on Hilbert, Gentzen Sequent and Tableau calculi; be familiar with the syntax and semantics of important temporal logics such as PLTL, CTL and description logics such as ALC; be able to apply deduction and model-checking techniques for the specification and verification of distributed and dynamic systems as well as semantic information processing.</td></tr>
<tr><td colspan="3">Remark:
The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Elemantary logic and discrete mathematics for computer scientists;
Basic programming skills.

Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended
Module Propositional and Predicate Logic (GdI-MfI-1) - recommended</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>Modal and Temporal Logic
Mode of Delivery: Lectures and Practicals
Lecturers: Prof. Ph.D. Michael Mendler</td><td>4,00 Weekly Contact Hours</td></tr>
</table>

Language: English/German
Frequency: every winter semester

Contents:
Through prepared class presentations and direct interactions with the students

the lecturer introduces the topics of the course in detail, poses exercises and suggests literature for self-study.

Literature:

- Fagin, R., Halpern, J. Y., Moses, Y., Vardi, M. Y.: Reasoning about Knowledge. MIT Press, (2nd printing) 1996.
- Hughes, G. E., Cresswell, M. J.: A New Introduction to Modal Logic. Routledge, (3rd reprint) 2003.
- Popkorn, S.: First Steps in Modal Logic. Cambridge University Press, 1994.
- Baader, F., Calvanese, D., McGuinness, D.L., Nardi, D., Patel-Schneider, P.F. (eds): The Description Logic Handbook: Theory, Implementation and Applications. Cambridge University Press, (2nd ed.) 2007.

Examination
Written examination / Duration of Examination: 90 minutes
Description:
90 min written examination. The exam takes place during the regular exam period after the end of the semester.

<table>
<tr><td colspan="2">Module GdI-MfI-1 Propositional and Predicate Logic
Mathematik für Informatik 1 (Aussagen- u. Prädikatenlogik)</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since SS17)
Person responsible for module: Prof. Ph.D. Michael Mendler</td></tr>
<tr><td colspan="3">Contents:
This module gives an introduction to basic constructions in the proof theory and model theory of propositional and typed predicate logic. It provides the necessary logical foundations for many computer science courses which use mathematical formalisations and deductive methods and/or directly use symbolic reasoning in applications.</td></tr>
<tr><td colspan="3">Learning outcomes:
At the end of this course students should be able to perform elementary calculations in algebraic structures such as Boolean, functional and relational algebras; be familiar with the concept of a formal system and formal calculus and have understood the fundamental difference between syntax and semantics, soundness and completeness; be able to formalize real-world concepts in propositional and predicate logic and have developed skills in reasoning using formal calculi for these logics; be able to apply elementary proof principles (proof by contraposition, proof by cases, natural and structural induction); be familar with the concept of types and logical signatures for static specification and language formalisation.</td></tr>
<tr><td colspan="3">Remark:
The main language of instruction in this course is German. However, all course materials (lecture slides and tutorial notes) as well as the exam are available in English.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
English language skills at Level B2 (UniCert II) or above.</td><td>Admission requirements:
none.</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>1. Mathematik für Informatik 1
Mode of Delivery: Lectures
Lecturers: Prof. Ph.D. Michael Mendler
Language: German
Frequency: every winter semester
Contents:
In der Vorlesung wird das Themengebiet der Veranstaltung durch
Dozentenvortrag eingeführt und Anregungen zum weiterführenden Literaturstudium gegeben.
Literature:
• Ehrig, H., Mahr, B., Cornelius, F., Große-Rhode, Zeitz, M. P.: Mathematisch strukturelle Grundlagen der Informatik. Springer Verlag, 2. Aufl., 2001.
• Grassmann, W. K., Tremblay, J.-P.: Logic and Discrete Mathematics - A Computer Science Perspective. Prentice Hall, 1996.</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

• Scheinerman, E. R.: Mathematics – A Discrete Introduction. Brooks/Cole, 2000. • Barwise, J., Etchemendy, J: Language, Proof, and Logic. Seven Bridges Press, 2000.	
2. Mathematik für Informatik 1 **Mode of Delivery:** Practicals **Lecturers:** Prof. Ph.D. Michael Mendler, N.N. **Language:** German **Frequency:** every winter semester **Contents:** Die Übung vertieft die Konzepte und Konstruktionen aus der Vorlesung an konkreten Beispielen. Sie dient damit auch der Klausurvorbereitung.	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes	

Module HCI-DISTP-B Design of Interactive Systems: Theory and Practice *Design Interaktiver Systeme: Theorie und Praxis*		3 ECTS / 90 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Theoretical, methodical, practical foundation of design and practical design with focus on a research challenge.		
Learning outcomes: The aim of this module is a general introduction to basic practical skills, processes, and methods of design with a special application-oriented focus on the user-centred design of complex interactive systems.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lecture units • Participation in the group meetings • Work on the tasks alone and with the team • Preparation of discussions and presentation • Exam preparation The workload for each participant may vary over the different tasks based on the task definitions and the joint coordination of tasks in the team The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:**
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Design of Interactive Systems: Theory and Practice **Mode of Delivery:** Lectures and Practicals **Lecturers:** Jochen Denzinger **Language:** German/English **Frequency:** every summer semester **Contents:** In this lecture the following topics are covered: • Design theory and history • Design of multimodal user interfaces • User-Centred Design, User-Experience Design • Practical design, incl. practical application of methods for the iterative design	**1,00 Weekly Contact Hours**

The assignements cover diverse topics based on the contents of the course. The practical part includes an iterative design as an assignment. The task is significantly more comprehensive than the normal assignments accompanying the lectures and therefore is solved in a small group. The results are documented and demonstrated in a final presentation. **Literature:** The course is based on a compilation of different sources; as additional sources and as a reference are recommended: • Krippendorff, K. The Semantic Turn. A New Foundation for Design. Taylor & Francis Group, Boca Raton, FL, 2006. • Moggridge, B. Designing Interactions. MIT Press, Cambridge, MA, 2007.	
Examination Colloquium / Duration of Examination: 30 minutes **Description:** Colloquium on the assignment process and results	

<table>
<tr><td colspan="2">Module HCI-IS-B Interactive Systems
Interaktive Systeme</td><td>6 ECTS / 180 h
45 h Präsenzzeit
135 h Selbststudium</td></tr>
<tr><td colspan="3">(since WS17/18)
Person responsible for module: Prof. Dr. Tom Gross</td></tr>
<tr><td colspan="3">Contents:
Theoretical, methodological, and practical foundation of Human-Computer Interaction</td></tr>
<tr><td colspan="3">Learning outcomes:
The aim of this module is a general introduction to fundamental paradigms, concepts, and principles of user interface design. The primary focus is on the conceptual design, the implementation, and the evaluation of interactive systems</td></tr>
<tr><td colspan="3">Remark:
http://www.uni-bamberg.de/hci/leistungen/studium

The workload for this module is roughly structured as following:
Attendance of the lectures and assignments: 45 hours
Preparation and postprocessing of the lecture (incl. research and study of additional sources): ca. 30 hours
Preparation and postprocessing of the assignments (incl. research and study of additional sources, but without homework assignment): ca. 30 hours
Solving the optional homework assignments: overall ca. 45 hours
Exam preparation: ca. 30 hours (based on the above mentioned preparation and revision of the subject material)
The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Basic knowledge in computer science to the extent of an introduction to computer science</td><td>Admission requirements:
Passing the exam</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>1. Interactive Systems
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Tom Gross
Language: German/English
Frequency: every winter semester<hr>Contents:
In this lecture the following topics are covered:
Introduction to the design of user interfaces
Human factors
Technological factors</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

• Interaction, design, prototyping, and implementation • Evaluation of interactive systems • Design process of interactive systems • Interactive systems in a broader context and related topics **Literature:** The course is based on a compilation of different sources; as additional sources and as a reference are recommended: • Preece, J., Rogers, Y. and Sharp, H. Interaction Design: Beyond Human-Computer Interaction. Wiley, New York, NY, 3rd Edition, 2011. • Dix, A., Finlay, J., Abowd, G.D. and Beale, R. Human-Computer Interaction. Pearson, Englewood Cliffs, NJ, 3rd Edition, 2004.	
2. Interactive Systems **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every winter semester **Contents:** Practical assignments based on the subjects of the lecture including the programming of small prototypes **Literature:** Cf. lecture	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** The written exam is worth a total of 90 points During the semester students can do assignments, which are optional. They are 12 points in total. The type, effort and amount of points of optional homework assignments as well as the deadlines are announced in detail at the beginning of the term. If the written exam is passed (as a rule 50% of the points have to be reached) the points from the assignments are a bonus and added to the points from the written exam. In any case, a top grade of 1,0 is also reachable without solving the assignments.	

Module HCI-KS-B Cooperative Systems *Kooperative Systeme*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Theoretical, methodological, and practical foundation of Computer-Supported Cooperative Work.		
Learning outcomes: The aim of this module is to teach advanced paradigms and concepts of computer-supported cooperative work (CSCW) and the resulting design principles and prototypes. Hereby a broad perspective on the topic is applied; accordingly a central concern is the general technological support of social interaction, spanning cooperative work and learning as well as leisure activities.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lectures and assignments: 45 hours • Credits of the lecture (incl. research and study of additional sources): ca. 30 hours • Credits of the assignments (incl. research and study of additional sources, but without optional homework assignment): ca. 30 hours • Solving the optional homework assignments: overall ca. 45 hours • Exam preparation: ca. 30 hours (based on the above mentioned preparation and revision of the subject material) The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge in computer science to the extent of an introduction to algorithms, programming and software, as well as programming skills in Java.		**Admission requirements:** Passing the written exam
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Cooperative Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tom Gross **Language:** German/English **Frequency:** every summer semester **Contents:** After an introduction into the subject the following topics are covered in this lecture: • Basic concepts	**2,00 Weekly Contact Hours**

- Technological support for mutual awareness, communication, coordination, collaboration, and online communities
- Analysis of cooperative environments
- Design of CSCW and groupware systems
- Implementation of CSCW and groupware systems
- CSCW in a broader context and related topics

Literature:
The course is based on a compilation of different sources; as additional sources and as a reference are recommended:

- Gross, T. and Koch, M. Computer-Supported Cooperative Work (Computer-Supported Cooperative Work; in German). Oldenbourg, Munich, 2007.
- Borghoff, U.M. and Schlichter, J.H. Computer-Supported Cooperative Work: Introduction to Distributed Applications. Springer-Verlag, Heidelberg, 2000.

Examination
Oral examination / Duration of Examination: 30 minutes
Description:
The oral exam takes 30 minutes and is worth a total of 90 points. Depending on the number of attendees the form of the exam can be changed to a written exam with 90 minutes and a total of 90 points. The final form of the exam is announced in the first lecture at the beginning of the term.

During the semester students can do assignments, which are optional. They are 12 points in total. The type of optional homework assignments as well as the deadlines are announced in detail at the beginning of the term. If the oral exam is passed (as a rule 50% of the points have to be reached) the points from the assignments are a bonus and added to the points from the oral exam. In any case, a top grade of 1,0 is also reachable without solving the assignments.

Module Units

Cooperative Systems **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: Practical assignments based on the subjects of the lecture including the programming of small prototypes	
Literature: Cf. lecture	

Examination
Written examination / Duration of Examination: 90 minutes
Description:

In Abhängigkeit von der Teilnehmerzahl wird die Modulprüfung entweder in Form einer Klausur **oder** in Form einer mündlichen Prüfung durchgeführt. Die Festlegung erfolgt zu Semesterbeginn und wird im ersten Lehrveranstaltungstermin bekannt gegeben. In der Klausur über 90 min. können 90 Punkte erzielt werden. Es besteht die Möglichkeit, optionale Studienleistungen zu erbringen. Diese umfassen insgesamt 12 Punkte. Die Art der optionalen Studienleistungen, die Punkte pro optionaler Studienleistung sowie deren Bearbeitungsfrist werden zu Beginn der Lehrveranstaltung verbindlich bekannt gegeben. Ist die Klausur bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die durch optionale Studienleistungen erreichten Punkte als Bonuspunkte angerechnet. Eine 1,0 ist in der Klausur auf jeden Fall auch ohne Punkte aus der Bearbeitung optionaler Studienleistungen erreichbar.	

Module HCI-MCI-M Human-Computer Interaction *Mensch-Computer-Interaktion*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Advanced theoretical, methodological, and practical foundation of Human-Computer Interaction		
Learning outcomes: The aim of this module is to teach advanced knowledge and skills in the area of human-computer interaction as well as a broad theoretical and practical methodological expertise concerned with the design, conception, and evaluation of ubiquitous systems. Students of this course learn the relevant literature and systems in breadth and depth and are later able to critical review new literature and systems.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lectures and assignments: 45 hours • Credits of the lecture (incl. research and study of additional sources): ca. 30 hours • Credits of the assignments (incl. research and study of additional sources, but without optional homework assignment): ca. 30 hours • Solving the optional homework assignments: overall ca. 45 hours • Exam preparation: ca. 30 hours (based on the above mentioned preparation and revision of the subject material) The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English.		
prerequisites for the module: none		
Recommended prior knowledge: Module Algorithms and data structures (MI-AuD-B) Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B)		**Admission requirements:** Passing the written exam
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Human - Computer Interaction **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tom Gross **Language:** German/English **Frequency:** every summer semester **Contents:** After an introduction into the subject the following topics are covered in this lecture: • Mobile human-computer interaction	**2,00 Weekly Contact Hours**

- Adaptivity and adaptibility
- Information visualisation
- Tangible user interaction
- Usability engineering
- Usability and economics

Literature:
The course is based on a compilation of different sources; as additional sources and as a reference are recommended:

- Jacko, J.A. and Sears, A., (Eds.). Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications. Lawrence Erlbaum, Hillsdale, NJ, 2002.
- Hammond, J., Gross, T. and Wesson, J., (Eds.). Usability: Gaining a Competitive Edge. Kluwer Academic Publishers, Dordrecht, 2002.

Examination
Oral examination / Duration of Examination: 30 minutes
Description:
The oral exam takes 30 minutes and is worth a total of 90 points. Depending on the number of attendees the form of the exam can be changed to a written exam with 90 minutes and a total of 90 points. The final form of the exam is announced in the first lecture at the beginning of the term.

During the semester students can do assignments, which are optional. They are 12 points in total. The type of optional homework assignments as well as the deadlines are announced in detail at the beginning of the term. If the oral exam is passed (as a rule 50% of the points have to be reached) the points from the assignments are a bonus and added to the points from the oral exam. In any case, a top grade of 1,0 is also reachable without solving the assignments.

Module Units

Human-Computer Interaction	2,00 Weekly Contact Hours
Mode of Delivery: Practicals **Lecturers:** Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every summer semester	
Contents: Practical assignments based on the subjects of the lecture.	
Literature: Cf. lecture	

Examination
Written examination / Duration of Examination: 90 minutes
Description:
In Abhängigkeit von der Teilnehmerzahl wird die Modulprüfung entweder in Form einer Klausur **oder** in Form einer mündlichen Prüfung

durchgeführt. Die Festlegung erfolgt zu Semesterbeginn und wird im ersten Lehrveranstaltungstermin bekannt gegeben. In der Klausur über 90 min. können 90 Punkte erzielt werden. Es besteht die Möglichkeit, optionale Studienleistungen zu erbringen. Diese umfassen insgesamt 12 Punkte. Die Art der optionalen Studienleistungen sowie deren Bearbeitungsfrist werden zu Beginn der Lehrveranstaltung verbindlich bekannt gegeben. Ist die Klausur bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die durch optionale Studienleistungen erreichten Punkte als Bonuspunkte angerechnet. Eine 1,0 ist in der Klausur auf jeden Fall auch ohne Punkte aus der Bearbeitung optionaler Studienleistungen erreichbar.	

Module HCI-Proj-B Project Human-Computer Interaction *Projekt Mensch-Computer-Interaktion*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Practical work on a research topic of Human-Computer Interaction.		
Learning outcomes: Based on the knowledge and skills obtained in the human-computer interaction lectures and assignments a group of students will develop a small prototype based on current research topics. Central to this project is the development of skills regarding the implementation of systems as well as competencies regarding project management and teamwork.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Participation in the kick-off meeting • Participation in the group meetings • Work on the project tasks alone and with the team • Preparation of project discussions and presentation • Exam preparation The workload for each participant may vary over the different tasks based on the project definition and the joint coordination of tasks in the team The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English		
prerequisites for the module: none		
Recommended prior knowledge: Module Algorithms and Data Structures (MI-AuD-B) Module Interactive Systems (HCI-IS-B)		**Admission requirements:** Passing the exam
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Project Human-Computer Interaction **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every winter semester **Contents:** The project covers diverse topics based on the contents of the courses. The project task is significantly more comprehensive than the normal assignments	**4,00 Weekly Contact Hours**

accompanying the lectures and therefore is solved in a small group. The results of the project are documented and demonstrated in a final presentation. **Literature:** To be announced in the course	
Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Documentation on the development process and project results as well as colloquium on the development process and project results.	

Module HCI-Proj-M Project Human-Computer Interaction *Projektpraktikum Mensch-Computer-Interaktion*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Advanced practical work on a research topic of Human-Computer Interaction.		
Learning outcomes: Based on the knowledge and skills obtained in the human-computer interaction lectures and assignments a group of students develops a small prototype based on current research topics. Central to this project is the development of skills regarding the implementation of systems as well as competencies regarding project management and teamwork. Through the complexity of the task and the direct relation to on-going research at the human-computer interaction group this project is significantly different from the projects at Bachelor’s level.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Participation in the kick-off meeting • Participation in the group meetings • Work on the project tasks alone and with the team • Preparation of project discussions and presentation • Exam preparation The workload for each participant may vary over the different tasks based on the project definition and the joint coordination of tasks in the team The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English.		
prerequisites for the module: none		
Recommended prior knowledge: Module Human-Computer Interaction (HCI-MCI-M) Module Algorithms and Data Structures (MI-AuD-B) - recommended		**Admission requirements:** Passing the exam
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Human-Computer Interaction **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every summer semester **Contents:**	**4,00 Weekly Contact Hours**

The project will cover varying topics based on the contents of the courses. As normally the aspects of several courses are relevant, teams of students that have visited different courses will supplement each other. The project task is significantly more comprehensive than the normal assignments accompanying the lectures and therefore is solved in a small group. The results of the project are documented and demonstrated in a final presentation. **Literature:** To be announced in the course	
Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Documentation on the development process and project results as well as colloquium on the development process and project results.	

Module HCI-Proj1-M Research-Project Human-Computer Interaction *Forschungsprojektpraktikum Mensch-Computer-Interaktion*		15 ECTS / 450 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Advanced practical work on a research topic of Human-Computer Interaction with scientific methods.		
Learning outcomes: Based on the knowledge and skills obtained in the human-computer interaction lectures and assignments a group of students work on a project on current research topics. Central to this project is the development of skills regarding the implementation of systems as well as competencies regarding project management and teamwork. This research project addresses recent trends and is research oriented. The primary focus of this interaction project is on learning methods for the analysis, design, and technical realisation of interaction concepts.		
Remark: The workload for this module is roughly structured as following: • Participation in the kick-off meeting • Participation in the group meetings • Work on the project tasks alone and with the team • Preparation of project discussions and presentation • Exam preparation The workload for each participant may vary over the different tasks based on the project definition and the joint coordination of tasks in the team The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English.		
prerequisites for the module: none		
Recommended prior knowledge: Module Human-Computer Interaction (HCI-MCI-M)		**Admission requirements:** Passing the exam
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Human-Computer Interaction **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every summer semester **Contents:** The project covers varying topics based on the contents of the courses. As normally the aspects of several courses are relevant, teams of students that have visited different courses will supplement each other. The project task is,	**6,00 Weekly Contact Hours**

according to the 15 ECTS, complex and challenging. The results of the project are documented and demonstrated in a final presentation.	
Literature: To be announced in the course	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Documentation on the development process and project results as well as colloquium on the development process and project results. The exact schedule of the project's homework and colloquium are announced at the beginning of the term.	

Module HCI-Proj2-M Research-Project Human-Computer Interaction *Forschungsprojektpraktikum Mensch-Computer-Interaktion*		15 ECTS / 450 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Advanced practical work on a research topic of Human-Computer Interaction with scientific methods.		
Learning outcomes: Based on the knowledge and skills obtained in the human-computer interaction lectures and assignments a group of students work on a project on current research topics. Central to this project is the development of skills regarding the implementation of systems as well as competencies regarding project management and teamwork. This research project addresses recent trends and is research oriented. The primary focus of this interaction project is on learning methods for the analysis, design, and technical realisation of interaction concepts.		
Remark: The workload for this module is roughly structured as following: • Participation in the kick-off meeting • Participation in the group meetings • Work on the project tasks alone and with the team • Preparation of project discussions and presentation • Exam preparation The workload for each participant may vary over the different tasks based on the project definition and the joint coordination of tasks in the team The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English.		
prerequisites for the module: none		
Recommended prior knowledge: Module Human-Computer Interaction (HCI-MCI-M)		**Admission requirements:** Passing the exam
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Human-Computer Interaction **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every winter semester **Contents:** The project covers varying topics based on the contents of the courses. As normally the aspects of several courses are relevant, teams of students that have visited different courses will supplement each other. The project task is,	**6,00 Weekly Contact Hours**

according to the 15 ECTS, complex and challenging. The results of the project are documented and demonstrated in a final presentation. **Literature:** To be announced in the course	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Documentation on the development process and project results as well as colloquium on the development process and project results. The exact schedule of the project’s homework and colloquium are announced at the beginning of the term.	

Module HCI-Prop-M Propaedeutic: Human-Computer-Interaction *Propädeutikum Mensch-Computer-Interaktion*		3 ECTS / 90 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Scientific foundation of the research field of Human-Computer Interaction		
Learning outcomes: The aim of this module is a general introduction to and teaching of fundamental paradigms and scientific methods of the organisation, the written documentation, oral presentation of research activities in Human-Computer Interaction. The primary focus is on domain-specific documentation and presentation of designs, prototypes, and user studies.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Participation in the course meetings (theoretical foundation; practical case studies): ca. 30 hours • Working on the case studies: ca. 30 hours • Preparation of presentation: ca. 15 hours • Writing of term paper: ca. 15 hours The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Propaedeutic: Human-Computer-Interaction **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every winter semester **Contents:** This seminar is concerned with the documentation and presentation of current concepts, technologies, and tools and user studies of human-computer interaction. **Literature:** The course is based on a compilation of different sources; as additional sources and as a reference are recommended:	**2,00 Weekly Contact Hours**

Jacko, Julie A., ed. Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications. (3rd ed.). Lawrence Erlbaum, Hillsdale, NJ, 2012.	
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 4 months **Description:** Written term paper and presentation on the chosen topic by the participant, incl. discussion	

Module HCI-Sem-B Bachelor-Seminar Human-Computer Interaction *Bachelorseminar Mensch-Computer-Interaktion*		3 ECTS / 90 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Active scientific work on current concepts, technologies and tools of Human-Computer Interaction		
Learning outcomes: The aim of this course is the acquisition of abilities to do research and presentation of topics in the field of human-computer interaction on basis of the existing literature. The focus lies on the development of skills that allow to critically and systematically review literature and to give presentations.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Participation in the seminars (introduction to the topics, discussions, presentations): ca. 20 hours • Literature review and getting familiar with the topic: ca. 25 hours • Preparation of presentation: ca. 15 hours Writing of term paper: ca. 30 hours The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English		
prerequisites for the module: none		
Recommended prior knowledge: Module Interactive Systems (HCI-IS-B)		**Admission requirements:** Passing the exam
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Human-Computer Interaction **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every summer semester **Contents:** Based on the knowledge and skills obtained in the human-computer interaction lectures and assignments varying, current research topics are discussed in this seminar. Thereby, aspects of several courses are of relevance. **Literature:** To be announced at the beginning of the course	**2,00 Weekly Contact Hours**
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 4 months	

Description: Written term paper and presentation on the chosen topic by the participant, incl. discussion	

Module HCI-Sem-HCC-M Master-Seminar Human-Centred Computing *Masterseminar Human-Centred Computing*		3 ECTS / 90 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Advanced active scientific work on own current concepts, technologies and tools of Human-Computer Interaction		
Learning outcomes: The aim of this course is the acquisition of abilities that allow the independent research and presentation of topics in the field of human-computer interaction on basis of the existing literature. The focus lies on the development of skills that allow to critically and systematically review literature in order to develop and present an own perspective.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Participation in the seminars (introduction to the topics, discussions, presentations): ca. 20 hours • Literature review and getting familiar with the topic: ca. 25 hours • Preparation of presentation: ca. 15 hours • Writing of term paper: ca. 30 hours The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English		
prerequisites for the module: none		
Recommended prior knowledge: Module Human-Computer Interaction (HCI-MCI-M)		**Admission requirements:** Passing the exam
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Human-Centred Computing **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every summer semester **Contents:** This seminar is concerned with novel research methods in the fields of human-computer interaction, computer-supported cooperative work, and ubiquitous computing. **Literature:** To be announced at the beginning of the course	**2,00 Weekly Contact Hours**
Examination	

Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 4 months **Description:** Written term paper and presentation on the chosen topic by the participant, incl. discussion	

Module HCI-Sem-M Master-Seminar Human-Computer Interaction *Masterseminar Mensch-Computer-Interaktion*		3 ECTS / 90 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Advanced active scientific work on current concepts, technologies and tools of Human-Computer Interaction		
Learning outcomes: The aim of this course is the acquisition of abilities that allow the independent research and presentation of topics in the field of human-computer interaction on basis of the existing literature. The focus lies on the development of skills that allow to critically and systematically review literature in order to develop and present an own perspective.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Participation in the seminars (introduction to the topics, discussions, presentations): ca. 20 hours • Literature review and getting familiar with the topic: ca. 25 hours • Preparation of presentation: ca. 15 hours • Writing of term paper: ca. 30 hours The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English.		
prerequisites for the module: none		
Recommended prior knowledge: Module Human-Computer Interaction (HCI-MCI-M)		**Admission requirements:** Passing the exam
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Human-Computer Interaction **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every winter semester **Contents:** This seminar is concerned with topics on current concepts, technologies, and tools of human-computer interaction. **Literature:** To be announced at the beginning of the course	**2,00 Weekly Contact Hours**
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes	

Duration of Coursework: 4 months **Description:** Written term paper and presentation on the chosen topic by the participant, incl. discussion	

Module HCI-US-B Ubiquitous Systems *Ubiquitäre Systeme*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Theoretical, methodological, and practical foundation of Ubiquitous Computing		
Learning outcomes: The aim of this module is to teach advanced knowledge and skills in the aerea of ubiquitous systems as well as abroad theoretical and practical methodological expertise concerned with the design, conception and evaluation of ubiquitous systems. Students of this course learn the relevant literature and systems in breadth and depth and should be able to critical review new litarature and systems		
Remark: htp://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lectures and assignments: 45 hours • Credits of the lecture (incl.research and study of additional sources): ca. 30 Hours • Credits of the assignments ((incl.research and study of additional sources, excluding optional homework assignment): ca. 30 hours • Solving the optional homework assignments: overall ca. 45 hours • Exam preparation: ca. 30 hours (based on the above mentioned preparation and revision of the subject material) The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English.		
prerequisites for the module: none		
Recommended prior knowledge: Module Algorithms and data structures (MI-AuD-B) Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B)		**Admission requirements:** Passing the written exam
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Ubiquitous Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tom Gross **Language:** German/English **Frequency:** every winter semester **Contents:** This lecture gives an introduction to the subject of Ubiquitous Computing—that is, the paradigm of invisible computing, with computers embedded into everyday objects that act as client and server and communicate with each other—and includes the following conceptual, technical and methodological topics:	**2,00 Weekly Contact Hours**

- Basic concepts
- Base technology and infrastructures
- Ubiquitous systems and prototypes
- Context awareness
- User interaction
- Ubiquitous systems in a broad context and related topics

Literature:
The course is based on a compilation of different sources; as additional sources and as a reference are recommended:

- Krumm, J. (Ed.). Ubiquitous Computing Fundamentals. Taylor & Francis Group, Boca Raton, FL, 2010.

Examination
Oral examination / Duration of Examination: 30 minutes
Description:
The oral exam takes 30 minutes and is worth a total of 90 points. Depending on the number of attendees the form of the exam can be changed to a written exam with 90 minutes and a total of 90 points. The final form of the exam is announced in the first lecture at the beginning of the term.

During the semester students can do assignments, which are optional. They are 12 points in total. The type of optional homework assignments as well as the deadlines are announced in detail at the beginning of the term. If the oral exam is passed (as a rule 50% of the points have to be reached) the points from the assignments are a bonus and added to the points from the oral exam. In any case, a top grade of 1,0 is also reachable without solving the assignments.

Module Units

Ubiquitous Systems **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every winter semester **Contents:** Practical assignments based on the subjects of the lecture including the programming of small prototypes **Literature:** Cf. lecture	**2,00 Weekly Contact Hours**

Examination
/ Duration of Examination: 90 minutes
Description:
In Abhängigkeit von der Teilnehmerzahl wird die Modulprüfung entweder in Form einer Klausur **oder** in Form einer mündlichen Prüfung durchgeführt. Die Festlegung erfolgt zu Semesterbeginn und wird im ersten

Lehrveranstaltungstermin bekannt gegeben. In der Klausur über 90 min. können 90 Punkte erzielt werden. Es besteht die Möglichkeit, optionale Studienleistungen zu erbringen. Diese umfassen insgesamt 12 Punkte. Die Art der optionalen Studienleistungen, die Punkte pro optionaler Studienleistung sowie deren Bearbeitungsfrist werden zu Beginn der Lehrveranstaltung verbindlich bekannt gegeben. Ist die Klausur bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die durch optionale Studienleistungen erreichten Punkte als Bonuspunkte angerechnet. Eine 1,0 ist in der Klausur auf jeden Fall auch ohne Punkte aus der Bearbeitung optionaler Studienleistungen erreichbar.	

Module HCI-Usab-M Usability in Practice *Usability in der Praxis*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Practical work on a real-world topic of Human-Computer Interaction.		
Learning outcomes: In this course the knowledge and skills obtained in the human-computer interaction lectures and assignments are applied in practice. Based on real use cases from industry contexts students will analyse the usability of existing concepts and systems and gather requirements for innovative concepts. Central to this course is the development of skills regarding the practical application of methods as well as competencies regarding project management and teamwork.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Participation in the kick-off meeting • Participation in the group meetings • Work on the tasks alone and with the team • Preparation of discussions and presentation • Exam preparation The workload for each participant may vary over the different tasks based on the task definitions and the joint coordination of tasks in the team The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English		
prerequisites for the module: none		
Recommended prior knowledge: Module Human-Computer Interaction (HCI-MCI-M)		**Admission requirements:** Passing the exam
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Usability in der Praxis **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every summer semester **Contents:** The course covers diverse topics from human-computer interaction that are cooperatively solved with companies. They typically range from specifying challenges to selecting and applying methods as well as analysing the captured data to deriving conclusions. The task is significantly more comprehensive than	**4,00 Weekly Contact Hours**

the normal assignments accompanying the lectures and therefore is solved in a small group. The results are documented and demonstrated in a final presentation. **Literature:** To be announced in the course	
Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Documentation on the project process and results as well as colloquium on the project process and results.	

Module IIS-E-Biz-B Electronic Business *Electronic Business*	6 ECTS / 180 h

(since SS19)
Person responsible for module: Prof. Dr. Sven Overhage

Contents:
Electronic Business describes the integrated execution of all automatable business processes within a company using information and communication technologies. On the one hand, this includes the purchase and sale of goods (electronic trading). On the other hand, this includes the company-internal processes for the production of goods and services (electronic company). The module provides in-depth knowledge about the actors, basic technologies, economic foundations, business processes and information systems in Electronic Business. It is divided into a lecture course and an exercise course in which the lecture course material will be systematically deepened.

Learning outcomes:
The goal of the module is to provide the following knowledge and abilities:

- Knowledge about the actors in Electronic Business
- Knowledge about the application of basic technologies in Electronic Business
- Knowledge about the economic foundations of Electronic Business
- Knowledge and ability to design business processes in Electronic Business
- Knowledge and ability to design information systems in Electronic Business

Remark:
The main language of instruction in this course is German. The tutorials may be delivered in English on demand.

prerequisites for the module:
none

Recommended prior knowledge:
Basic knowledge about the structure and architecture of business information systems. This knowledge, for example, will be provided through the following modules:

- SEDA-GbIS-B
- IIS-EBAS-B

Admission requirements:
none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Lecture Course Electronic Business	**2,00 Weekly Contact Hours**

Mode of Delivery: Lectures
Lecturers: Prof. Dr. Sven Overhage
Language: German
Frequency: every winter semester

Contents:
The lecture course provides knowledge about the actors, basic technologies, economic foundations, business processes and information systems in Electronic Business. The focus of the lecture course is on the following topics:

- E-Business: term definitions and description
- Actors and communication in Electronic Business
- Foundations of the internet
- Economic foundations
- Business models in Electronic Business
- E-Commerce: electronic sale
- E-Procurement: electronic purchase
- E-Marketplace: electronic coordination of supply and demand
- E-Communities: electronic communication
- E-Company: electronic production of goods and services

Literature:

Kollmann, T.: E-Business - Grundlagen elektronischer Geschäftsprozesse in der Net Economy. 4. Aufl., Gabler, Wiesbaden 2011.
Wirtz, B. W.: Electronic Business. 3. Aufl., Gabler, Wiesbaden 2010.
Meier, A.; Stormer, H.: eBusiness & eCommerce: Management der digitalen Wertschöpfungskette. 3. Aufl., Springer, Heidelberg 2012.

2. Exercise Course Electronic Business **Mode of Delivery:** Practicals **Lecturers:** Julian Weidinger **Language:** German **Frequency:** every winter semester **Contents:** The exercise course systematically deepens the knowledge transferred by the lecture course. Students will work in small groups on exercises, which will afterwards be discussed in the plenum. The focus of the exercise course is on the following topics: • Reproduction tasks to recap the lecture course material • Transfer tasks to apply the transferred knowledge • Complex use cases and case studies	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** It is possible to earn bonus points for the exam during the lecture term. Earned bonus points will be credited to the results if the exam has been passed successfully. Bonus points can be earned by completing a voluntary, written coursework in which students independently have to work on transfer tasks related to the lecture course. A final grade of 1.0 can be achieved without bonus points from the coursework.	

Module IIS-EBAS-B Development and Operation of Application Systems *Entwicklung und Betrieb von Anwendungssystemen*		6 ECTS / 180 h
(since WS18/19) Person responsible for module: Prof. Dr. Sven Overhage		
Contents: The development and operation of application systems is one of the core tasks of the Information Systems discipline. The module delivers in-depth knowledge about business development environments, which provide processes, methods, tools and standards to support the systematic, plan-driven development and operation of application systems. The module is divided into a lecture course and an exercise course in which the lecture course material will be systematically deepened.		
Learning outcomes: The goal of the module is to provide the following knowledge and abilities: • Knowledge about development paradigms and system architectures • Knowledge about process models for the development • Knowledge and ability to apply development methods and tools • Knowledge about standards and standard parts for the development • Knowledge and ability to apply methods for the project management and the quality assurance		
Remark: The main language of instruction in this course is German. The tutorials may be delivered in English on demand.		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge about the structure and architecture of business information systems. This knowledge, for example, will be provided through the following modules: • SEDA-GbIS-B		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture Course Development and Operation of Application Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Sven Overhage **Language:** German **Frequency:** every summer semester **Contents:** The lecture course delivers knowledge about business development environments, which provide processes, methods, tools and standards to support the systematic, plan-driven development and operation of application systems. The focus of the lecture course is on the following topics:	**2,00 Weekly Contact Hours**

• General structure and types of application systems • Development paradigms and architectures of application systems • Process models to support the development process • Methods for the creation of business process and data models • Methods for the design of systems • Methods for the project management and quality assurance • Methods for the operation of application systems	
Literature: Balzert, H.: Lehrbuch der Softwaretechnik: Entwurf, Implementierung, Installation und Betrieb. Spektrum 2011. Balzert, H.: Lehrbuch der Softwaretechnik: Softwaremanagement. Spektrum 2008. Ferstl, O.; Sinz, E.: Grundlagen der Wirtschaftsinformatik. 7. Aufl., Oldenbourg 2012.	
2. Exercise Course Development and Operation of Application Systems **Mode of Delivery:** Practicals **Lecturers:** Julian Weidinger **Language:** German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: The exercise course systematically deepens the knowledge transferred by the lecture course. Students will work in small groups on exercises, which will afterwards be discussed in the plenum. The focus of the exercise course is on the following topics: • Reproduction tasks to recap the lecture course material • Transfer tasks to apply the transferred knowledge • Complex use cases and case studies	

Examination Written examination / Duration of Examination: 90 minutes **Description:** It is possible to earn bonus points for the exam during the lecture term. Earned bonus points will be credited to the results if the exam has been passed successfully. Bonus points can be earned by completing a voluntary, written coursework in which students independently have to work on transfer tasks related to the lecture course. A final grade of 1.0 can be achieved without bonus points from the coursework.	

Module IIS-IBS-M Intra-Organizational Systems *Innerbetriebliche Systeme*	6 ECTS / 180 h	
(since WS18/19) Person responsible for module: Prof. Dr. Sven Overhage		
Contents: Intra-organizational industrial information systems are the backbone for the creation of value in manufacturing and trading companies. Enterprise Resource Planning (ERP) systems allow the operative planning, management and control of all business resources. Management Support Systems (MSS) use the operational data basis to support the strategic planning and decision-making of complex, ill-structured problems. The module delivers in-depth knowledge about tasks, architectures and technologies of intra-organizational industrial information systems. The module is divided into a lecture course and an exercise course in which the lecture course material will be systematically deepened.		
Learning outcomes: The goal of the module is to provide the following knowledge and abilities: • Knowledge and ability to analyze industrial business processes, tasks and solution procedures • Ability to solve problems related to the domains of ERP and MSS • Knowledge about the architecture and functions of inter-organizational systems • Ability to integrate and customize inter-organizational systems		
Remark: The main language of instruction in this course is German. The tutorials may be delivered in English on demand.		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge about the structure and architecture of business information systems. This knowledge, for example, will be provided through the following modules: • SEDA-GbIS-B • IIS-EBAS-B		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture Course Intra-Organizational Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Sven Overhage **Language:** German **Frequency:** every summer semester **Contents:** The lecture course delivers knowledge about tasks, architectures and technologies of intra-organizational industrial information systems. The focus of the lecture course is on the following topics:	**2,00 Weekly Contact Hours**

• Industrial business processes • Architectures of Enterprise Resource Planning (ERP) and Management Support Systems (MSS) • Functions of ERP systems: procurement, material planning, production, sales and distribution, human resources management and finance • Functions of MSS: data modeling, data acquisition and data usage • Integration of intra-organizational industrial information systems **Literature:** Kurbel, K.: Enterprise Resource Planning und Supply Chain Management in der Industrie. 7. Aufl., Oldenbourg 2012. Gronau, N.: Enterprise Resource Planning. 2. Aufl., Oldenbourg 2010. Chamoni, P. et al.: Analytische Informationssysteme. 4. Aufl., Springer 2010. Gluchowski, P. et al.: Management Support Systeme und Business Intelligence. 2. Aufl., Springer 2008.	
2. Exercise Course Intra-Organizational Systems **Mode of Delivery:** Practicals **Lecturers:** Thomas Friedrich **Language:** German **Frequency:** every summer semester **Contents:** The exercise course systematically deepens the knowledge transferred by the lecture course. Students will work in small groups on exercises, which will afterwards be discussed in the plenum. The focus of the exercise course is on the following topics: • Reproduction tasks to recap the lecture course material • Transfer tasks to apply the transferred knowledge • Complex use cases and case studies	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** It is possible to earn bonus points for the exam during the lecture term. Earned bonus points will be credited to the results if the exam has been passed successfully. Bonus points can be earned by completing a voluntary, written coursework in which students independently have to work on transfer tasks related to the lecture course. A final grade of 1.0 can be achieved without bonus points from the coursework.	

Module IIS-MODS-M Modular and On-Demand Systems *Modulare und On-Demand-Systeme*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Dr. Sebastian Schlauderer		
Contents: Modular systems that consist of independent components and on-demand systems that can be used over the internet as a service open up new opportunities for the selection, customization and scaling of industrial information systems. The module delivers in-depth knowledge about modular and on-demand concepts for the design of industrial information systems. The module covers theoretical basics as well as practical applications. The module is divided into a lecture course and an exercise course in which the lecture course material will be systematically deepened.		
Learning outcomes: The goal of the module is to provide the following knowledge and abilities: • Knowledge about component-oriented industrial information systems: modularity concepts, architectures and applications • Knowledge and ability to apply the Software as a Service (SaaS) paradigm: on-demand concepts and architectures for industrial information systems • Knowledge about modular and cloud-based industrial information systems • Knowledge and ability to use platforms, software marketplaces and software ecosystems		
Remark: The main language of instruction in this course is German. The tutorials may be delivered in English on demand.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture Course Modular and On-Demand Systems **Mode of Delivery:** Lectures **Lecturers:** Dr. Sebastian Schlauderer **Language:** German **Frequency:** every winter semester **Contents:** The lecture course delivers knowledge about modular and on-demand concepts for the design of industrial information systems. The focus of the lecture course is on the following topics: • Modular on-demand systems: term definitions and description • Distinction from other practices • Economic analysis • Marketplaces for modular on-demand systems	**2,00 Weekly Contact Hours**

• Methods and process models **Literature:** Szyperski, C.; Gruntz, D. & Murer, S.: Component Software - Beyond Object-Oriented Programming, Addison-Wesley, 2002.	
2. Exercise Course Modular and On-Demand Systems **Mode of Delivery:** Practicals **Lecturers:** Dr. Sebastian Schlauderer **Language:** German **Frequency:** every winter semester **Contents:** The exercise course systematically deepens the knowledge transferred by the lecture course. Students will work in small groups on exercises, which will afterwards be discussed in the plenum. The focus of the exercise course is on the following topics: • Reproduction tasks to recap the lecture course material • Transfer tasks to apply the transferred knowledge • Complex use cases and case studies	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** It is possible to earn bonus points for the exam during the lecture term. Earned bonus points will be credited to the results if the exam has been passed successfully. Bonus points can be earned by completing a voluntary, written coursework in which students independently have to work on transfer tasks related to the lecture course. A final grade of 1.0 can be achieved without bonus points from the coursework.	

Module IIS-MobIS-B Modeling of Business Information Systems *Modellierung betrieblicher Informationssysteme*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Sven Overhage		
Contents: Die konzeptuelle Modellierung betrieblicher Informationssysteme gehört zu den Kernkompetenzen der Wirtschaftsinformatik. Dieses Modul vermittelt vertiefte Kenntnisse über Theorien und Methoden der konzeptuellen Modellierung. Die Studierenden erwerben dabei erweiterte Kenntnisse über verbreitete Modellierungsansätze und lernen, diese auf komplexe Problemstellungen anzuwenden und ihre Eignung bzw. Leistungsfähigkeit zu beurteilen. Darüber hinaus beschäftigt sich das Modul mit der Qualitätssicherung konzeptueller Modelle.		
Learning outcomes: Ziel der Veranstaltung ist die Vermittlung folgender Kenntnisse und Fähigkeiten: • Kenntnis der Theorien zur konzeptuellen Modellierung • Kenntnis von Methoden der konzeptuellen Modellierung und ihrer Konzepte • Kenntnis der Leistungsfähigkeit konzeptueller Modellierungsmethoden • Kenntnis der und Fähigkeit zur Qualitätssicherung konzeptueller Modelle		
prerequisites for the module: none		
Recommended prior knowledge: Grundlegende Kenntnisse über den Aufbau und die Architekturen betrieblicher Informationssysteme. Diese werden bspw. in folgendm Modul vermittelt: • Entwicklung und Betrieb von Anwendungssystemen (IIS-EBAS-B)		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Modellierung betrieblicher Informationssysteme **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Sven Overhage **Language:** German **Frequency:** every winter semester **Contents:** Die Vorlesung vermittelt Kenntnisse über die Theorien, Methoden und Techniken der konzeptuellen Modellierung betrieblicher Informationssysteme. Im Mittelpunkt der Veranstaltung stehen folgende Inhalte: • Einführung in die konzeptuelle Modellierung betrieblicher Informationssysteme • Theorien der konzeptuellen Modellierung • Konzepte der konzeptuellen Modellierung	**2,00 Weekly Contact Hours**

• Metamodellierung • Datenmodellierung • Prozessmodellierung • Qualitätssicherung konzeptueller Modelle **Literature:** Wird in der Veranstaltung bekanntgegeben.	
2. Modellierung betrieblicher Informationssysteme **Mode of Delivery:** Practicals **Lecturers:** Julian Weidinger **Language:** German **Frequency:** every winter semester **Contents:** Die Übung vertieft die in der Vorlesung vermittelten Kenntnisse systematisch anhand von Übungsaufgaben, die von den Studierenden in Kleingruppen bearbeitet und anschließend im Plenum besprochen werden. Im Mittelpunkt der Übung stehen folgende Aufgaben: • Reproduktionsaufgaben zur Rekapitulation der Vorlesungsinhalte • Transferaufgaben zur Anwendung der vermittelten Kenntnisse • Komplexe Anwendungsfälle und Fallstudien	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** In der Klausur werden die in Vorlesung und Übung behandelten Inhalte geprüft. Es können 90 Punkte erzielt werden. Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.	

Module IIS-Sem-B Bachelor Seminar Industrial Information Systems *Bachelorseminar Industrielle Informationssysteme*	3 ECTS / 90 h
(since WS17/18) Person responsible for module: Prof. Dr. Sven Overhage	
Contents: Seminar with changing topics in industrial information systems. The specific seminar topic will be announced by the examiner at the beginning of the winter semester.	
Learning outcomes: none	
Remark: The main language of instruction in this course is German. The exam may be delivered in English on demand.	
prerequisites for the module: none	
Recommended prior knowledge: none	**Admission requirements:** none
Frequency: every winter semester **Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelor Seminar Industrial Information Systems **Mode of Delivery:** Introductory seminar **Lecturers:** Prof. Dr. Sven Overhage **Language:** German **Frequency:** every winter semester **Contents:** The specific seminar topic will be announced by the examiner at the beginning of the winter semester.	**2,00 Weekly Contact Hours**

Examination	
Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 3 months	

Module IIS-Sem-M Master Seminar Industrial Information Systems *Masterseminar Industrielle Informationssysteme*	3 ECTS / 90 h

(since WS17/18)
Person responsible for module: Prof. Dr. Sven Overhage

Contents:
Seminar with changing topics in industrial information systems. The specific seminar topic will be announced by the examiner at the beginning of the winter semester.

Learning outcomes:
none

Remark:
The main language of instruction in this course is German. The exam may be delivered in English on demand.

prerequisites for the module:
none

Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Master Seminar Industrial Information Systems **Mode of Delivery:** Introductory seminar **Lecturers:** Prof. Dr. Sven Overhage **Language:** German **Frequency:** every winter semester **Contents:** The specific seminar topic will be announced by the examiner at the beginning of the winter semester.	**2,00 Weekly Contact Hours**

Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 3 months	

Module IIS-WI-Proj-B Project Industrial Information Systems *Wirtschaftsinformatik-Projekt Industrielle Informationssysteme*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Sven Overhage		
Contents: Industrial information systems are the backbone for the creation of value in manufacturing and trading companies. The module thematizes the design and application of industrial information systems using complex case studies, which will be worked on independently by the students using SAP's standard software. The module transfers theoretical concepts as well as practical applications.		
Learning outcomes: The goal of the module is to provide the following knowledge and abilities: • Knowledge about the architecture and functions of enterprise resource planning systems • Ability to use enterprise resource planning systems • Knowledge about the architecture and functions of management support systems • Ability to use management support systems		
Remark: The main language of instruction in this course is German. The tutorials may be delivered in English on demand.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Project Industrial Information Systems **Mode of Delivery:** Practicals **Lecturers:** Dr. Sebastian Schlauderer **Language:** German **Frequency:** annually **Contents:** The Project Industrial Information Systems transfers theoretical as well as practical knowledge about SAP's standard software, which will be used for solving complex case studies. The focus of the project course is on the following topics: • Architectures and functions of enterprise resource planning (ERP) and management support systems (MSS) • Structure and functions of mySAP ERP and Business Warehouse (BW) • Concept and practical application of the SAP ERP Central Component • Concept and practical application of the SAP BW **Literature:**	**4,00 Weekly Contact Hours**

Hildebrand, K.; Rebstock, M.: Betriebswirtschaftliche Einführung in SAP R/3. Oldenbourg-Verlag, München 2000. Körsgen, F.: SAP R/3 Arbeitsbuch - Grundkurs mit Fallstudien. Erich Schmidt Verlag, Berlin 2005 Forndron, F. et al.: mySAP ERP - Geschäftsprozesse, Funktionalität, Upgrade-Strategie. Galileo Press, Bonn 2006. Kießwetter, M.; Vahlkamp, D.: Data Mining in SAP Net Weaver BI. Gallileo Press, Bonn 2007. Frick, M.; Maasen, A.; Schoenen, M.: Grundkurs SAP R/3. 4. Aufl., Vieweg, Wiesbaden 2006.	

Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** The weighting of the exam, which consists of a written homework and a colloquium, will be announced by the lecturer at the beginning of the lecture course.	

Module ISDL-IOM-B International Outsourcing Management *International Outsourcing Management*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Dr. Bernhard Moos		
Contents: IT outsourcing has become a very common practice in most industries. The whole IT function or parts of it are transferred to an external provider firm which subsequently delivers the IT function as service to the client firm. In this course, students learn the basic concepts of outsourcing and its different forms. As learning outcome, they will be able to evaluate benefits and risks of different IT outsourcing strategies, to plan outsourcing projects (outsourcing strategy, business case, operating models), and to conduct (contract management, outsourcing governance in terms of control, relationship management, and knowledge transfer). Particular emphasis will be put on international cross-border outsourcing such as transferring IT activities to Eastern European or Asian countries (nearshore and offshore outsourcing).		
Learning outcomes: Students will learn how to identify and evaluate opportunities and risks of IT outsourcing options and to plan and manage outsourcing projects (contract management, relationship management, knowledge transfer).		
Remark: **The language of instruction in this course is German. However, all course materials (lecture slides and tutorial notes) as well as the exam are available in English.**		
prerequisites for the module: none		
Recommended prior knowledge: Grundlagen betrieblicher Informationssysteme, IT-Controlling		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture: International Outsourcing Management **Mode of Delivery:** Lectures **Lecturers:** Dr. Bernhard Moos **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: Outsourcing is an important option for IT managers. In this course, we will introduce and discuss basics, pros and cons of outsourcing as well as decision models, procedures, "good practices" and also problems and cultural barriers in the field of IT outsourcing and offshoring. The topics are: Basics and definitions of outsourcing • Benefits of outsourcing: financial and strategic reasons for outsourcing • Risks of Outsourcing: financial and strategic risks for outsourcing • Outsourcing decision and vendor selection process	

• Outsourcing project: contract and legal issues, due diligence, readiness, and transfer • Outsourcing governance: management and monitoring of IT suppliers including change management, relationship management, knowledge transfer management • Offshore and nearshore: particular issues regarding to risks, opportunities, costs and management of cultural differences • Global consequences of outsourcing and offshoring **Literature:** • Beimborn, D. 2008. Cooperative Sourcing - Simulation Studies and Empirical Data on Outsourcing Coalitions in the Banking Industry. Wiesbaden: Gabler. • Carmel, E., and Tjia, P. 2005. Offshoring Information Technology - Sourcing and Outsourcing to a Global Workforce. Cambridge: Cambridge University Press. • IAOP. 2010. Outsourcing Professional Body of Knowledge. Zaltbommel: Van Haren Publishing. • - Lacity, M.C., Khan, S.A., and Willcocks, L.P. 2009. "A Review of the IT Outsourcing Literature: Insights for Practice," Journal of Strategic Information Systems (18:3), pp 130-146. • Oshri, I., Kotlarksy, J., and Willcocks, L. 2009. The Handbook of Global Outsourcing and Offshoring. London, New York: Palgrave. • Further readings will be announced in class.	
2. Tutorial: International Outsourcing Management **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Wirtschaftsinformatik, insb. Informationssysteme in Dienstleistungsbereichen **Language:** German/English **Frequency:** every winter semester **Contents:** The tutorial provides further insights and exercises of the content taught in the lecture. We will practice and apply the acquired knowledge on exercises and case studies. **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** In the exam, the content of the lecture and tutorial is covered and tested. 90 points can be achieved. The exam lasts 90 minutes. During the semester, an optional and voluntary semester assignment can be accomplished in order to collect extra points. The semester assignments are evaluated and if the final exam is passed (normally 45 points are required for this purpose) the extra points will be added to the points earned by the exam. However, a 1.0 grade is achievable without extra points from the semester assignment.	

Module ISDL-ISS1-M Standards and Networks *Standards und Netzwerke*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tim Weitzel		
Contents: Standardization and standards are examined from an economical perspective (e.g., problems related to standardization and their solutions) as well as from a technical perspective (e.g., XML and EDI). The lecture material is reinforced in the exercises.		
Learning outcomes: The students get an understanding about adoption and diffusion of technologies in and between organizations. Methods for evaluating, designing, and controlling standardization in an intra- and inter-organizational context are convoyed.		
Remark: The main language of instruction in this course is German. However, the lectures and/or tutorials may be delivered in English if all participating students are fluent in English. All course materials (lecture slides and tutorial notes) are in English. In addition, the exam are available in English. Presentations may be delivered in English or in German.		
prerequisites for the module: none		
Recommended prior knowledge: keine		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture: Standards und Netzwerke (ISS1) **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tim Weitzel **Language:** German **Frequency:** every winter semester **Contents:** This module focuses on models and methods covering intra- and inter-organizational networks and on the necessity of standardization of information systems. Technical aspects of internal and external system integration as well as the economic impact of standards for information production and services cause standardization problems which are one of the basic topics in the Information Systems discipline. The lecture will focus on the question of how standards can support the automation and inter-organizational integration of processes (e.g., technical aspects of integration; main application domain will be XML and electronic data interchange (EDI)). Furthermore, economic aspects of standardization are discussed like questions regarding the strategic problems of	**2,00 Weekly Contact Hours**

standardization and how economic and game-theoretical models can be used to solve standardization problems.	
Literature: Arthur, W.B.: "Competing technologies, increasing returns, and lock-in by historical events", Economic Journal (99:March) 1989, pp. 116-131. Beck, R. und Weitzel, T.: "Some Economics of Vertical Standards: Integrating SMEs in EDI Supply Chains", Electronic Markets (15:4) 2005, pp. 313-322. Weitzel, T., Beimborn, D. und König, W.: "A unified economic model of standard diffusion: the impact of standardization cost, network effects, and network topology," MIS Quarterly (30:special issue) 2006, pp. 489-514. Weitzel, T., Harder, T. und Buxmann, P.: „Electronic Business und EDI mit XML", dpunkt, Heidelberg, 2001. Weitzel, T., Wendt, O., and von Westarp, F.: "Reconsidering network effect theory", 8th European Conference on Information Systems (ECIS), Wien, 2000. Abrahamson, E. und Rosenkopf, L.: "Social Network Effects on the Extent of Innovation Diffusion: A Computer Simulation", Organization Science (8:3) 1997, pp. 289-309. Goldenberg, J., Libai, B. und Muller, E.: "Riding the Saddle: How Corss-Market Communications Can Create a Major Slump in Sales", Journal of Marketing (66:2) 2002, pp. 1-16. Iacovou, C.L., Benbasat, I. und Dexter, A.S.: "EDI and Small Organizations: Adoption and Impact of Technology", MIS Quarterly (19:4) 1995, pp. 465-485. Further literature will be announced during the lecture.	
2. Tutorial: Standards und Netzwerke (ISS1) **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Wirtschaftsinformatik, insb. Informationssysteme in Dienstleistungsbereichen **Language:** German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: The lecture material is reinforced based on assignments and case studies. In computer-based exercises economic models of network effect theory are studied and applied. Further, quantitative approaches (e.g., decision support by standardization problem by applying Excel Solver) and technologies (e.g., XML Schema) are convoyed as a basis for intra- and inter-organizational standardization processes.	
Literature: cf. lecture	

Examination Written examination / Duration of Examination: 90 minutes **Description:**	

Content of the exam are all subjects of the lectures including all elements of the exercises. The maximum score of the exam is 90 points. Usually 50% are necessary to pass the exam successfully. During the semester, students have the opportunity to attend assignments voluntarily. These assignments are evaluated and by passing the exam successfully, the achieved points of the assignments are taken into account for the calculation of the final mark. Passing the exam with a 1.0 is possible without attending the voluntary assignments.	

Module ISDL-ISS2-M Optimization of IT-Reliant Processes *Optimierung IT-lastiger Geschäftsprozesse*	6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tim Weitzel	

Contents:
Content of the module covers theories, models and process models for optimization of IT-focused business processes. The module focuses primarily on the optimization of service provider processes. As a basis for this, the module provides theories and concepts of business process management and specializes in financial and HR processes (these processes are taken as examples for service provider processes). In the framework of the module the parallels to the industrialization of production processes will be discussed and the presented content will be deepened by case studies.

Learning outcomes:
Participants of the session should be able to identify and create optimization potential in IT-intensive business processes in service provider sector. In this context the module focuses on theories, concepts and methodologies of business process management. Here the module conveys analysis and design methods for the development of internal and external optimization, cooperation and sourcing potential.

Remark:
The language of instruction in this course is German. However, all course materials (lecture slides and tutorial notes) as well as the exam are available in English.

prerequisites for the module:
none

Recommended prior knowledge: Keine		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture: Optimierung IT-lastiger Geschäftsprozesse (ISS2) **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tim Weitzel **Language:** German/English **Frequency:** every summer semester **Contents:** The aim of the course is to introduce knowledge and skills to provide optimization of IT-focused business processes. Hereby will be reviewed principles and tools of business process management and their implementation and application into financial and HR processes will be presented. Similarly, approaches to business process optimization through appropriate use of IT will be thematized in the lecture; typical primary and secondary service provider processes will be analyzed in terms of integration, efficiency and effectiveness; goals and methods for optimization will be discussed and process models for optimal process design and change management will be presented.	**2,00 Weekly Contact Hours**

Another focal point is a created economics theoretical dispute about the phenomenon, that companies outsource business processes or parts of them to external service providers. The four main areas of this lecture are:
Main focus is on **Business Process Management (BPM).** Design of business processes is one of the core competencies of IS professionals. Therefore, this lecture focuses on theories, models, tools, and methods of BPM, change management and business process standardization. These BPM concepts will be examined in more detail within the E-Finance, HER and Outsourcing sections. The objective is that students are able to design, standardize, manage and change business processes effectively and efficiently.
E-Finance: Financial processes can be generally considered as completely digitalizable and appear both as primary processes in the financial services industry and as secondary processes in all other firms. The lecture discusses how optimal IT usage can be attained in the financial service industry, which optimization potentials can be uncovered in the financial chain management of non-banks, and which re-structuring alternatives for the value chain by a “value chain crossing” are practical.
E-HR: The IT support of HR management processes is surprisingly low. Therefore, the status quo and additional possibilities for this typical secondary process will be introduced. Particularly, a (partial) automation of the personnel selection process can be realized by employing recommender systems. The lecture will discuss enablers and inhibitors of IT usage in general and in HR in particular.

Sourcing: The questions of which services to be delivered, to where, and by whom, are strategic questions in a BPM context. Advantages and disadvantages, like economies of skill, scale, and scope, will be discussed and decision support models as well as “good practices” of business process outsourcing (BPO), along with problems and cultural barriers, will be examined.

The scientific perspective is introduced and presented by the practice cases from partner companies.

Literature:

- Balaji et al. (2011), IT-led Business Process Reengineering: How Sloan Valve Redesigned it’s New Product Development Process, MIS Quarterly Executive, 10, 2, 81-92
- Borman, M. (2006): Identifying the Factors Motivating and Shaping Cosourcing in the Financial Services Sector, Journal of Information Technology Management, vol.17:3, pp. 11-25
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- Gibson, C. (2003): IT-enabled business change: an approach to understanding and managing risk, MIS Quarterly Executive, 2 (2), 104-115
- Gilson et al. (2005): Creativity and Standardization: Complementary or Conflicting Drivers of Team Effectiveness? Academy of Management Journal, Vol. 48, No. 3, 521-531.
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- Münstermann, Eckhardt, & Weitzel (2010): The performance impact of business process standardization. In: Business Process Management Journal (16:1), 29-56
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- Reijers at el. (2005), Best practices in business process redesign: an overview and qualitative evaluation of successful redesign heuristics. Omega 33(4), 283–306
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2. Tutorial: Optimierung IT-lastiger Geschäftsprozesse (ISS2) — **2,00 Weekly Contact Hours**

Mode of Delivery: Practicals
Lecturers: Scientific Staff Wirtschaftsinformatik, insb. Informationssysteme in Dienstleistungsbereichen
Language: German/English
Frequency: every summer semester

Contents:

The contents of the course will be deepened based on exercises and

case studies. Communication of the content is focused on the exercises

of the approach of "teaching cases". Hereby, the developed case studies will

be developed and discussed with students. In addition to the work-up of the lecture content here will be emphasized: communication of soft skills, preparation for students’ own application process to achieve and complete a successful management position. Corresponding workshops will be conducted jointly with partners from practice.

Literature:

siehe Vorlesung

Examination Written examination / Duration of Examination: 90 minutes **Description:** In the exam the discussed content of lecture and tutorial will be tested. It is possible to achieve 90 points. During the semester there will be a possibility to process a semester assignment. The results will be assessed and by passed exam (usually achieving 45 points is required), points for the semester assignment will be taken into account by grading for the module. But achieving a 1.0 is possible without the credits for the semester assignment in any case.	

Module ISDL-ISS3-M IT Business Value *IT-Wertschöpfung*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tim Weitzel		
Contents: This module covers approaches for leveraging the human and technological IT resources and IT capabilities to create business value and generate a competitive advantage. Basic IT issues like the IT paradox, IT assets, IT strategy, IT architecture, IT governance and IT outsourcing management will be discussed. Using these concepts, practical guidelines for IT management will be illustrated with the help of several real world cases. Particularly in the services industry, IT represents a key production resource, and therefore, the focus of this module will be both on how to determine and how to increase the business value contribution of IT. A main aspect for high IT effectiveness is the alignment of business and IT both at strategic (goals, plans, …) and at operational level (processes, services, …). Business/IT alignment is considered to be a key issue for academics and practitioners alike, dealing with the question of how the interplay between business and IT units can be put into effect? It will be shown that the superior application of IT is not primarily a technical challenge (choosing the right technology and implementing the right systems) rather than the consideration of an IT/IS portfolio which ensures effective usage and high productivity in the context of particular supported business processes. Based upon this, key techniques for IT management and the valuation of information systems will be introduced.		
Learning outcomes: This module deals with the question to what extent and under which conditions IT contributes to organizational business value. Starting from this broad debate students will learn underlying theories, state-of-the-art concepts and concrete managerial guidelines on how to address the challenge of IT business value in practice. A key objective of the module is to provide the students with an in-depth understanding of managing both the technological and the human IT resources in order to use IT strategically and create measurable business value.		
Remark: **The language of instruction in this course is German. However, all course materials (lecture slides and tutorial notes) as well as the exam are available in English.**		
prerequisites for the module: none		
Recommended prior knowledge: keine		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture: IT-Wertschöpfung (ISS3) **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tim Weitzel **Language:** German/English **Frequency:** every summer semester **Contents:**	**2,00 Weekly Contact Hours**

The lecture covers core issues within the areas IT business value and IT management.

- Theoretical lenses (e.g., Resource-based view, Dynamic Capabilities)
- IT Strategy
- IT Architecture
- IT Governance
- IT Business Alignment
- IT Outsourcing Management
- IT Valuation

Literature:

- Carr, N. (2003): IT Doesn't Matter, in: Harvard Business Review, Vol. 81, No. 5, With Letters to the Editor.
- Chan, Y.E., und Reich, B.H. (2007): IT alignment: what have we learned?, in: Journal of Information Technology, No. 22, pp. 297-315.
- Henderson, B.D. und Venkatraman, N. (1993): Strategic alignment: leveraging information technology for transforming organizations, in: IBM Systems Journal (32:1), pp. 4-16.
- Kohli, R., and Grover, V. (2008): Business Value of IT: An Essay on Expanding Research Directions to Keep up with the Times, in: Journal of the AIS, Vol. 9, No. 1, pp. 23-39.
- Melville, N., Kraemer, K., Gurbaxani, V. (2004): Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value, in: MIS Quarterly (28:2), pp. 283-322.
- Mitra et al. (2011): Measuring IT Performance and Communicating Value, in: MISQ Executive (10:1), pp. 47-59.
- Ross, J.W. (2003): Creating a Strategic IT Architecture Competency: Learning in Stages, in: MISQ Executive (2:1), pp. 31-43.
- Wade, M., und Hulland, J.S. (2004): Review : The Resource-Based View and Information Systems Research: Review, Extension, and Suggestions for Future Research, in: MIS Quarterly (28:1), pp. 107-142.

Weitere Literatur wird in der Veranstaltung bekannt gegeben.

2. Tutorial: IT-Wertschöpfung (ISS3)	**2,00 Weekly Contact Hours**
Mode of Delivery: Practicals **Lecturers:** Scientific Staff Wirtschaftsinformatik, insb. Informationssysteme in Dienstleistungsbereichen **Language:** German/English **Frequency:** every summer semester	
Contents: The content of the lectures will be discussed based on case studies.	
Literature: siehe Vorlesung	

Examination	
Written examination / Duration of Examination: 90 minutes	

Description: The exam questions cover the content presented and discussed in lecture and tutorial. During the semester, students have the (optional) opportunity to do assignments and get extra points. However, these extra points will only be included into the evaluation if the exam itself is passed without the extra points (45 points or more).	

<table>
<tr><td colspan="2">Module ISDL-ITCHANGE-M Management of IT-induced Change
Management IT-bedingter Veränderungen</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS17/18)
Person responsible for module: Dr. Sven Laumer</td></tr>
<tr><td colspan="3">Contents:
Business organizations cannot operate without information systems, but many IT initiatives fail to meet expectations and many IT-enabled systems satisfy neither IT employees, business employees, nor customers. In this context, organizational structure and processes are subject to continual changes such that the implementation of information systems in an organization and its acceptance by employees is still one of the major challenges for IT, project, or top management. A lot of system implementations fail due to the missing support by employees. Almost any large-scale IS implementation project requires changes in organizational elements such as tasks, routines, processes, culture, or employee roles, which are in advance of or concurrent with the new IS.

In science and practice the concept of change management has established that manages, governs, and controls the transformation of organizations in order to enable a successful change such as the implementation of technologies. Change management can be defined as to manage the people-side of business change to achieve the required business outcome, and to realize that business change effectively within the social infrastructure of the workplace. The objective of the module is to provide an organizational and social perspective to enable students to analyze, discuss, and manage the consequences of the introduction of new systems and possible implementation problems.

Therefore, the module offers an understanding of the different forms information systems can take in organizations, individual and organizational acceptance of technology and methods available to manage IT-induced change. Furthermore, it provides an introduction to the management of IT personnel itself such that those responsible for the change can manage both the business and IT people to enable a successful implementation of information systems in organizations.</td></tr>
<tr><td colspan="3">Learning outcomes:
The general objectives of the module is to provide a rigorous, but not for the main part a technical approach that enables students to visualize, analyze, and discuss information systems related opportunities and challenges in organizations. After successfully passing the module students are understand the basic concepts of IT-induced change management to manage both the business and IT people involved in an IT-induced change.</td></tr>
<tr><td colspan="3">Remark:
The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
none</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every summer semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

Module Units

1. Lecture: Management IT-bedingter Veränderungen — **2,00 Weekly Contact Hours**

Mode of Delivery: Lectures
Lecturers: Dr. Sven Laumer
Language: German/English
Frequency: every summer semester

Contents:
The module consists of three major components:

Information Systems as Work Systems

Basics and introduction to information as a work system, the work system method for analyzing information systems in organizations, the work system life cycle to understand dynamic interplays over time, and issues and challenges related with information systems in organizations.

IT-induced Change Management

Fundamentals of change management, disruptive vs. evolutionary change, business process reengineering, change management methods, change management and IT/Business alignment, change management and business process management,

IT Personnel Management

Sourcing of the IT workforce, personnel planning and management
The language of instruction will be announced in the first week. The regular language is English; however, when all students are fluent in German the language of instruction can be German.

Literature:
Alter, S. (2006). The work system method: Connecting people, processes, and IT for business results. Larkspur, CA: Work System Press
Alter, S. (2008). Defining information systems as work systems: Implications for the IS field. European Journal of Information Systems, 17(5), 448-469.
Alter, S. (2013). Work System Theory: Overview of Core Concepts, Extensions, and Challenges for the Future. Journal of the Association for Information Systems, 14 (2), 72-121
Besson, P., and Rowe, F. 2012. “Strategizing information systems-enabled organizational transformation: A transdisciplinary review and new directions,” *The Journal of Strategic Information Systems* (21:2), pp. 103–124.
Kotter, J.P. (2005). Out Iceberg is Melting. St.Martin’s Press, New York
Kotter, J.P. (2010). Leading Change, Harvard Business Press
Krell, K., Matook, S., and Rohde, F. 2011. “Development of an IS change reason–IS change type combinations matrix,” *European Journal of Information Systems* (20:6), pp. 629–642.
Laumer, S., Eckhardt, A., and Weitzel, T. (2010). Electronic Human Resources Management in an E-Business Environment, Journal of Electronic Commerce Research (11:4), 240-250

Robey, D., Ross, J. W., and Boudreau, M.-C. 2002. “Learning to Implement Enterprise Systems: An Exploratory Study of the Dialectics of Change,” *Journal of Management Information Systems* (19:1), pp. 17–46.
Venkatesh, V., Morris, M., Davis, G., and Davis, F. D. 2003. “User acceptance of information technology: toward a unified view,” MIS Q (27:3), pp. 425–478.
Weitzel, T., Eckhardt, A., and Laumer, S. (2009). A Framework for Recruiting IT Talent: Lessons from Siemens, MIS Quarterly Executive (8:4), 123-137

2. Tutorial: Management IT-bedingter Veränderungen

2,00 Weekly Contact Hours

Mode of Delivery: Practicals
Lecturers: Dr. Sven Laumer
Language: German/English
Frequency: every summer semester

Contents:
The objective of the tutorial is to discuss the concepts and methods introduced in the lecture. Based on case studies and business simulations students will analysis work systems, challenges by implementing work systems in organizations, different change management methods, and the management of both business and IT people. The objective of the tutorial is to enable student to analysis and discuss real-business work systems by interviewing managers responsible for work systems in different organizations.
The language of instruction will be announced in the first week. The regular language is English; however, when all students are fluent in German the language of instruction can be German.

Literature:
See Lecture

Examination
Written examination / Duration of Examination: 90 minutes
Description:
In the exam the content of the lecture and tutorial is covered and tested. 90 points can be achieved. The exam lasts 90 minutes. During the semester, a voluntary semester assignments are processed to provide students the opportunity to collect extra points. The semester assignments are evaluated and if the final exam is passed (normally 45 points are required for this purpose) the extra points will be added to the points earned by the exam. A 1.0 is achievable even without extra points collected by the semester assignment.

The exam is offered in English and German.

Module ISDL-ITCon-B IT-Controlling *IT-Controlling*	6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tim Weitzel	

Contents:
“IT-Controlling” is the controlling of a firm’s information technology (IT) and related resources in order to ensure their effective and efficient usage in terms of time, costs, and quality. IT-Controlling represents a comprehensive coordination function (planning, monitoring, control) for the value-oriented management of IT, including information and information systems (IS). The lecture will cover topics like IT/IS portfolio controlling, IT/IS project controlling, IT/IS product and service controlling, and IT infrastructure controlling. Besides a basic theoretical view on these topics relevant methods and tools that are used by firms to control their IT will be discussed and practiced (e.g., IT balanced scorecard, IT portfolio management, benefit and risk analysis, profitability analysis, business case calculation, IT activity-based costing, IT cost allocation).

Learning outcomes:
The module offers a basic understanding of the different IT-controlling objectives. Therefore the module covers IT-strategy, IT-projects, IT-performance, and introduces methods for controlling and managing IT usage in organizations.

Remark:
The language of instruction in this course is German.

prerequisites for the module:
none

Recommended prior knowledge: keine		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Lecture: IT-Controlling **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tim Weitzel **Language:** German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: The lecture covers the following aspects of IT-controlling: IT-strategy IT-portfolio management IT-project management IT-internal cost allocation IT-performance measurement	
Literature:	

- Gadatsch, A. und Mayer, E.: Masterkurs IT-Controlling, Vieweg+Teubner, 4. Auflage, Wiesbaden, 2010.
- Hofmann, J. und Schmidt, W.: IT-Management, Vieweg+Teubner, 2. Auflage, Wiesbaden, 2010.
- Kesten, R., Müller, A., Schröder, H.: IT-Controlling, Vahlen, 2. Auflage, München, 2013.
- Kütz, M.: Kennzahlen in der IT – Werkzeuge für Controlling und Management, dpunkt, 4. Auflage, Heidelberg, 2010.
- Kütz, M.: IT-Controlling für die Praxis – Konzeption und Methoden, dpunkt, 2. Auflage, Heidelberg, 2013.
- Strecker, S.: Integrationsdefizite des IT-Controllings – Historischer Hintergrund, Analyse von Integrationspotenzialen und Methodenintegration, in: Wirtschaftsinformatik 3 (2009), S. 238-248.

Weitere Literatur wird in der Vorlesung bekannt gegeben.

2. Tutorial: IT-Controlling **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Wirtschaftsinformatik, insb. Informationssysteme in Dienstleistungsbereichen **Language:** German **Frequency:** every winter semester **Contents:** The content of the lectures will be discussed based on case studies and several tutorials. **Literature:** siehe Vorlesung.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** The exam questions cover the content presented and discussed in lecture and tutorial. During the semester, students have the (optional) opportunity to do assignments and get extra points. However, these extra points will only be included into the evaluation if the exam itself is passed without the extra points (45 points or more).	

Module ISDL-KIP-B Artificial Intelligence in Practice *Künstliche Intelligenz in der betrieblichen Praxis*	3 ECTS / 90 h

(since WS18/19)
Person responsible for module: Dr. Jochen Malinowski

Contents:

1 - Artificial Intelligence defined

AI defined

History of AI

Classification of AI technologies and applications

2 - AI technology

Machine Learning concepts and algorithms

AI architectures

AI capabilities and applications

3- AI Frameworks, Tools and Providers

4 - Applications in practice

AI in Production, Supply Chain and Distribution

AI in Corporate Functions

AI in R&D and Business Innovation

AI in Customer Service, Sales and Marketing

AI Benefits and Market trends

5 - Introducing AI to an organization

Acceptance of AI

Impact on Leadership

Impact on Organizational Models

Adapted Operating Models

Impact on talent and required skills

Responsible AI

6 - AI from a society perspective and Outlook

Learning outcomes:

Das Modul “KI in der betrieblichen Praxis» behandelt das Thema Künstliche Intelligenz aus einer ganzheitlichen Perspektive. Es befasst sich sowohl mit der Geschichte von KI und der Technologie und den Algorithmen dahinter, als auch mit Anwendungsgebieten in der Praxis. Es untersucht wie KI in Organisationen eingeführt werden kann und diskutiert die Auswirkungen auf Organisationsstrukturen, Prozesse, Betriebsmodelle und notwendige Skills. Teilnehmer des Moduls erhalten ein umfassendes Verständnis wie künstliche Intelligenz funktioniert und wie es in der betrieblichen Praxis eingesetzt werden kann.

Remark:

Kurssprache ist Deutsch. Vorlesungs- und Übungsmaterialien sind in Englisch. Die Klausur wird in Deutsch angeboten.

Die Anzahl der Teilnehmer ist beschränkt. Sollte aufgrund von Kapazitätsrestriktionen gegebenenfalls eine Auswahl gemäß der Satzung zur Festlegung der Kriterien für die Aufnahme von Studierenden in Lehrveranstaltungen von Bachelor- und Masterstudiengängen mit beschränkter Aufnahmekapazität notwendig werden, so wird nach Ablauf der Anmeldefrist über die Zulassung entschieden. Beachten Sie bitte ferner, dass die Anmeldung nicht gleichbedeutend ist mit der Zulassung zur Lehrveranstaltung oder der Anmeldung zur Modulprüfung.

prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Künstliche Intelligenz in der betrieblichen Praxis **Mode of Delivery:** Lectures and Practicals **Lecturers:** Dr. Jochen Malinowski **Language:** German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: Die Vorlesung befasst sich mit den Technologien und Algorithmen, die hinter dem Begriff «Künstliche Intelligenz» stehen und macht diese anhand konkreter Übungen verständlich und anwendbar. Darauf aufbauend werden verschiedene Anwendungsarten untersucht wie z.B. Chatbots oder Empfehlungssysteme sowie das Verständnis dieser Anwendungen durch Übungen geschärft. Nach einer Diskussion verschiedenster Anwendungsmöglichkeiten von KI in der betrieblichen Praxis, wird untersucht, wie KI konkret in Organisationen eingeführt werden kann und was es dabei im Hinblick auf Organisationsstrukturen, Prozessen, Betriebsmodellen und notwendigen Skills zu betrachten gilt. Die Vorlesung schliesst mit einer Diskussion der Auswirkungen von KI auf die Gesellschaft und einem Ausblick.	
Literature: Eine Liste der Kurs-begleitenden Literatur wird den Teilnehmern mit der Zusage zur Veranstaltung zugesendet und im VC-Kurs zur Verfügung gestellt.	

Examination Written examination / Duration of Examination: 90 minutes **Description:** In der Klausur können die Lehrinhalte des gesamten Moduls abgefragt und insgesamt 90 Punkte erzielt werden. Die Klausur gilt als bestanden, wenn mindestens die Hälfte der maximal erzielbaren Punktanzahl erreicht wurde.	

Module ISDL-MED-B Management of external IT Service Providers *Management externer IT-Dienstleister*		3 ECTS / 90 h
(since WS15/16) Person responsible for module: Prof. Dr. Wolfgang Bremer		

Contents:

1. Motivation for IT Outsourcing
2. Service Delivery Models in the IT Outsourcing Market
3. Deciding on the Depth of IT Services Delivered In-house and by External Provider(s): Outtasking vs. Outsourcing
4. The IT Supplier Lifecycle
    - Initiation of a New IT Outsourcing Relationship
    - Ongoing Operations and Management
    - Termination and Provider Change
5. Legally Compliant Design of IT Outsourcing Contracts
6. Nearshoring and Offshoring - The Role of Cultural Aspects
7. Benchmarking of IT Outsourcing Relationships

Learning outcomes:
This module imparts basic knowledge and conditions for outsourcing intentions in enterprises. Attendees is given an overview on elementary aspects of outsourcing decisions and their practical relevance for cooperating with IT service providers. The module is strongly practically oriented and demands an active participation of the students.

Remark:
The effort for this module is divided into the following components:

- Participation at the lecture: 21 hours
- Preparation and further study of the lecture: 35 hours
- Preparation of the examination: 34 hours

The language of instruction in this course is German. The course materials (lecture slides and tutorial notes) are delivered partly in German and English. The final exam is only available in German.

prerequisites for the module:
none

Recommended prior knowledge: none		**Admission requirements:** Pass the written exam
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Management externer IT-Dienstleister **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Wolfgang Bremer **Language:** German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents:	

Outsourcing IT tasks is common practice in many companies. Thereby, the outsourcer resp. the client company is motivated by both cost reasons and a focus on core competencies.
Until a few years ago, the outsourcing market was mainly characterized by large scale enterprises on the provider as well as on the client side. Today, however, highly diverse delivery models can be observed. Labeled, for instance, “Cloud”, “Software-as-a-Service” or “On-Demand”, outsourcing becomes more and more important for small and medium-sized enterprises (SME) as well.
This module addresses the wide range of IT outsourcing possibilities in a structured way and reveals courses of action and control mechanisms for client companies. A core section is about the IT supplier lifecycle: From the initiation of a new IT supplier relationship to its ongoing management and monitoring/controlling to its possible termination and the subsequent shift to another IT service provider, a wide range of feasible instruments, documents, and decision-making procedures are discussed. At that, the legal form of the outsourcing contracts, from which rights and obligations of the client and the IT service provider follow, plays a special role.
Moreover, with regard to IS nearshoring and offshoring, cultural aspects and specificities concerning the geographic distance of IT outsourcing relationships will be revealed. The module concludes with the benchmarking of outsourcing performance, i.e., the regular assessment of the provider’s market-conform service provision.

Literature:

- Gründer (2010): „IT-Outsourcing in der Praxis: Strategien, Projektmanagement, Wirtschaftlichkeit", Erich Schmidt Verlag, Berlin, 2. Auflage, ISBN-13: 978-3503090150.
- Hodel/Berger/Risi (2006): „Outsourcing realisieren", Vieweg Verlag, Wiesbaden, 2. Auflage, ISBN-13: 978-3834801142.
- Köhler (2007): „Die leise Revolution des Outsourcing: IT-Services aus dem Netz", Frankfurter Allgemeine Buch, Frankfurt am Main, 1. Auflage, ISBN-13: 978-3899811322.
- Herzwurm/Pietsch (2008): „Management von IT-Produkten: Geschäftsmodelle, Leitlinien und Werkzeugkasten für softwareintensive Systeme und Dienstleistungen", dpunkt Verlag, Heidelberg, 1. Auflage, ISBN-13: 978-3898645621.
- Hendel/Messner/Thun (2008): „Rightshore! Successfully Industrialize SAP Projects Offshore", Springer Verlag, Berlin & Heidelberg, 1. Auflage, ISBN-13: 978-3540772873.

In the lecture, the students might be informed about further sources of information.

Examination

Written examination / Duration of Examination: 90 minutes

Description:

In total, 90 points can be achieved.

Module ISDL-SaaS Recent Trends and Perspectives of Enterprise Software: Cloud, Consumerization, Big Data *Aktuelle Trends und Perspektiven der Unternehmenssoftware: Cloud, Consumerization, Big Data*	3 ECTS / 90 h
(since WS18/19) Person responsible for module: Dr. Wolfgang Faisst	

Contents:

1. Introduction
2. Market Overview
• Key Players
• Market Perspective
• Customer Perspective
• Innovation Perspective
3. New Applications
• Cloud Applications
• Mobile Applications
• Big Data Applications
• Synthesis: Next Generation Enterprise Software
4. New Ways of Operations & Infrastructure
• Parallel Computing & Virtualization
• Mega-scale Data Center
• Cloud Operations
• Engineering Approach
5. New Ways of Co-innovation
• Design Approach
• Lean Development
• Platform-as-a-Service
• Ecosystem Co-innovation
• Platform Leadership
6. New Ways to Sell & Buy
• Internet Economics
• Software-as-a-Service
• New Sales Models
• Appstore Model
• Applification
7. Summary & Outlook

Learning outcomes:

- Overview of the key trends and current concepts in the field of enterprise software
- Understanding of potential benefits and challenges of the current concepts of "cloud", "Consumerization" and "Big Data" with practical examples
- Learning of selected management practices of a software vendor along the software life cycle from development, on the sale, through to operation
- Deepening of the learning content based on a project in a (randomly selected) team, including relaying the results to the fellow students by means of a presentation

Remark:
The effort for this module is divided into the following components:
• Participation at the lecture: 21 hours
• Preparation and further study of the lecture: 21 hours
• Elaboration of the obtained exercises on presentation slides and presentation (graded): 27 hours
• Preparation of the examination: 21 hours

prerequisites for the module:
none

Recommended prior knowledge: none		**Admission requirements:** keine
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

Aktuelle Trends und Perspektiven der Unternehmenssoftware: Cloud, Consumerization, Big Data	**2,00 Weekly Contact Hours**

Mode of Delivery: Lectures and Practicals
Lecturers: Dr. Wolfgang Faisst
Language: German
Frequency: every winter semester

Contents:
This course provides an inside-view into enterprise standard software, spanning the entire software life cycle from development to sales to operations from the software providers' and the customers' perspective. Three important trends in the area of enterprise software are presented: Cloud, Consumerization and Big Data. The term "Cloud" encompasses topics such as software-as-a-service, platform-as-a-service and cloud computing. In essence, it refers to the on-demand provision of IT services in combination with simple pricing models, chiefly based on the actual usage of the software. The software provider firm often uses large cloud computing plants to provide solutions for the customer, allowing it to operate with a much smaller amount of own IT resources and competencies. In order to meet the specific requirements of certain niche industries, software providers, apart from the actual software-as-a-service solution, also offer platform-as-a-service solutions compromising of a wide range of highly productive tools which enable independent software providers to create, sell, and maintain their own custom-tailored software.
"Consumerization" describes the effect of enterprise software being particularly affected by developments in the consumer market. Traditionally, the business sector has been the pace maker for progress in IT. However, in light of online shopping (e.g., Amazon) and the wide adoption of mobile devices (e.g., Apple or Android) the consumer is more and more becoming the driving force for innovation. Employees have
become accustomed to the technological amenities that they know from their private lives and now expect that enterprise software can be used as easy and continuously and especially on their mobile devices in all places.

"Big Data" refers to the real-time analysis of very large amounts of data using mathematical methods. This trend is accelerated by current technological developments such as multi-core processors and the resulting parallel data processing combined with in-memory databases and corresponding software applications. In particular, in-memory databases enable concurrent real-time analytical (OLAP) and transactional (OLTP) processing on a single database. In this course, the topics are illustrated using demos of selected applications as well as videos of notable experts on these trends. **Literature:** Will be announced during the lecture and placed in the VC Course (Virtual Campus) of the lecture.	

Examination Written examination / Duration of Examination: 90 minutes **Description:** In total 90 points can be achieved.	

Module ISDL-WAWI-B Scientific Research in Information Systems *Wissenschaftliches Arbeiten in der Wirtschaftsinformatik*		4 ECTS / 120 h
(since WS18/19) Person responsible for module: Prof. Dr. Tim Weitzel		
Contents: The course starts with a general introduction into scientific work as well as an overview of different research methods which are used in Information Systems (e.g. Wilde/Hess 2007). After an introduction into literature research and administration, this will be followed by the development of prototypes (design science research), simulation, experiments, case studies and quantitative methods (empiricism). It is especially suited for students with none to basic knowledge in this area, therefore this course will offer an in-depth insight into the relevant subjects based on practical exercises (computerized when possible), among others with using Citavi, MAXQDA, Excel, SPSS and SmartPLS.		
Learning outcomes: This course aims at helping students familiarize themselves with a scientific style of working, particular addressing students of Information Systems and interested students of other fields planning to write a project/seminar paper or bachelor/master thesis in the field of Information Systems.		
Remark: Die Veranstaltung richtet sich gezielt an Studierende, die noch keine oder wenige Kenntnisse haben. Deshalb wird während der Veranstaltung jedes Thema anhand von Übungsaufgaben (sofern möglich auch am PC) praktisch vertieft. Hierzu werden unter anderem Citavi, MAXQDA, Excel, SPSS und SmartPLS verwendet.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Wissenschaftliches Arbeiten in der Wirtschaftsinformatik **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tim Weitzel **Language:** German **Frequency:** every winter semester **Contents:** Die Veranstaltung gliedert sich in sieben Themenschwerpunkte. 1. Grundlagen: Aufbau eines Verständnisses, was wissenschaftliches Arbeiten bedeutet, welche Anforderungen an das Schreiben einer wissenschaftlichen Arbeit gestellt werden und wie eine Forschungsarbeit strukturiert werden sollte. Diskussion des Zusammenspiels von Methode, Hypothese und Theorie sowie Kennenlernen der Bedeutung und Formulierung von Forschungsfragen.	**1,00 Weekly Contact Hours**

2. Literaturanalyse: Aufbau eines Verständnisses, wie eine Literaturanalyse durchgeführt wird, welche Bedeutung Literatur im Rahmen von wissenschaftlichen Arbeiten besitzt, wie Literatur strukturiert gesucht und ausgewertet werden kann, sowie wie die Qualität von wissenschaftlichen Quellen beurteilt werden kann. Zudem erfolgt die Einführung in die Verwendung von Citavi zur Literaturverwaltung.
3. Theorien: Überblick über verschiedene Arten von Theorien. Aufbau eines Verständnisses für die Unterscheidung zwischen explorativer und konfirmatorischer bzw. induktiver und deduktiver Forschung. Diskussion der Bausteine und Inhalte von ausgewählten Theorien der Wirtschaftsinformatik.
4. Fallstudien/qualitative Forschung: Aufbau eines Verständnisses, für welche Arten von Forschungsfragen die Verwendung von Fallstudien eine geeignete Methodik ist. Diskussion der Unterschiede zwischen quantitativer und qualitativer Forschung sowie der Schritte, die im Rahmen von Fallstudien durchgeführt werden müssen und was es dabei zu beachten gilt. Einführung in das Erstellen eines Interviewleitfadens sowie Einführung in die Software MAXQDA, zur Auswertung von qualitativen Daten.
5. Quantitative Forschung: Aufbau eines Verständnisses für welche Forschungsfragen sich quantitative Methoden eigenen, in welche Phasen sich ein empirisches Forschungsprojekt gliedert sowie wie ein Forschungsmodell im Rahmen von quantitativer Forschung aufgebaut ist. Einführung in den Zusammenhang zwischen latenten Variablen, Indikatoren, Skalen und Hypothesen. Einführung in Fragebogenerstellung, Datenauswertung und Werkzeuge wie SPSS und PLS.
6. Experimente: Aufbau eines grundlegenden Verständnisses von Experimenten und Diskussion der Gebiete, in welchen Experimente in der Forschung eingesetzt werden können. Diskussion der Unterschiede zwischen Experimenten in den Wirtschaftswissenschaften und der Psychologie.
7. Design Science Research: Aufbau eines Verständnisses der grundlegenden Anforderungen an eine gestaltungsorientierte Forschung und wie gestaltungs- und verhaltensorientierte Forschung in der Wirtschaftsinformatik zusammenspielen. Einführung in Methoden, mit welchen Design Science Research evaluiert werden kann.

Literature:

- Backhaus, Klaus (2008): Multivariate Analysemethoden: Eine anwendungsorientierte Einführung. 12. Aufl. Berlin: Springer.
- Bühl, Achim (2008): SPSS 16. Einführung in die moderne Datenanalyse. 11. Aufl. München: Pearson Studium.
- Chin, W.W. "The Partial Least Squares Approach to Structural Equation Modeling," in: Modern Methods for Business Research, G.A. Marcoulides (ed.), Lawrence Erlbaum Associates, 1998b, pp. 295-336.
- Dubé, L.; Paré, G.: Rigor in Information Systems Positivist Case Research: Current Practices, Trends, and Recommendations. MIS Quarterly, Vol. 27, No. 4, 2003, pp. 597-635.

- Eisenhardt, K. M.; Graebner, M. E.: Theory Building from Cases: Opportunities and Challenges. Academy of Management Journal, Vol. 50, No. 1, 2007, pp. 25-32.
- Eisenhardt, K.M. "Building Theories from Case Study Research," Academy of Management Review (14:4) 1989, pp 532-550.
- Fettke, Peter (2006): Eine Untersuchung der Forschungsmethode „Review" innerhalb der Wirtschaftsinformatik. In: Wirtschaftsinformatik, Jg. 48, H. 4, S. 257–266.
- Götz, O., and Liehr-Gobbers, K. "Analyse von Strukturgleichungsmodellen mit Hilfe der Partial-Least-Squares(PLS)-Methode," Die Betriebswirtschaft (64:6) 2004, pp 714-738.
- Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. "Design Science in Information Systems Research," MIS Quarterly (28:1), pp. 75-105.
- Lee, A.S. "Methodology for MIS Case Scientific Studies," MIS Quartely (13:1) 1989, pp 33-50.
- Peffers, K., Tuunanen, T., Gengler, C., Rossi, M., Hui, W., Virtanen, V. and Bragge, J. (2006): The design science research process: a model for producing and presenting information systems research. In Proceedings of the First International Conference DESRIST, pp. 83–106.
- Sutton, Robert I.; Staw, Barry M. (1995): What Theory is Not. In: Administrative Science Quarterly, Jg. 40, S. 371-384.
- Webster, Jane; Watson, Richard T. (2002): Analyzing the Past to Prepare for the Future: Writing a Literature Review. In: MIS Quarterly, Jg. 26, H. 2, S. xiii–xxiii.
- Weitzel, T., Beimborn, D., König, W. (2006): A Unified Economic Model of Standard Diffusion: The Impact of Standardization Cost, Network Effects, and Network Topology. MIS Quarterly (30, Special Issue), pp. 489-514.
- Whetten, David A. (1989): What Constitutes a Theoretical Contribution? In: Academy of Management Review, Jg. 14, H. 4, S. 490-495.
- Wilde, T./ Hess, T. (2006): Methodenspektrum der Wirtschaftsinformatik: Überblick und Portfoliobildung, Arbeitsbericht Nr. 2/2006
- Winter, R. (2008): Design science research in Europe, European Journal of Information Systems 17, pp. 470-475.
- Yin, Robert K. (1996): Case Study Research: Design and Methods. 2. Aufl. Thousand Oaks: Sage Publications.

2. Wissenschaftliches Arbeiten in der Wirtschaftsinformatik **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Wirtschaftsinformatik, insb. Informationssysteme in Dienstleistungsbereichen **Language:** German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: This course comprises seven key subjects: **1.Basics:** Creation of an understanding of scientific work as such, the requirements of scientific papers as well as the best possible layout of research papers;	

discussions of the interactions of methods, hypotheses and theories as well as the significance and formulation of research problems.

2. Literature review:

Development of an understanding of how to conduct literature reviews, the significance of literature in the context of scientific work, how to research and evaluate academic sources and how to assess the quality of academic sources as well as an introduction to the usage of Citavi in literature administration.

3. Theories:

Overview of different types of theories; development of an understanding for the difference between explorative and confirmatory research, as well as inductive and deductive research of contingency factors; discussion of the components and contexts of particular theories of Information Systems.

4. Design Science Research:

Development of an understanding of the basic requirements for design oriented research as well as design and behavior-oriented research; introduction of methods to evaluate Design Science Research.

5. Case studies:

Development of an understanding which type of research case studies are best suited for; discussion of differences between quantitative and qualitative research as well as required steps regarding case studies and what to pay attention to. Introduction to the methods of case studies so students are able to conduct their own case studies and to create their own interview guide lines. Introduction to MAXQDA as possibility to evaluate case studies with the support of software.

6. Quantitative research:

Development of an understanding which research questions are suitable for quantitative methods, introduction to the phases into which a research project should be divided as well as the structure of a research model in quantitative research. Introduction into the relation between latent variables, indicators, scales and hypotheses; introduction to data evaluation software and methods like SPSS and PLS.

7. Experiments and simulations:

Development of a basic understanding of simulations and discussion of the fields in which simulations are suitable for research as well as an understanding of Monte-Carlo-Simulations, System Dynamics and ACE. Development of a basic understanding of experiments and assessing in which fields of research experiments can be used. Discussion of the differences between experiments in the fields of psychology and business economics.

Literature:

- Backhaus, Klaus (2008): Multivariate Analysemethoden: Eine anwendungsorientierte Einführung. 12. Aufl. Berlin: Springer.
- Bühl, Achim (2008): SPSS 16. Einführung in die moderne Datenanalyse. 11. Aufl. München: Pearson Studium.

- Chin, W.W. "The Partial Least Squares Approach to Structural Equation Modeling," in: Modern Methods for Business Research, G.A. Marcoulides (ed.), Lawrence Erlbaum Associates, 1998b, pp. 295-336.
- Dubé, L.; Paré, G.: Rigor in Information Systems Positivist Case Research: Current Practices, Trends, and Recommendations. MIS Quarterly, Vol. 27, No. 4, 2003, pp. 597-635.
- Eisenhardt, K. M.; Graebner, M. E.: Theory Building from Cases: Opportunities and Challenges. Academy of Management Journal, Vol. 50, No. 1, 2007, pp. 25-32.
- Eisenhardt, K.M. "Building Theories from Case Study Research," Academy of Management Review (14:4) 1989, pp 532-550.
- Fettke, Peter (2006): Eine Untersuchung der Forschungsmethode „Review“ innerhalb der Wirtschaftsinformatik. In: Wirtschaftsinformatik, Jg. 48, H. 4, S. 257–266.
- Götz, O., and Liehr-Gobbers, K. "Analyse von Strukturgleichungsmodellen mit Hilfe der Partial-Least-Squares(PLS)-Methode," Die Betriebswirtschaft (64:6) 2004, pp 714-738.
- Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. “Design Science in Information Systems Research,” MIS Quarterly (28:1), pp. 75-105.
- Lee, A.S. "Methodology for MIS Case Scientific Studies," MIS Quartely (13:1) 1989, pp 33-50.
- Peffers, K., Tuunanen, T., Gengler, C., Rossi, M., Hui, W., Virtanen, V. and Bragge, J. (2006): The design science research process: a model for producing and presenting information systems research. In Proceedings of the First International Conference DESRIST, pp. 83–106.
- Sutton, Robert I.; Staw, Barry M. (1995): What Theory is Not. In: Administrative Science Quarterly, Jg. 40, S. 371-384.
- Webster, Jane; Watson, Richard T. (2002): Analyzing the Past to Prepare for the Future: Writing a Literature Review. In: MIS Quarterly, Jg. 26, H. 2, S. xiii–xxiii.
- Weitzel, T., Beimborn, D., König, W. (2006): A Unified Economic Model of Standard Diffusion: The Impact of Standardization Cost, Network Effects, and Network Topology. MIS Quarterly (30, Special Issue), pp. 489-514.
- Whetten, David A. (1989): What Constitutes a Theoretical Contribution? In: Academy of Management Review, Jg. 14, H. 4, S. 490-495.
- Wilde, T./ Hess, T. (2006): Methodenspektrum der Wirtschaftsinformatik: Überblick und Portfoliobildung, Arbeitsbericht Nr. 2/2006
- Winter, R. (2008): Design science research in Europe, European Journal of Information Systems 17, pp. 470-475.
- Yin, Robert K. (1996): Case Study Research: Design and Methods. 2. Aufl. Thousand Oaks: Sage Publications.

Examination
Written examination / Duration of Examination: 60 minutes
Description:

In der Klausur werden die in derVorlesung und Übung behandelten Inhalte geprüft. Es können 60 Punkte erzielt werden. Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.	

Module ISDL-eFin-B Electronic Finance *Electronic Finance*		6 ECTS / 180 h
(since WS18/19) Person responsible for module: Dr. Christian Maier		

Contents:

The module gives an overview on methods, models and systems of process and information management on the example of selected business processes in the financial services sector and financial processes in other sectors. Students should learn the basics of a successful financial process management as well as understand and learn to apply the decision criteria for the efficient and effective IT support for these business processes.

Information technology, besides human resources, is the most important “production resource” in financial processes. Therefore, information systems competencies are very important in the financial industry.

In this case the lecture electronic finance would like to contribute to the Student’s profile upgrade by establishing connection between general information systems methods & knowledge and the financial industry / financial processes domain.Information technology is – besides human resources – the critical production factor in all of these processes. The focus of this module is to learn methods that help to shape efficient and effective IT usage within these processes. Main areas will be: types of information systems in financial processes and in the financial industry (such as transaction systems, production systems, CRM, expert systems (e.g. for risk analysis), trading platforms), outsourcing of financial business functions, operational risk management, inter-organizational IT infrastructures for payments and securities transactions, IT compliance in financial services, automation and integration of banking processes, and algorithmic trading.

Learning outcomes:

Students acquire general domain-related knowledge and competencies in terms of IT use in financial companies and in financial processes. In addition, application-oriented skills for use of various heuristic methods for the evaluation of risks will be established.

Remark:

Der Arbeitsaufwand für dieses Modul gliedert sich ungefähr wie folgt:

- Teilnahme an Vorlesung und Übung: insgesamt 45 Stunden
- Vor- und Nachbereitung der Vorlesung und Übung (inkl. Recherche und Studium zusätzlicher Quellen): 90 Stunden
- Prüfungsvorbereitung: 45 Stunden (basierend auf dem bereits im obigen Sinne erarbeiteten Stoff)

prerequisites for the module:

none

Recommended prior knowledge: Recommended but not required SEDA-GBI-B, Mathematik für Wirtschaftswissenschaftler I and Statistik II		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture: Electronic Finance **Mode of Delivery:** Lectures	**2,00 Weekly Contact Hours**

Lecturers: Dr. Christian Maier
Language: German
Frequency: every winter semester

Contents:

E-finance identifies the electronic support of Financial processes and transactions in internal and inter-company context. This includes

- the primary processes of financial services such as credit settlement, payment transactions, securities trading, etc.
- the secondary financial processes of all companies, such as Cash Management, Asset Management, Financial Chain Management (from the pricing on the invoice to the payment receipt control)
- and the inter-company financial transactions, which usually are settled by products / services of the financial service providers and their networks (payment transactions, securities trading). There financial transactions will be increasingly integrated to the financial processes of other companies.

Here will be also considered business processes in different areas of the financial industry as well as the respective roles in information systems, standards and integration infrastructures. Main areas will be:

- business processes and information systems in Retail Banking and CRM
- processes, information systems and standards in payment transactions
- processes, information systems and standards in securities trading
- business processes and information systems in credit transactions
- business processes and information systems in insurance industry
- business processes, information systems and standards from financial information suppliers
- outsourcing of financial business processes (BPO) and meaning of Information technology
- risk management with IT and in IT
- innovative bank products and business models, such as technology-driven trends of financial industry reorganization
- financial industry methods: risk assessment, solvency check, algorithmic trading etc.

Literature:

- Bartmann, Nirschl, Peters: Retail Banking, Frankfurt School Verlag, Frankfurt, 2008.
- Bodendorf, Robra-Bissantz: E-Finance, Springer, 2003.
- Buhl, Kreyer, Steck: e-Finance: Innovative Problemlösungen für Informationssysteme in der Finanzwirtschaft, Berlin, 2001.
- Farny: Versicherungsbetriebslehre, VVW, Karlsruhe, 2006 (4. Aufl.).
- Freedman: An Introduction to Financial Technology. Elsevier Science 2006.
- Lamberti, H.-J., Marlière, A., Pöhler, A.: Management von Transaktionsbanken, Springer, Heidelberg, 2004.
- Pfaff, D.; Skiera, B.; Weitzel, T.: Financial-Chain-Management: Ein generisches Modell zur Identifikation von Verbesserungspotenzialen WIRTSCHAFTSINFORMATIK (46:2), 2004, S. 107-117.

2. Tutorial: Electronic Finance **Mode of Delivery:** Practicals **Lecturers:** Dr. Christian Maier **Language:** German **Frequency:** every winter semester **Contents:** The contents of the course will be elaborated based on exercises and case studies. Using computer-based tasks, the basic concepts of solvency check and risk assessment based on neuronal networks and Fuzzy-Decision-Support systems will be delivered, such as the algorithmic trading conveys. **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** In the exam the discussed content of lecture and tutorial will be tested. It is possible to achieve 90 points. During the semester there will be a possibility to process a semester assignment (not obligatory), which should be done in min. 3 weeks, in order to get extra credits (10 points). If the exam is passed (usually achieving 50% of the points is required), then maximum 10 points for the semester assignment will be taken into account by grading for the module. But achieving a 1.0 is possible without the credits for the semester assignment in any case.	

<table>
<tr><td colspan="2">Module ISM-EidWI-B Introduction into Information Systems
Einführung in die Wirtschaftsinformatik</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS18/19)
Person responsible for module: Prof. Dr. Daniel Beimborn</td></tr>
<tr><td colspan="3">Contents:
Das Modul vermittelt eine Einführung in die Themen- und Methodenwelt der Wirtschaftsinformatik und legt somit die Grundlagen für das weitere Studium von Wirtschaftsinformatik und International Information Systems Management.</td></tr>
<tr><td colspan="3">Learning outcomes:
Nach Abschluss des Kurses haben die Studierenden ein Verständnis über die Natur, die Rolle und den Wertbeitrag von Informationssystemen im betrieblichen Kontext. Sie können unterschiedliche Typen von Anwendungssystemen identifizieren sowie die Vor- und Nachteile von Integration und Automatisierung vermitteln. Sie sind in der Lage, einfache Datenstrukturen und Prozesse zu modellieren und mittels solcher Modelle zu kommunizieren. Zudem können Sie die grundlegenden Aufgaben des Informationsmanagements beschreiben und in der Gesamtorganisation verorten.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
none</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:
from 1.</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>1. Einführung in die Wirtschaftsinformatik
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Daniel Beimborn
Language: German
Frequency: every winter semester

Contents:
Die Vorlesung gibt einen Überblick über die verschiedenen Themen und

Methoden der Wirtschaftsinformatik und zeichnet dadurch eine „Landkarte“ für das weitere Studium der Wirtschaftsinformatik bzw. von International Information Systems Management.
Ausgehend vom Thema der Digitalisierung als allgegenwärtigem Veränderungselement sowohl im betrieblichen als auch privaten Umfeld, den daraus entstehenden Herausforderungen – denen sich naturgemäß insbesondere Wirtschaftsinformatiker und IS-Manager stellen müssen – behandelt der Kurs zunächst das Gestaltungsobjekt der Wirtschaftsinformatik, nämlich betriebliche Informationssysteme, gibt eine Einführung in die theoretischen und technologischen Grundlagen, vermittelt anschließend erste methodische Kompetenzen (Modellieren von Datenstrukturen und Prozessen) und zeigt im dritten Teil die verschiedenen Managementaufgaben und ihre Verzahnung auf. Zum Abschluss wird ein dreifacher Ausblick gegeben: Welche möglichen</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

Aufgaben und Berufsprofile ergeben sich für WI/IISM-Absolventen? Mit welchen spannenden Themen und Fragestellungen beschäftigt sich die Wirtschaftsinformatik in der Forschung? Wie ist das weitere Bachelor-Studium inhaltlich strukturiert, wie hängen die Inhalte zusammen und welche Möglichkeiten gibt es für das individuelle Setzen von inhaltlichen Schwerpunkten im Rahmen der eigenen Studienplangestaltung? (Dies beinhaltet auch eine Vorstellung der Themenschwerpunkte der verschiedenen Bamberger Wirtschaftsinformatik-Lehrstühle.)

Der Kurs ist wie folgt strukturiert (Änderungen vorbehalten):

Teil A - Grundlagen:

- Einführung und Motivation
- Was ist Wirtschaftsinformatik? Was sind Informationssysteme?
- Konzeptuelle und theoretische Grundlagen
- Technologische Grundlagen: Infrastrukturkomponenten (Rechner, Netzwerke, Standards)
- Technologische Grundlagen: Betriebliche Anwendungssysteme und Integration

Teil B – Methoden:

- Modellierung und Management von Daten
- Modellierung und Management von Prozessen
- Ganzheitliche Sicht: Enterprise Architecture Management

Teil C – IS-Management:

- Grundlagen des Informationsmanagement
- Strategisches Informationsmanagement
- Entwicklung von Anwendungssystemen
- Beschaffung und Betrieb von IT
- E-Business und elektronische Märkte
- Digitalisierung und Digitale Transformation

Teil D – Ausblick:

- Quo vadis? Das weitere Bachelor-Curriculum in IISM und WI
- Berufsbilder und Aufgabenspektrum für Wirtschaftsinformatiker und IISM-ler
- Wirtschaftsinformatik als wissenschaftliche Disziplin: Forschungsziele und -methoden

Literature:

Die Vorlesung basiert auf folgenden einführenden Standardwerken der Wirtschaftsinformatik.

- Laudon/Laudon/Schoder: Wirtschaftsinformatik: Eine Einführung. Pearson Studium, 3. Auflage, 2015, bzw. Laudon/Laudon: Management Information Systems. Pearson Education, 15th Edition, 2017.
- Leimeister: Einführung in die Wirtschaftsinformatik. Springer Gabler, 12. Auflage, 2015.
- Ferstl/Sinz: Grundlagen der Wirtschaftsinformatik. Oldenbourg, 7. Auflage, 2012.

• Gallaugher: Information Systems: A Manager's Guide to Harnessing Technology. Flatworld Knowledge, 7th edition, 2018 • Lemke/Brenner: Einführung in die Wirtschaftsinformatik (2 Bände). Springer, Gabler, 2014 & 2017. Weitere Literatur, insb. Pflichtlektüre, wird im Rahmen des Unterrichts bekanntgegeben und soweit möglich digital zur Verfügung gestellt.	
2. Einführung in die Wirtschaftsinformatik **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Daniel Beimborn **Language:** German **Frequency:** every winter semester **Contents:** Die Inhalte der Vorlesung werden anhand von Übungsaufgaben und Fallbeispielen vertieft. Zusätzlich werden Tutorien angeboten, die auf freiwilliger Basis besucht werden können. **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes	

Module ISM-FIISM-B Fundamentals of International IS Management *Fundamentals of International IS Management*	6 ECTS / 180 h

(since SS19)
Person responsible for module: Prof. Dr. Daniel Beimborn

Contents:
This module equips IISM students with the basics of their IISM curriculum and serves as introductory course.

Building on the basics of information systems (such as learned about in ISM-EidWI-B, SNA-WIM-B or in a similar course), we will develop a deeper understanding about information systems (IS) management, about international management, and about particularities of IS management in an international context. Accordingly, the course consists of three parts, covering those areas.

Learning outcomes:
After having accomplished this course, students will have an understanding about particularities of general management and IS management in an international context. They will be able to handle basic IS management tasks in an international environment and they will be sensitive to challenges caused by international and intercultural settings as well as by virtual collaboration.

Remark:
The workload of 180 academic hours is allocated as follows:

- 56h for participating in class
- 80h for preparing classes (i.e., retrieving and studying literature and case studies, accomplishing small assignments) and reviewing course material after class
- 44h for self-managed studies and preparing for the final exam including the final exam

prerequisites for the module:
none

Recommended prior knowledge: ISM-EidWI-B (or any equivalent „Introduction into IS“ course) is required. SNA-WIM-B is recommended, but not necessary (students can catch up the relevant parts by reading some extra literature).	**Admission requirements:** none

Frequency: every summer semester	**Recommended semester:** from 4.	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Fundamentals of International IS Management **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Daniel Beimborn **Language:** English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: In this course, students will gain a deeper understanding of IS management tasks and issues with a particular focus on international contexts and environments. Therefore, the course will first give an overview about important IS management	

fields, then give an introduction to (general) international management,

and finally combine both foundational parts by discussing particularities of managing information systems in an international context (i.e., the core of IISM). Accordingly, the course will consist of three parts:
Part 1: Information Systems Management (IS Management):

- 1.1 Strategic IS Management: IT Strategy and Strategic Alignment, IT Organization and IT

Governance

- 1.2 Tactical IS Management: IS Development & Project Management, IS Procurement &

Outsourcing Management

- 1.3 Operational IS Management; IT Service Management, IT Operations

Part 2: International Management

- 2.1 Theoretical and Conceptual Foundations of International Management
- 2.2 Organization of International Firms
- 2.3 Foreign Market Entry Strategies
- 2.4 Intercultural Management and Virtual Teams

Part 3: International IS Management

- 3.1 Managing Global IT Organizations and People
- 3.2 Managing Global IT/Software Development Projects and System Roll-outs
- 3.3 Managing Offshore IT Outsourcing
- 3.4 Global Issues of IS Management – Ethics and Sustainability

While parts 1 and 2 will be primarily taught using teaching books, lectures, and

exercises, part 3 will draw on the knowledge and skills gained in the first two parts by applying a predominantly case-based teaching approach.

Literature:
Will be announced in class.

2. Fundamentals of International IS Management **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Daniel Beimborn **Language:** English **Frequency:** every summer semester **Contents:** The content of the course will be reviewed by assignment tasks and discussion of case studies **Literature:** see lecture	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes	

Description: In the exam, the contents covered in the module (lecture, exercise, readings) are examined. 90 points can be scored. It is possible to earn bonus points for the exam during the lecture term. Earned bonus points will be credited to the results if the exam has been passed successfully. Bonus points can be earned by completing a voluntary, written coursework in which students independently have to work on transfer tasks related to the lecture course. At the beginning of the course it will be announced whether bonus points are offered. If bonus points are offered, the number, type, scope, and duration of the assignments as well as the number of attainable bonus points will be announced at this time. A final grade of 1.0 can be achieved without bonus points from the coursework.	

<table>
<tr><td>Module ISM-IOM-M International Outsourcing Management
International Outsourcing Management</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="2">(since WS19/20)
Person responsible for module: Prof. Dr. Daniel Beimborn</td></tr>
</table>

Contents:

- Grundlagen des Outsourcings: Definitionen, grundlegende Konzepte und Arten von Outsourcing; Geschichte, Trends; Märkte und Wachstum; Überblick über die wissenschaftliche Forschung im Outsourcing-Kontext
- Outsourcing-Gründe und grundlegende Theorien: Ökonomische und strategische Gründe für Outsourcing; Theorien zu Kosten- und strategischen Vorteilen, Kernkompetenzen usw.
- Outsourcing-Risiken: Ökonomische und strategische Risiken durch Outsourcing
- Outsourcing-Entscheidungen: Analyse der Nutzenpotenziale und Risiken durch Outsourcing; Modelle zur Bewertung der Vorteilhaftigkeit von Outsourcing; Prozess und Bewertungskriterien zur Auswahl von Dienstleistern
- Outsourcing-Verträge: Gestaltung und Verhandlung von Outsourcing-Verträgen und Service-Level-Agreements; Verhandlung mit einem Dienstleister; ausgewählte regulatorische Rahmenbedingungen
- Organisatorische Vorbereitungen im eigenen Unternehmen („Outsourcing Readiness"); Vorbereitung und Durchführung des Transitionsvorgangs
- Outsourcing-Governance: Aufbau einer Outsourcing-Governance zur Steuerung der Dienstleisterbeziehung; Kontrolle, Change-Management und Beziehungsmanagement; Management des Wissensaustausches und Fördern von Innovationen
- Besonderheiten beim Cloud Computing: Grundlegende Konzepte und Arten von Cloud Computing als besonderer Form von Outsourcing; Spezifische Vorteile, Herausforderungen und Risiken von Cloud Computing; spezifische Aspekte bei Cloud-basierten Sourcing-Entscheidungen sowie bei einer Cloud-Computing-Governance
- Offshore- und Nearshore-Outsourcing: Besonderheiten hinsichtlich Risiken, Kosten und Chancen; Bedeutung von und Umgang mit kulturellen Unterschieden; Globale IT-Delivery-Modelle
- Ökonomische und gesellschaftliche Auswirkungen von Outsourcing und Offshoring: Gesellschaftliche Reaktionen und Veränderungen; Implikationen für nationale Arbeitsmärkte und globale IT-Märkte

Learning outcomes:

Die Teilnehmer können Chancen und Risiken von IT-Outsourcing in Firmen identifizieren, Outsourcing-Projekte planen (Outsourcing-Strategie, Business Case, Auswahl unterschiedlicher Sourcing-Modi und Vendorenmodelle) und implementieren (Vertragsmanagement, Outsourcing-Governance, Beziehungsmanagement, Wissenstransfer). Damit sind Sie in der Lage,

- die grundlegenden Argumente für das Treffen von IT-Outsourcing-Entscheidungen zu identifizieren und zu evaluieren(Wann macht Outsourcing Sinn?),
- IT-Outsourcing-Optionen zu identifizieren und zu bewerten (Welche Form von Outsourcing ist sinnvoll?),
- IT-Outsourcing-Projekte zu planen und zu managen (Wie kann ein erfolgreicher Transfer zum Dienstleister gewährleistet werden?),
- eine Outsourcing-Governance zu implementieren (Wir wird gesteuert? Wer hat welche Verantwortlichkeiten inne?),
- IT-Outsourcing-Beziehungen zu gestalten und zu managen (Vertragsmanagement, Kontrolle, Beziehungsmanagement, Wissenstransfer) sowie

Nearshore- und Offshore-IT-Outsourcing-Optionen zu identifizieren und zu bewerten.
Remark: Der Arbeitsaufwand für dieses Modul gliedert sich ungefähr wie folgt: • Teilnahme an Vorlesung und Übung: insgesamt 45 Stunden • Vor- und Nachbereitung der Vorlesung und Übung (inkl. Recherche und Studium zusätzlicher Quellen): 90 Stunden • Prüfungsvorbereitung inkl. Prüfung: 45 Stunden (basierend auf dem bereits im obigen Sinne erarbeiteten Stoff) Für das erfolgreiche Absolvieren des Moduls ist die regelmäßige Teilnahme an den Lehrveranstaltungen und die Vorbereitung von Fallstudien/Readings erforderlich.
prerequisites for the module: none

Recommended prior knowledge: Keine		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. International Outsourcing Management **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Daniel Beimborn **Language:** German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: Outsourcing, der Fremdbezug von Leistungen von einem Dienstleister, ist eine wichtige Handlungsoption für IT-Manager. In diesem Modul werden Grundlagen, Vor- und Nachteile des Outsourcing sowie Entscheidungsmodelle, Vorgehensweisen, „Good Practices" („warum outsourcen, was outsourcen, wie outsourcen?"), aber auch Probleme und kulturelle Hürden im Bereich IT-Outsourcing und -Offshoring vermittelt, diskutiert und angewendet. Neben klassischem Outsourcing werden auch Cloud-basierte IT-Delivery-Modelle und die entsprechenden Management-besonderheiten betrachtet. Auf Basis von ausführlichen Vorlesungsunterlagen und mittels Diskussion von Fallstudien werden die Management-Anforderungen für die Gestaltung eines erfolgreichen Outsourcing-Arrangements umfassend vermittelt. Die Universität Bamberg ist der einzige deutsche Academic Alliance Partner der International Association of Outsourcing Professionals (IAOP), die sich die globale Qualitätssteigerung und Standardisierung von Outsourcing-Management-Kompetenzen zum Ziel gesetzt hat. Entsprechend werden maßgeblich auch internationale (englischsprachige) Lehrmaterialien der IAOP verwendet.	
Literature: Beimborn, D. 2008. Cooperative Sourcing - Simulation Studies and Empirical Data on Outsourcing Coalitions in the Banking Industry. Wiesbaden: Gabler.	

Carmel, E., and Tjia, P. 2005. Offshoring Information Technology - Sourcing and Outsourcing to a Global Workforce. Cambridge: Cambridge University Press. IAOP. 2014. Outsourcing Professional Body of Knowledge. Zaltbommel: VanHaren Publishing. Lacity, M.C., Khan, S.A., and Willcocks, L.P. 2009. "A Review of the IT Outsourcing Literature: Insights for Practice," Journal of Strategic Information Systems (18:3), pp 130-146. Oshri, I., Kotlarksy, J., and Willcocks, L. 2015. The Handbook of Global Outsourcing and Offshoring. London, New York: Palgrave. Weitere Literatur zu den einzelnen Themen wird in den jeweiligen Vorlesungen bekannt gegeben.	
2. International Outsourcing Management **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Daniel Beimborn **Language:** German/English **Frequency:** every winter semester **Contents:** Die Inhalte der Vorlesung werden anhand von Übungsaufgaben und Fallstudien vertieft. Eine Vorbereitung der Lektüre für jede Übungseinheit ist zwingend erforderlich. Literatur: siehe Vorlesung. Konkrete Readings/Fallstudien werden für jede Übungseinheit rechtzeitig bekannt gegeben.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung und in der Modulprüfung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.	

Module ISM-LCR-B Legal and Compliance Requirements for IT Governance *Legal and Compliance Requirements for IT Governance*		3 ECTS / 90 h
(since SS19) Person responsible for module: Ass.jur. David SÄNGER		
Contents: Trotz seiner unbestreitbaren Konjunktur in den letzten Jahren unterliegt das Thema Compliance auch in Deutschland einer ambivalenten Betrachtungsweise: Angesichts auch deutsche Unternehmen betreffende Skandale um schwarze Konten, Datenschutzverletzungen etc. und deren rechtlichen wie wirtschaftlichen erheblichen Folgen, steigt unter deutschen Unternehmen das Bedürfnis nach der Implementierung von Compliance-Systemen. Demgegenüber finden sich die nicht immer unberechtigten Vorbehalte, es werde ein weiterer Verwaltungsapparat geschaffen, der zu mehr Bürokratie und Kosten sowie einer Beeinträchtigung der Effizienz führt. Hierin liegt die Herausforderung bei der Implementierung eines Compliance-Systems: Maßnahmen, die ein regelkonformes Operieren von Unternehmen gewährleisten sollen, können nur erfolgreich sein, wenn sie auf die entsprechende Akzeptanz im Unternehmen treffen und den Anforderungen der alltäglichen Arbeitsabläufe angepasst sind. Die Vorlesung soll den Teilnehmern die wesentlichen rechtlichen Gesichtspunkte erläutern, auf die es bei der Schaffung von Compliance-Systemen ankommt. Hierbei kommt es nicht auf ein Detailwissen an, sondern vielmehr auf die Schaffung eines praxisorientierten Grundverständnisses für Compliance-relevante Rechtsthemen. Zunächst wird die Corporate Governance eines Unternehmens erläutert, also der Ordnungsrahmen, innerhalb dessen die Leitung eines Unternehmens stattfindet. Anschließend werden die einzelnen Rechtsgebiete dargestellt, die sich in Bezug auf Haftungsthemen für Unternehmen als besonders wichtig erweisen. Neben dem allgemeinen Aufbau und den Grundsätzen dieser Rechtsgebiete werden praxisrelevante Einzelthemen vertieft dargestellt. Zuletzt werden dann die Möglichkeiten und Anforderungen in Hinsicht auf Compliance-Systeme und deren Implementierung, insbes. durch eine IT-Governance, behandelt.		
Learning outcomes: Die Vorlesung "Legal and Compliance Requirements for IT Governance" soll die Grundkenntnisse der rechtlichen Voraussetzungen und Rahmenbedingungen für die Implementierung einer Compliance-Organisation in den verschiedenen Unternehmensformen, von der mittelständischen GmbH bis zum internationalen Großkonzern, vermitteln. Die Teilnehmer erhalten eine Übersicht über die hierfür wesentlichen Rechtsgebiete und deren praktische Relevanz im Rahmen der Compliance. Gerade Nichtjuristen sollen anhand der Vorlesung in die Lage versetzt werden, bei der Beratung von Unternehmen mögliche Compliance-Themen zu identifizieren und Compliance-Systeme zu entwerfen, die ein regelkonformes Verhalten der Unternehmen gewährleisten sollen.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Legal and Compliance Requirements for IT Governance **Mode of Delivery:** Lectures and Practicals **Lecturers:** Ass.jur. David SÄNGER **Language:** German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: **Gliederung:** 1. Gesellschaftsrecht, die Corporate Governance 2. Kapitalmarktrecht 3. Compliance bei M&A-(Mergers & Acquisitions)Transaktionen 4. Compliance in der Unternehmenskrise und der Insolvenz 5. Kartellrecht 6. Compliance in nationalen und internationalen Vertragsbeziehungen, Außenwirtschaftsrecht 7. Wettbewerbsrecht und gewerblicher Rechtsschutz, insbesondere Lizenz- und Software-Entwicklungsvertragsrechte 8. IT-Compliance und IT-Governance (Governance der IT und Governance mit IT) 9. Datenschutz 10. Arbeitsrecht 11. Verbraucherschutz 12. Steuerrecht 13. Strafrechtliche Aspekte 14. Branchenspezifische Compliance-Aspekte 15. Die Implementierung einer Compliance-Organisation, insbesondere... a. ... die Corporate Governance b. ... die IT-Governance c. ... der Compliance-Beauftragte	
Literature: • Günter/Inderst/Bannenberg (2010): "Compliance: Aufbau – Management – Risikobereiche", C.F. Müller Verlag, Frankfurt am Main/Unterföhring/Gießen. • Hauschka (2010): "Compliance: Handbuch der Haftungsvermeidung in Unternehmen", C. H. Beck Verlag, München. • Umnuß (2008): "Corporate Compliance Checklisten: Rechtliche Risiken im Unternehmen erkennen und vermeiden", C. H. Beck Verlag, München. • Hommelhoff/Hopt/Werder (2009): "Handbuch Corporate Governance: Leitung und Überwachung börsennotierter Unternehmen in der Rechts- und Wirtschaftspraxis", Schäffer-Poeschel Verlag, Stuttgart. • Krieger/Schneider (2010): "Handbuch Managerhaftung: Vorstand, Geschäftsführer, Aufsichtsrat, Pflichten und Haftungsfolgen, typische Risikobereiche", Otto Schmidt Verlag, Köln. Weitere Quellen werden unter Umständen noch während der Veranstaltung bekanntgegeben.	

Examination Written examination / Duration of Examination: 90 minutes	

Module ISM-MDI-M Managing Digital Innovation *Managing Digital Innovation*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Daniel Beimborn		
Contents: Unternehmen aller Branchen arbeiten darauf hin, ihre Produkte, Services und Geschäftsmodelle durch digitale Innovationen zu transformieren, um erfolgreich am Markt bestehen zu bleiben und die Vorteile digitaler Technologien für ihr Geschäft zu nutzen. Bekannte Beispiele wie Uber vs. Taxibranche, AirBnB vs. Hotellerie, Netflix vs. Medienindustrie zeigen, dass auf digitalen Technologien basierende Geschäftsmodelle in der Lage sind, große Unternehmen und ihr Geschäft substanziell zu gefährden. In diesem Kontext haben Wirtschaftsinformatik und Informationssystemmanagement die strategische Aufgabe, Unternehmen bestmöglich bei der Innovationsfindung und -realisierung zu unterstützen; es wird sogar zunehmend zur Kernaufgabe unserer Disziplin, die Frage zu beantworten, wie mit Hilfe von digitalen Technologien und Daten ein strategischer Innovationsbeitrag für den Erfolg von Unternehmen geleistet werden kann. Das Modul MDI beschäftigt sich mit modernen Management-Ansätzen, die von Unternehmen eingesetzt werden, um digitale Strategien zu entwickeln sowie digitale Innovationen zu identifizieren und erfolgreich im Markt zu positionieren. Auf Basis einer Betrachtung moderner digitaler Innovationstheorien und der Besonderheiten digitaler Technologien werden die Anforderungen an die Gestaltung eines digitalen Innovationsmanagements betrachtet und Umsetzungsstrategien beleuchtet. Dabei werden Ansätze des Strategy Management, Innovation Management und Marketing mit denen der Information-Systems-Disziplin integriert.		
Learning outcomes: none		
prerequisites for the module: none		
Recommended prior knowledge: Grundlagen der Wirtschaftsinformatik z.B. ISM-EidWI-B, Informationsmanagement z.B. SNA-WIM-B.		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Managing Digital Innovation **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Daniel Beimborn **Language:** German **Frequency:** every winter semester **Learning outcome:** Nach Absolvierung des Kurses haben die Studierenden ein Verständnis für die Herausforderungen, Ziele und Ansätze digitaler Strategieentwicklung und digitalen Innovationsmanagements entwickelt. Sie sind in der Lage, digitale Geschäftsmodelle zu entwerfen und organisatorische Strukturen für ein digitales Innovationsmanagement zu definieren zu gestalten sowie mittels geeigneter Managementansätze ein Vorgehen zu deren Realisierung zu schaffen.	**4,00 Weekly Contact Hours**

Contents:

Der Kurs orientiert sich an folgender Gliederung (vorbehaltlich Änderungen):

1.) Grundlagen von Innovationsmanagement digitaler Innovation

2.) Theoretische Grundlagen digitaler Innovation

3.) Spezifische Charakteristika digitaler Technologien à Notwendigkeit für ein Digital Innovation Management

4.) Typen digitaler Geschäftsmodelle und Entwicklung einer Digital Business Strategy

5.) Digital Innovation Discovery: Identifizieren neuer digitaler Innovationen und Geschäftsmodelle

6.) Digital Innovation Diffusion: Erfolgreiches Rollout und Verankerung der digitalen Innovationen/Geschäftsmodelle im Markt

7.) Ethische und gesellschaftliche Implikationen

Der Arbeitsaufwand von 180 akademischen Stunden gliedert sich in etwa wie folgt:

- 56 Stunden: Teilnahme am Präsenzunterricht
- 80 Stunden: für Vor- und Nachbereitung des Präsenzunterrichts

(Recherchieren und Lesen von Literatur und Fallstudien, Bearbeitung von Übungsaufgaben zur Lernzielkontrolle. Erstellung von Konzepten und Präsentationen (tlw. Gruppenarbeiten))

Literature:

Literatur: Die konkret verwendete Literatur wird jeweils im Unterricht bzw. über die elektronische Lernplattform (VC) bekannt gegeben. Teilweise müssen Fallstudien erworben werden.

Grundlegende Quellen sind:

- Hoffmeister (2013): Digitale Geschäftsmodelle richtig einschätzen. Hanser-Verlag, München.
- Kreutzer, Neugebauer, Pattloch (2017): Digital Business Leadership. Springer Gabler, Heidelberg.
- March (1991): Exploration and Exploitation in Organizational Learning. Organization Science 2 (1), pp. 71-87.
- McAfee, Brynjolfsson (2017): Machine, Platform, Crowd: Harnessing our Digital Future. Norton & Company.
- Osterwalder, Pigneur (2010): Business Model Generation. John Wiley & Sons.
- Osterwalder, Pigneur, Bernarda, Smith (2014): Value Proposition Design. John Wiley & Sons.
- Parker, van Alstyne, Choudary (2017): Platform Revolution – How Networked Markets Are Transforming and How to Make Them Work for You. Norton & Company.

- Schilling (2017): Strategic Management of Technological Innovation. McGraw-Hill. - Weill, Woerner: What's your Digital Business Model? Harvard Business Review Press, 2018. - Westerman, Bonnet, McAfee (2014): Leading Digital – Turning Technology into Business Transformation. Harvard Business Review Press. - Zahra, George (2002): Absorptive Capacity: A Review, Reconceptualization, and Extension, Academy of Management Review (22) 2, pp. 185-203.	
Examination Written examination / Duration of Examination: 60 minutes **Description:** In der Klausur werden die im Modul (Vorlesung, Übung, Readings) behandelten Inhalte geprüft. Es können 60 Punkte erzielt werden. Durch die aktive Mitarbeit im Unterricht können Bonuspunkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne diese Bonuspunkte bestanden ist. Eine Bewertung von 1,0 kann auch ohne Bonuspunkte erreicht werden.	

Module ISM-MDT-M Managing Digital Transformation *Managing Digital Transformation*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Daniel Beimborn		
Contents: Unternehmen aller Branchen sehen sich seit einigen Jahren enormem Druck ausgesetzt, ihre Produkte, Services, Geschäftsprozesse und Geschäftsmodelle durch digitale Innovationen zu transformieren, um nicht durch neue Player vom Markt verdrängt zu werden. Bekannte Beispiele wie Uber vs. Taxibranche, AirBnB vs. Hotellerie, Netflix vs. TV-Medienindustrie zeigen, dass auf digitalen Technologien basierende Geschäftsmodelle in der Lage sind, große Unternehmen und ihr Geschäft substanziell zu gefährden. In diesem Kontext haben Wirtschaftsinformatik und Informationssystemmanagement die strategische Aufgabe, Unternehmen bestmöglich bei der Innovationsfindung und -umsetzung zu unterstützen; es wird sogar zunehmend zur Kernaufgabe unserer Disziplin, die Frage zu beantworten, wie mit Hilfe von digitalen Technologien und Daten ein strategischer Innovationsbeitrag für den Erfolg von Unternehmen geleistet werden kann. Das Modul MDT beschäftigt sich mit modernen Management-Ansätzen, die von Unternehmen eingesetzt werden, um digitale Innovationen zu implementieren und die auf deren Basis die eigenen Geschäftsmodelle, Strukturen, Abläufe und Architekturen transformieren. So beschäftigt sich der Kurs mit der Schaffung neuer „digitaler“ Rollen (Chief Digital Officers u.a.) und Organisationseinheiten (Digital Innovation Labs etc.), der kompletten Neustrukturierung von Aufbauorganisationen (bspw. Scaled Agile, Implementierung von Squads & Tribes entsprechend des Spotify-Konzepts), der Implementierung eines auf digitale Ergebnisse orientierten betrieblichen Innovationsmanagements, der Verzahnung mit dem Unternehmensarchitekturmanagement sowie der überbetrieblichen Umgestaltung eines digitalen Ökosystems.		
Learning outcomes: Nach Absolvierung des Kurses haben die Studierenden ein Verständnis für die Herausforderungen, Ziele und Ansätze digitaler Transformation entwickelt. Sie sind in der Lage, aus ganzheitlicher Perspektive Geschäftsmodelle und zugrundeliegende Organisations- und IT-Strukturen zu gestalten und mittels geeigneter Managementansätze ein Vorgehen zu deren Umsetzung zu implementieren.		
prerequisites for the module: none		
Recommended prior knowledge: Grundlagen der Wirtschaftsinformatik (z.B. aus dem Bachelorstudium ISM-EidWI-B), Unternehmensarchitekturmanagement (z.B. aus dem Bachelorstudium IIS-EAM-B), Informationsmanagement (z.B aus dem Bachelorstudium SNA-WIM-B).		**Admission requirements:** keine
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** Semester

Module Units	
Managing Digital Transformation **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Daniel Beimborn **Language:** German	**4,00 Weekly Contact Hours**

Frequency: every summer semester

Contents:

Der Kurs orientiert sich an folgender Gliederung (vorbehaltlich Änderungen):

- 1.) Grundlagen von digitaler Innovation und digitaler Transformation
- 2.) Digital Innovation Discovery: Identifizieren neuer digitaler Innovationen und Geschäftsmodelle
- 3.) Digital Innovation Implementation: Implementieren neuer Innovationen/ Geschäftsmodelle und korrespondierende Transformation der Organisation (Strukturen, IT, Kultur, Ökosystem)
- 4.) Digital Innovation Diffusion: Erfolgreiches Rollout und Verankerung der digitalen Innovationen/Geschäftsmodelle im Markt
- 5.) Digital Innovation Impact: Nachhaltige Erwirtschaftung des aus digitalen Innovationen resultierenden Werts sowie ethische und gesellschaftliche Implikationen digitaler Transformation

Der Schwerpunkt wird auf Abschnitt 3 „Digital Innovation Implementation“ liegen.

Ein zukünftiges weiteres Mastermodul „Managing Digital Innovation“ wird im Wintersemester den Fokus komplementäre auf die Abschnitte 2 und 4 legen, während die Abschnitte 1 und 5 in beiden Teilen eine begleitende Rolle spielen.
Organisatorische Hinweise:

Dieser Kurs unterscheidet nicht zwischen Vorlesung und Übung, sondern

vermittelt die Konzepte in Form eines seminaristischen, fallstudienbasierten, interaktiven Unterrichts im Rahmen von wöchentlichen Blöcken zu je 4 akademischen Stunden.
Eine Vorab-Anmeldung zu dem Kurs ist notwendig (s. Lehrstuhl-Website)

und es wird aktive Mitarbeit sowie die dafür nötige Vor- und Nachbereitung erwartet – typischerweise ist pro Woche ein Reading/Fallstudie zu lesen und vorzubereiten. (Studierende, die nicht regelmäßig im Unterricht anwesend sind, bekommen ihren Status als Kursteilnehmer wieder entzogen.) Klausurrelevant sind alle Unterrichtsmaterialien und vor allem auch die gemeinsam im Unterricht erarbeiteten Konzepte.
Die Teilnehmer und Teilnehmerinnen werden nach ihrer Anmeldung im

entsprechenden VC-Kurs eingetragen und darüber mit allen Informationen, der Lektüre und den (Haus-)Aufgaben/Assignments versorgt.
Es wird angestrebt, den Kurs durch Praxisvorträge und Workshops mit

Unternehmenspartnern anzureichern. Diese Planung findet jedoch aufgrund der Verfügbarkeit von Unternehmensvertretern kurzfristiger statt – die angemeldeten Kursteilnehmer erhalten die entsprechenden Informationen dann via VC-Kurs.

Literature:

Die konkret verwendete Literatur wird jeweils im Unterricht bzw. über die

elektronische Lernplattform (VC) bekannt gegeben. Teilweise müssen Fallstudien erworben werden.
Grundlegende Quellen sind:

• McAfee, Brynjolfsson: Machine, Platform, Crowd: Harnessing our Digital Future. Norton & Company, 2017. • Rogers: The Digital Transformation Playbook. Columbia Business School Publishing, 2016. • Parker, van Alstyne, Choudary: Platform Revolution – How Networked Markets Are Transforming and How to Make Them Work for You. Norton & Company, 2017. • Uhl, Gollenia: Digital Enterprise Transformation – A Business-Driven Approach to Leveraging Innovative IT • Weill, Woerner: What's your Digital Business Model? Harvard Business Review Press, 2018. • Westerman, Bonnet, McAfee: Leading Digital – Turning Technology into Business Transformation. Harvard Business Review Press, 2014.	

Examination Written examination / Duration of Examination: 60 minutes	

Module ISM-SaaS-B Recent Trends and Perspectives of Enterprise Software: Cloud, Consumerization, Big Data *Aktuelle Trends und Perspektiven der Unternehmenssoftware: Cloud, Consumerization, Big Data*	3 ECTS / 90 h
(since WS19/20) Person responsible for module: Dr. Wolfgang Faisst	

Contents:

Die Veranstaltung zeigt einen Blick aus der Praxis auf den Bereich der betriebswirtschaftlichen Standardsoftware bzw. Unternehmenssoftware entlang des Software-Lebenszyklus von der Entwicklung, über den Verkauf, bis hin zum Betrieb aus Sicht von Kunden und Softwareherstellern. Dabei beleuchtet der Dozent die drei wichtigsten Trends im Bereich der Unternehmenssoftware: **Cloud**, **Consumerization** und **Big Data**.

Unter dem Begriff **„Cloud“** lassen sich Themen wie „Software-as-a-Service“, „Platform-as-Service“ und „Cloud Computing“ zusammenfassen, also die Lieferung von IT-Leistungen „aus der Steckdose“. Mit Software-as-a-Service (SaaS) kommt eine neue Generation der Standardsoftware. Dies wird begleitet durch einfache Preismodelle, die sich nahezu komplett an der Nutzung der Software orientieren. Dabei betreibt der Softwarehersteller zumeist die Lösungen für den Kunden in großen „Cloud-Computing-Fabriken“, so dass dieser mit einem Mindestmaß an eigenen IT-Ressourcen und IT-Kompetenzen auskommt. Um speziellen Anforderungen bestimmter Nischen oder Industrien gerecht zu werden, stellen Software-Anbieter neben der eigentlichen SaaS-Lösung Plattformen bzw. Platform-as-a-Service-Angebote bereit, die es unabhängigen Softwareanbietern ermöglichen, eigene Anwendungen mittels hochproduktiver Werkzeuge nicht nur zu erstellen, sondern auch zu vertreiben und zu warten.

„Consumerization“ beschreibt den Effekt, dass Unternehmenssoftware insbesondere durch die Entwicklungen im Konsumentenbereich beeinflusst wird. Während in der Vergangenheit der Unternehmenssektor der Schrittmacher für Fortschritt im IT-Bereich war, ist dies etwa mit dem Aufkommen von Online-Shopping (z. B. über Amazon) oder auch der breiten Nutzung von mobilen Endgeräten (z. B. Apple oder Android) immer mehr der Konsumentenbereich. Die in ihren privaten Leben damit „ausgebildeten“ Mitarbeiter verlangen, dass die Software im Unternehmen ähnlich einfach, durchgängig und insbesondere auf mobilen Endgeräten überall nutzbar ist.

„Big Data“ beinhaltet die Auswertung sehr großer Datenmengen mittels mathematischer Verfahren in Echtzeit. Big Data wird gefördert durch technologische Entwicklungen wie Mehr-Kern-Prozessoren und damit verbundener paralleler Verarbeitung in Kombination mit Hauptspeicher-Datenbanken („In-memory“-Datenbanken) sowie darauf hin angepasster Anwendungssoftware. Insbesondere In-memory-Datenbanken erlauben es, analytische (OLAP) und transaktionale (OLTP) Verarbeitung in Echtzeit auf der gleichen Datenbank durchzuführen.

Learning outcomes:

- Überblick zu den wichtigsten Trends und aktuellen Konzepten im Bereich der Unternehmenssoftware
- Verständnis zu Nutzenpotenzialen und Herausforderungen der aktuellen Konzepte "Cloud","Consumerization" und "Big Data" anhand praktischer Beispiele
- Erlernen ausgewählter Managementpraktiken eines Softwareherstellers entlang des Software-Lebenszyklus von der Entwicklung, über den Verkauf, bis hin zum Betrieb
- Vertiefung der Lerninhalte anhand einer Projektarbeit in einem (zufällig ausgewählten) Arbeitsteam inkl. Vermittlung der Ergebnisse an die Kommilitonen mittels einer Präsentation

prerequisites for the module:

none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Aktuelle Trends und Perspektiven der Unternehmenssoftware: Cloud, Consumerization, Big Data **Mode of Delivery:** Lectures and Practicals **Lecturers:** Dr. Wolfgang Faisst **Language:** German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**

Contents:

Der Dozent veranschaulicht die Themen jeweils anhand von Demos ausgewählter

Anwendungen sowie Videos von namhaften Experten zu den jeweiligen Trends.

Gliederung

1. Introduction
2. Market Overview
   a) Key Players
   b) Market Perspective
   c) Customer Perspective
   d) Innovation Perspective
3. New Applications
   a) Cloud Applications
   b) Mobile Applications
   c) Big Data Applications
   d) Synthesis: Next Generation Enterprise Software
4. New Ways of Operations & Infrastructure
   a) Parallel Computing & Virtualization
   b) Mega-scale Data Center
   c) Cloud Operations
   d) Engineering Approach
5. New Ways of Co-innovation
   a) Design Approach
   b) Lean Development
   c) Platform-as-a-Service
   d) Ecosystem Co-innovation
   e) Platform Leadership
6. New Ways to Sell & Buy
   a) Internet Economics
   b) Software-as-a-Service
   c) New Sales Models
   d) Appstore Model
   e) Applification

7. Summary & Outlook	

Examination Written examination / Duration of Examination: 90 minutes	

<table>
<tr><td colspan="2">Module KInf-DigBib-B Digital Libraries and Social Computing
Digitale Bibliotheken und Social Computing</td><td>6 ECTS / 180 h
45 h Präsenzzeit
135 h Selbststudium</td></tr>
<tr><td colspan="3">(since WS17/18)
Person responsible for module: Prof. Dr. Christoph Schlieder</td></tr>
<tr><td colspan="3">Contents:
Das Modul führt ein in die Grundlagen Digitaler Bibliotheken und in die Verwaltung von Wissensbeständen mit Verfahren des Social Computing. Es besteht aus zwei Lehrveranstaltungen: einer Vorlesung, die Konzepte und Methoden vermittelt sowie einer Übung, in der die Anwendung der Methoden auf konkrete Problemstellungen eingeübt wird.

Eine weitergehende Inhaltsbeschreibung findet sich bei den Lehrveranstaltungen.</td></tr>
<tr><td colspan="3">Learning outcomes:
Die Studierenden lernen Grundbegriffe sowie wichtige Methoden aus dem Bereich der Digitalen Bibliotheken und Social Computing kennen. Sie erwerben folgende Kompetenzen:
grundlegende Datenmodelle und Funktionen von digitalen Bibliotheken und Archiven zu vergleichen und in Bezug auf eine fachliche Problemstellung zu bewerten
grundlegende Methoden des Social Computing auf die Verwaltung von textuellen und nicht-textuellen Wissensbeständen anzuwenden</td></tr>
<tr><td colspan="3">Remark:
Der Arbeitsaufwand für dieses Modul gliedert sich grob wie folgt:
• Teilnahme an Vorlesung und Übung: 45 Stunden
• Vor- und Nachbereitung der Vorlesung: 15 Stunden
• Vor- und Nachbereitung der Projektübung inkl. Recherche und Studium
zusätzlicher Quellen aber ohne Bearbeitung der Projektübungsaufgaben: 30
Stunden
• Bearbeiten der Projektübungsaufgaben: 60 Stunden
• Prüfungsvorbereitung: 30 Stunden</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Grundkenntnisse in Algorithmen und Datenstrukturen, wie sie in dem empfohlenen Modul vermittelt werden

Module Algorithms and Data Structures (MI-AuD-B) - recommended</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>Digitale Bibliotheken und Social Computing
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Christoph Schlieder
Language: German
Frequency: every winter semester
Contents:</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

Digitale Bibliotheken im engeren Sinne organisieren Bestände digitaler Dokumente wie Texte, Bilder, Filme oder Tonaufzeichnungen und bieten diese über verschiedene Bibliotheksdienste den Nutzern an. Im Vordergrund steht dabei das Problem, die Inhalte der Bibliothek auf einheitliche und intuitive Weise zugänglich zu machen, d.h. das Problem der Informationssuche. Jenseits dieser klassischen Funktionen befassen sich digitale Bibliotheken im weiteren Sinn auch mit Fragen der Analyse von Inhalten und der Organisation von Wissensbeständen (Content Management, Knowledge Management). So helfen beispielsweise Technologien der Informationsvisualiserung beim Navigieren im Inhaltsangebot. Mit Methoden des Social Computing lässt sich einerseits die Vernetzung der Inhalte (Links, Zitationen, ...) andererseits die Vernetzung der Inhalte mit Akteuren (Autoren, Lesern) erfassen. Behandelt werden in diesem Zusammenhang Verfahren der Zitationsanalyse und Ansätze für Recommender Systems. **Literature:** Arms, William (2001): Digital libraries. Cambridge, MA: MIT Press. Langville, A. & Meyer, C. (2006): Google's PageRank and beyond. The Science of Search Engine Rankings. Princeton, N.J: Princeton University Press. Breslin, J., Passant, A. & Decker, S. (2009): The Social Semantic Web. Berlin: Springer.	
Examination Written examination / Duration of Examination: 60 minutes **Description:** In der schriftlichen Prüfung werden die in der Vorlesung behandelten Themengebiete geprüft. Die Note der Klausur geht zu 50% in die Modulnote ein.	

Module Units	
Digitale Bibliotheken und Social Computing **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Angewandte Informatik in den Kultur-, Geschichts- und Geowissenschaften **Language:** German **Frequency:** every winter semester **Contents:** Die Projektübung bietet eine praktische Vertiefung zu Themen der Digitalen Bibliotheken. Anhand wechselnder Themenstellungen wird das konzeptuelle Herangehen an Problemstellungen im Bereich Digitaler Bibliotheken sowie das Entwickeln passender Softwarelösungen eingeübt.	**2,00 Weekly Contact Hours**
Examination Coursework Assignment, Hausarbeit / Duration of Coursework: 4 months **Description:** Die Hausarbeit besteht aus der schriftlichen Bearbeitung von 3-6 im Laufe des Semesters gestellten Übungsaufgaben. Die Note der Hausarbeit geht zu 50% in die Modulnote ein.	

Module KInf-GeoInf-B Geographical Information Systems

Geoinformationssysteme

6 ECTS / 180 h
45 h Präsenzzeit
135 h Selbststudium

(since WS17/18)
Person responsible for module: Prof. Dr. Christoph Schlieder

Contents:
Das Modul führt ein in die Grundlagen der Geoinformationsverarbeitung. Es besteht aus zwei Lehrveranstaltungen: einer Vorlesung, die Konzepte und Methoden vermittelt sowie einer Übung, in der die Anwendung der Methoden auf konkrete Problemstellungen eingeübt wird.

Eine weitergehende Inhaltsbeschreibung findet sich bei den Lehrveranstaltungen.

Learning outcomes:
Die Studierenden lernen Grundbegriffe sowie wichtige Methoden aus dem Bereich der Geoinformationssysteme kennen. Sie erwerben folgende Kompetenzen:

- fachliche Anforderungen im Hinblick auf die Geodatenmodellierung zu analysieren und passende Geodatenmodelle zu erstellen
- geoinformatische Analyseverfahren vergleichend zu bewerten und die für ein Anwendungsproblem geeigneten Verfahren zu identifizieren.

Remark:
Der Arbeitsaufwand für dieses Modul glieder sich grob wie folgt:

- Teilnahme an Vorlesung und Übung: 45 Stunden
- Vor- und Nachbereitung der Vorlesung: 30 Stunden
- Vor- und Nachbereitung der Übung inkl. Recherche und Studium zusätzlicher Quellen aber ohne Bearbeitung der Übungsaufgaben: 30 Stunden
- Bearbeiten der Übungsaufgaben: 45 Stunden
- Prüfungsvorbereitung: 30 Stunden

prerequisites for the module:
none

Recommended prior knowledge:
Grundkenntnisse der Informatik, wie sie in den empfohlenen Modulen vermittelt werden

Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended
Module Informatik und Programmierung für die Kulturwissenschaften (KInf-IPKult-E) - recommended

Admission requirements:
none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Geoinformationssysteme
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Christoph Schlieder
Language: German

2,00 Weekly Contact Hours

Frequency: every summer semester **Contents:** Geoinformationssysteme (GIS) dienen der effizienten Erfassung, Analyse und Bereitstellung georeferenzierter Daten. Die Lehrveranstaltung stellt die grundlegenden Konzepte vor, die der Modellierung von Geodaten zugrunde liegen. Hierzu gehört z.B. die unterschiedliche Repräsentation räumlicher Objekte in Vektor- und Raster-GIS. Weitere Themen sind die Geodaten-Erfassung sowie Ansätze zur Geodatenvisualisierung. Anwendungen der Geoinformationsverarbeitung werden an klassischen Einsatzfeldern (Umweltinformationssysteme) und aktuellen technologischen Entwicklungen (mobile Computing) illustriert. Querverbindungen zum Bereich der Semantischen Informationsverarbeitung ergeben sich vor allem im Zusammenhang mit der Interoperabilität von GIS. **Literature:** Longley, P., Goodchild, M., Maguire, D., Rhind, D. (2001): Geographic Information: Systems and Science, Wiley: Chichester, UK. Shekhar, S., Chawla, S. (2003): Spatial Databases: A Tour, Prentice Hall: Upper Saddle River, NJ. Smith, M., Goodchild, M., and Longley, P. (2007): Geospatial Analysis, 2nd edition, Troubador Publishing Ltd.	
2. Geoinformationssysteme **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Angewandte Informatik in den Kultur-, Geschichts- und Geowissenschaften **Language:** German **Frequency:** every summer semester **Contents:** siehe Vorlesung **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** In der schriftlichen Prüfung werden die in Vorlesung und Übung behandelten Themengebiete geprüft.	

<table>
<tr><td colspan="2">Module KInf-IPKult-E Informatik und Programmierung für die Kulturwissenschaften
Informatik und Programmierung für die Kulturwissenschaften</td><td>9 ECTS / 270 h
45 h Präsenzzeit
135 h Selbststudium</td></tr>
<tr><td colspan="3">(since WS17/18)
Person responsible for module: Prof. Dr. Christoph Schlieder</td></tr>
<tr><td colspan="3">Contents:
Das Modul gibt eine Einführung in die Informatik und die Programmierung, wobei Anwendungen in den Kulturwissenschaften in besonderer Weise berücksichtigt werden. Es besteht aus drei Lehrveranstaltungen: einer Vorlesung, die Konzepte und Methoden vermittelt sowie einer Übung, in der die Anwendung der Methoden auf konkrete Problemstellungen eingeübt wird. Dem Erlernen der Programmierung ist eine eigene Lehrveranstaltung gewidmet, der Programmierkurs.

Eine weitergehende Inhaltsbeschreibung findet sich bei den Lehrveranstaltungen.</td></tr>
<tr><td colspan="3">Learning outcomes:
• Erwerb von Orientierungswissen, das die Zuordnung von Anwendungsproblemen aus den Kulturwissenschaften zu informatischen Lösungsansätzen ermöglicht
• Verständnis der Grundbegriffe und Methoden der Informatik, die für eine effektive und effiziente Nutzung von kulturwissenschaftlichen Anwendungssystemen unerlässlich sind
• Verständnis für den Prozess der Softwareentwicklung, insbesondere für die Aufgabe der Fachanwender in diesem Prozess
• Erwerb elementarer Programmierkenntnisse in der Porgrammiersprache Java und von Orientierungswissen über die objektorientierte Softwareentwicklung</td></tr>
<tr><td colspan="3">Remark:
Der Arbeitsaufwand für dieses Modul gliedert sich grob wie folgt:

• Teilnahme an Vorlesung und Übung: 45 Stunden
• Teilnahme am Programmierkurs: 23 Stunden
• Vor- und Nachbereitung der Vorlesung: 30 Stunden
• Vor- und Nachbereitung der Übung inkl. Recherche und Studium zusätzlicher Quellen aber ohne Bearbeitung der Übungsaufgaben: 52 Stunden
• Bearbeitung der Übungsaufgaben: 90 Stunden
• Prüfungsvorbereitung: 30 Stunden</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Das Modul wendet sich an Studienanfänger aus den Kulturwissenschaften. Kenntnisse der Informatik, insbesondere Programmierkenntnisse, werden nicht vorausgesetzt. Erwartet wird allerdings, dass die Teilnehmerinnen und Teilnehmer mit den Grundzügen der PC-Nutzung vertraut sind.</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><th colspan="2">Module Units</th></tr>
<tr><td>1. Informatik für die Kulturwissenschaften
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Christoph Schlieder
Language: German
Frequency: every semester
Contents:
Die Vorlesung vermittelt informatisches Grundwissen und stellt dieses in Bezug zu Anwendungsproblemen aus den Kulturwissenschaften. Drei inhaltliche Bereiche werden abgedeckt: Grundlagen, Softwareentwicklung und Anwendungssysteme.
Der erste Teil der Vorlesung führt ein in Grundbegriffe und Methoden der Informatik und schafft damit die Voraussetzung für die weitere selbstständige Beschäftigung mit informatischen Inhalten. Behandelt werden u.a. die Codierung von Texten und Bildern, der prinzipielle Aufbau eines Rechners, die Funktionen des Betriebssystems, die Datenhaltung in Datenbanken, der Aufbau von Rechnernetzen und des Internets.
Im zweiten Teil stellt die Vorlesung den Prozess der Softwareentwicklung vor. Es werden Kenntnisse vermittelt, die es kulturwissenschaftlichen Fachanwendern ermöglichen, eine aktive Rolle bei der Entwicklung und Einführung von Informationssystemen einzunehmen. Insbesondere wird auf die Analyse der Anforderungen für ein Informationssystem und die systematische Beschreibung von Anwendungsfällen (Use Cases) eingegangen.
Die wichtigsten Typen von kulturwissenschaftlichen Anwendungssystemen behandelt der dritte Teil der Vorlesung. Schwerpunktmäßig werden digitale Bibliotheken und Geoinformationssysteme vorgestellt. Daneben kommen aber auch Spezialanwendungen (z.B. Dokumentationssysteme für die Baudenkmalpflege) zur Sprache. Vermittelt werden grundlegende Kenntnisse über Funktionsumfang und Aufbau dieser Informationssysteme, die für unterschiedliche Softwareprodukte Gültigkeit haben.
Literature:
Einführungen in die Informatik, die speziell auf die Bedürfnisse der Kulturwissenschaften abgestimmt sind gibt es noch nicht. Die umfangreiche Ratgeberliteratur zur Rechnernutzung für spezielle Fächer („Internet für Theologen“) ist nicht zu empfehlen. Man ist besser bedient mit einem Lehrbuch der Informatik, das man zur Vertiefung neben der Vorlesung und später zum Nachschlagen nutzen kann.
Gumm, H. & Sommer, M (2006). Einführung in die Informatik, 7. Aufl., Oldenbourg Verlag.</td><td>2,00 Weekly Contact Hours</td></tr>
<tr><td>2. Informatik für die Kulturwissenschaften
Mode of Delivery: Practicals
Lecturers: Scientific Staff Angewandte Informatik in den Kultur-, Geschichts- und Geowissenschaften
Language: German</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

Frequency: every semester **Contents:** Die Übung setzt die in der Vorlesung erworbenen Kenntnisse anhand praktischer Aufgaben um. Dabei kommen exemplarische Anwendungssysteme zum Einsatz. Beispielsweise wird ein einfaches Datenbankprojekt konzipiert und mit einem marktgängigen Datenbanksystem umgesetzt. **Literature:** siehe Übung	
Examination Written examination / Duration of Examination: 60 minutes **Description:** Im Rahmen der schriftlichen Prüfung werden der in Vorlesung und Übung behandelten Themengebiete geprüft. Die Klausur geht zu 66,7% in die Modul-Gesamtnote ein, die Hausarbeit zu 33,3%.	

Module Units	
Programmierung Informatik für die Kulturwissenschaften **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Angewandte Informatik in den Kultur-, Geschichts- und Geowissenschaften **Language:** German **Frequency:** every semester **Contents:** Der Programmierkurs führt ein in die objektorientierte Softwareentwicklung anhand der Programmiersprache Java. Der Kurs ist speziell konzipiert für Studierende der Kulturwissenschaften ohne informatische Vorkenntnisse.	**2,00 Weekly Contact Hours**
Examination Coursework Assignment / Duration of Coursework: 4 months **Description:** Die Hausarbeit besteht aus der Lösung von Programmieraufgaben. Die Klausur geht zu 66,7% in die Modul-Gesamtnote ein, die Hausarbeit zu 33,3%.	

Module KInf-MobAss-M Mobile Assistance Systems *Mobile Assistance Systems*		6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS17/18) Person responsible for module: Prof. Dr. Christoph Schlieder		
Contents: The module introduces students into the research literature on mobile assistance systems. It consists of two parts, a lecture and reading course (Vorlesung) which covers methods and lab sessions in which the methods are applied in a software development project (Übung). For more detail refer to the content descrition of the lecture.		
Learning outcomes: After completion of this module, students will be able to • explain and compare the fundamental concepts of mobile assistance systems • describe and analyze methods for geo-positioning and place modeling • critically discuss approaches to specific types of mobile applications such as: • geographic recommender, tourist guides, location-based games, documentation systems		
Remark: The main language of instruction in this course is English. The lab may be delivered in German if all participating students are fluent in German. The total workload of 180 hrs. is split approximately as follows: • 45 hrs. attending lecture and lab sessions • 30 hrs. preparing and reviewing the lectures • 30 hrs. preparing and reviewing the lab sessions • 45 hrs. working on the written assignment • 30 hrs. preparation for the exam		
prerequisites for the module: none		
Recommended prior knowledge: Students are expected to come with general programming and software engineering skills and to be familiar with formal methods in computer science		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Mobile Assistance Systems **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Angewandte Informatik in den Kultur-, Geschichts- und Geowissenschaften **Language:** English **Frequency:** every summer semester **Contents:**	**2,00 Weekly Contact Hours**

Students solve a small number of programming problems related to mobile assistance systems. The software is developed in Android and typically tested on GPS smartphones. Students should come with basic Java programming skills and can familiarize themselves with Android during the course. Solutions to the programming problems are presented by the students in a colloquium (20 min) at the end of the semester. **Literature:** Literature and online ressouces are presented in the course.	
Examination Colloquium / Duration of Examination: 20 minutes **Description:** In the lab, students are working on a software development project. At the end of the semester, each student presents the results of her or his lab project (Kolloquium). The grade for the lab project contributes 50% to the final grade.	

Module Units	
Mobile Assistance Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Christoph Schlieder **Language:** English/German **Frequency:** every summer semester **Contents:** A digital travel guide running on a smart phone and a CAD-based system for the documentation of built heritage with a TabletPC are two examples of software solutions designed to assist mobile users, that is, examples of mobile assistance systems. The course introduces students to the research literature on mobile assistance systems and enables them to put concepts and methods into practice. Introductions to positioning technologies, place models, and mobile applications such as geographic recommender or location-based games are presented in form of a lecture. Other parts of the material are organized in form of a reading course in which the students critically analyze and discuss the research literature. **Literature:** Taylor, George and Blewitt, Geoff (2006): Intelligent Positioning: GIS-GPS Unification, Wiley & Sons, ISBN 0470850035 Further literature is presented in the course.	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 60 minutes **Description:** The written exam covers the material of the reading couse. The grade of the written exam contributes 50% to the final grade.	

<table>
<tr><td colspan="2">Module KInf-Projekt-B Bachelor Project Computing in the Cultural Sciences
Bachelorprojekt Kulturinformatik</td><td>6 ECTS / 180 h
45 h Präsenzzeit
135 h Selbststudium</td></tr>
<tr><td colspan="3">(since WS18/19)
Person responsible for module: Prof. Dr. Christoph Schlieder</td></tr>
<tr><td colspan="3">Contents:
Das Modul behandelt die praktische Anwendung grundlegender Methoden aus dem Bereich der Kulturinformatik im Rahmen eines Softwareentwicklungsprojekts. Die behandelten Problemstellungen stammen aus den Anwendungsfeldern der Angewandten Informatik der Kultur-, Geschichts- und Geowissenschaften.</td></tr>
<tr><td colspan="3">Learning outcomes:
Die Studierenden lernen im Projekt wie man mit Methoden der Kulturinformatik eine Softwarelösung für eine Problemstellung entwickelt. Sie erwerben folgende Kompetenzen:
grundlegende Methoden aus dem Bereich der Kulturinformatik auf eine fachliche Problemstellung anzuwenden
ein Softwareentwicklungsprojekt unter Anleitung zu planen und selbständig durchzuführen
eine Softwarelösung zu konzipieren und zu implementieren
einen Lösungsansatz sowohl aus der Fachsicht wie in seinen informatischen Details darzustellen</td></tr>
<tr><td colspan="3">Remark:
Der Arbeitsaufwand für dieses Modul gliedert sich grob wie folgt:
Teilnahme an Gruppen- und Einzelbesprechungen: 45 Stunden
Vor- und Nachbereitung inkl. Recherche und Studium zusätzlicher Quellen aber ohne Bearbeitung der Projektaufgaben: 30 Stunden
Bearbeiten der Projektaufgaben: 90 Stunden
Kolloquiumsvorbereitung: 15 Stunden</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Die Inhalte der Veranstaltungen "Algorithmen und Datenstrukturen" sowie "Softwaretechnik" (oder entsprechende Vorkenntnisse) werden vorausgesetzt.
Module Algorithms and Data Structures (MI-AuD-B) -</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>Bachelorprojekt Kulturinformatik
Mode of Delivery: Practicals
Lecturers: Prof. Dr. Christoph Schlieder, Scientific Staff Angewandte Informatik in den Kultur-, Geschichts- und Geowissenschaften
Language: German
Frequency: every winter semester
Contents:</td><td>4,00 Weekly Contact Hours</td></tr>
</table>

Wechselnde Themen aus dem Bereich der Kulturinformatik **Literature:** Aktuelle Literatur wird in der Veranstaltung vorgestellt.	

Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Im Laufe des Semesters wird eine größere Softwareentwicklungsaufgabe bearbeitet und in Form einer Hausarbeit dokumentiert. Im Kolloquium stellen die Teilnehmer ihren Arbeitsprozess und ihr Arbeitsergebnis vor. In die Leistungsbewertung geht die Hausarbeit zu 67% und das Kolloquium zu 33% ein.	

Module KInf-Projekt-M Master Project Computing in the Cultural Sciences *Masterprojekt Kulturinformatik*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium

(since WS17/18)
Person responsible for module: Prof. Dr. Christoph Schlieder

Contents:
Das Modul behandelt die praktische Anwendung fortgeschrittener Methoden aus dem Bereich der Kulturinformatik im Rahmen eines Softwareentwicklungsprojekts. Der Schwerpunkt liegt auf Methoden der Semantischen Informationsverarbeitung, wobei die behandelten Problemstellungen aus den Anwendungsfeldern der Angewandten Informatik der Kultur-, Geschichts- und Geowissenschaften stammen.

Learning outcomes:
Die Studierenden lernen im Projekt wie man mit Methoden der Kulturinformatik eine Softwarelösung für eine Problemstellung entwickelt. Sie erwerben folgende Kompetenzen:

- fortgeschrittene Methoden aus dem Bereich der Kulturinformatik, insbesondere Verfahren der Semantischen Informationsverarbeitung, auf eine fachliche Problemstellung anzuwenden
- ein Softwareentwicklungsprojekt selbständig zu planen und durchzuführen
- eine Softwarelösung zu konzipieren und zu implementieren
- einen Lösungsansatz sowhl aus der Fachsicht wie in seinen informatischen Details darzustellen

Remark:
Der Arbeitsaufwand für dieses Modul gliedert sich grob wie folgt:

- Teilnahme an Gruppen- und Einzelbesprechungen: 45 Stunden
- Vor- und Nachbereitung inkl. Recherche und Studium zusätzlicher Quellen aber ohne Bearbeitung der Projektaufgaben: 30 Stunden
- Bearbeiten der Projektaufgaben: 90 Stunden
- Kolloquiumsvorbereitung: 15 Stunden

prerequisites for the module:
none

Recommended prior knowledge: Allgemeine Informatik-Kenntnisse in den Bereichen Programmierung und formale Methoden	**Admission requirements:** none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Masterprojekt Kulturinformatik **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Christoph Schlieder, Scientific Staff Angewandte Informatik in den Kultur-, Geschichts- und Geowissenschaften **Language:** German **Frequency:** every summer semester **Contents:**	**4,00 Weekly Contact Hours**

Das Projekt bietet eine praktische Vertiefung zu Themen der Semantischen Informationsverarbeitung. Anhand wechselnder Themenstellungen wird das selbstständige Entwickeln von Softwarelösungen in diesem Bereich eingeübt. Im Projekt werden alle Phasen des Entwicklungsprozesses, von einer umfassenden Problemanalyse über den Systementwurf bis zur Implementierung durchlaufen. Die bearbeiteten Themenstellungen stammen beispielsweise aus dem Bereich der ontologischen Wissensmodellierung. **Literature:** Aktuelle Literatur wird in der Lehrveranstaltung vorgestellt.	

Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Im Laufe des Semesters wird eine größere Softwareentwicklungsaufgabe bearbeitet und in Form einer Hausarbeit dokumentiert. Im Kolloquium stellen die Teilnehmer ihren Arbeitsprozess und ihr Arbeitsergebnis vor.	

Module KInf-SemInf-M Semantic Information Processing *Semantische Infomationsverarbeitung*		6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS19/20) Person responsible for module: Prof. Dr. Christoph Schlieder		
Contents: The module introduces students into the research field of semantic information processing. It consists of two parts, a lecture (Vorlesung) which covers the basic methods and lab sessions in which the methods are applied to problems (Übung). For more detail refer to the content descritiption of the lecture.		
Learning outcomes: After completion of this module, students will be able to • explain and compare the fundamental concepts of semantic information processing • describe and analyze methods for problem solving by heuristic search • critically discuss different approaches to knowledge representation • select algorithms that are appropriate for a given type of application problem		
Remark: The main language of instruction in this course is English. The lab sessions may be delivered in German if all participating students are fluent in German. The total workload of 180 hrs. is split approximately as follows: • 45 hrs. attending lecture and lab sessions • 30 hrs. preparing and reviewing the lectures • 30 hrs. preparing and reviewing the lab sessions • 45 hrs. working on the written assignment • 30 hrs. preparation for the exam		
prerequisites for the module: none		
Recommended prior knowledge: Students are expected to come with general programming skills and to be familiar with formal methods in computer science		**Admission requirements:** keine
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures on Semantic Information Processing **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Christoph Schlieder **Language:** German **Frequency:** every winter semester **Contents:** Semantic information processing addresses problems in which software systems need to represent knowledge, not just data. Facts from different knowledge	**2,00 Weekly Contact Hours**

sources are combined and integrated by machine reasoning processes. The services of the Semantic Web provide a prominent example for applications that make extensive use of knowledge representation and reasoning. The lecture introduces into the computational methods and tools for semantic information processing which have been developed by Artificial Intelligence research. Topics covered include problem solving by heuristic search, constraint solving, search strategies for games, representations for domain-specific knowledge, reasoning with formal ontologies, technologies of the Semantic Web, machine learning and knowledge discovery. The design of intelligent agents and agent systems is adopted as unifying perspective for presenting the material. Applications from different fields such as geographic information systems, digital libraries, and social computing illustrate how the methods from semantic information processing are used to build intelligent assistant systems. **Literature:** Russell, S., Norvig, P. & Davis, E. (2010): Artificial Intelligence. A Modern Approach. 3rd. Upper Saddle River: Prentice Hall. Hitzler, P.; Krötzsch, M.; Rudolph, S. (2010): Foundations of Semantic Web technologies. CRC Press	
2. Übung Semantische Informationsverarbeitung **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Angewandte Informatik in den Kultur-, Geschichts- und Geowissenschaften **Language:** German **Frequency:** every winter semester **Contents:** The course applies the concepts and methods taught in the lecture by solving practical exercises. Most of the exercises can be completed with paper and pencil while some include programming in Java or working with software tools for semantic information processing. The solutions to the exercises are prepared as homework and presented by the students during the lab sessions. **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** The written exam covers the material presented in the lecture and the lab sessions	

<table>
<tr><td>Module KTR-Datkomm-B Data communication
Datenkommunikation</td><td>6 ECTS / 180 h
45 h Präsenzzeit
135 h Selbststudium</td></tr>
<tr><td colspan="2">(since WS17/18)
Person responsible for module: Prof. Dr. Udo Krieger</td></tr>
<tr><td colspan="2">Contents:
Diese Lehrveranstaltung behandelt die technischen Grundlagen der öffentlichen, betrieblichen und privaten Rechnerkommunikation in lokalen Netzen und Weitverkehrsnetzen sowie grundlegende Aspekte ihres Diensteangebots. Es werden die geläufigsten Dienste-, Netz- und Protokollarchitekturen öffentlicher und privater Datenkommunikationsnetze wie das OSI-Referenzmodell bzw. die TCP/IP-Protokollfamilie mit aufgesetzten Dateitransfer, World Wide Web und Multimedia-Diensten vorgestellt.

Ferner werden die Grundprinzipien der eingesetzten Übertragungsverfahren, der Übertragungssicherungs- und Steuerungsalgorithmen und der wichtigsten Medienzugriffsverfahren diskutiert, z.B. geläufige Übertragungs- und Multiplextechniken wie FDMA, TDMA, CDMA, Medienzugriffstechniken der CSMA-Protokollfamilie inklusive ihrer Umsetzung in LANs nach IEEE802.x Standards, Sicherungsprotokolle der ARQ-Familie sowie Flusskontrollstrategien mit variablen Fenstertechniken und ihre Realisierung im HDLC-Protokoll.

Außerdem werden grundlegende Adressierungs- und Vermittlungsfunktionen in Rechnernetzen wie Paketvermittlung in Routern und Paketverkehrslenkung nach Kürzeste-Wege-Prinzipien bzw. Verkehrslenkung nach dem Prinzip virtueller Wege dargestellt. Darüber hinaus werden die Grundfunktionen der Transportschicht und ihre exemplarische Umsetzung in TCP erläutert.</td></tr>
<tr><td colspan="2">Learning outcomes:
Die Studierenden sollen zu eigenständigem Arbeiten im Bereich moderner Kommunikationsnetze befähigt werden. Es werden Grundkenntnisse der Datenkommunikation und die systematische Analyse der verwendeten Algorithmen mit Hilfe eines interaktiven Konzeptes theoretischer und praktischer Übungsaufgaben vermittelt. Die Studierenden lernen, gegebene Implementierungen der vorgestellten Datenkommunikationsverfahren zu analysieren und durch Messungen im Kommunikationslabor ihr Leistungsverhalten zu überprüfen.</td></tr>
<tr><td colspan="2">Remark:
Der Arbeitsaufwand gliedert sich grob wie folgt:
Teilnahme an Präsenzveranstaltungen (Vorlesung, Übung, Laborbesprechungen): 45 Stunden
Vor- und Nachbereitung von Vorlesungen und Übungen: 100 Stunden
Prüfungsvorbereitung: 35 Stunden</td></tr>
<tr><td colspan="2">prerequisites for the module:
none</td></tr>
<tr><td>Recommended prior knowledge:
erfolgreich abgeschlossene Prüfungen der Grundlagenfächer des Bachelorstudiums, insbesondere Einführung in Algorithmen, Programmierung und Software sowie grundlegende Kenntnisse effizienter Algorithmen
gute Programmierkenntnisse in JAVA (oder C++)
Module Advanced Java Programming (DSG-AJP-B) - recommended</td><td>Admission requirements:
none</td></tr>
</table>

Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended Module Propositional and Predicate Logic (GdI-MfI-1) - recommended		
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Datenkommunikation **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Udo Krieger **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: Diese Lehrveranstaltung behandelt die technischen Grundlagen der öffentlichen, betrieblichen und privaten Rechnerkommunikation in lokalen Netzen und Weitverkehrsnetzen sowie grundlegende Aspekte ihres Diensteangebots. Es werden die geläufigsten Dienste-, Netz- und Protokollarchitekturen öffentlicher und privater Datenkommunikationsnetze wie das OSI-Referenzmodell bzw. die TCP/IP-Protokollfamilie mit aufgesetzten Dateitransfer, World Wide Web und Multimedia-Diensten vorgestellt. Ferner werden die Grundprinzipien der eingesetzten Übertragungs-, Übertragungssicherungs- und Steuerungsalgorithmen und des Medienzugriffs diskutiert, z.B. geläufige Übertragungs- und Multiplextechniken wie FDMA, TDMA und CDMA Medienzugriffstechniken der CSMA-Protokollfamilie inklusive ihrer Umsetzung in LANs nach IEEE802.x Standards, Sicherungsprotokolle der ARQ-Familie sowie Flusskontrollstrategien mit variablen Fenstertechniken und ihre Realisierung. Außerdem werden grundlegende Adressierungs- und Vermittlungsfunktionen in Rechnernetzen wie Paketvermittlung in Routern und Paketverkehrslenkung dargestellt. Darüber hinaus werden die Grundfunktionen der Transportschicht und ihre exemplarische Umsetzung in TCP erläutert. Die Bekanntgabe der Lehrsprache erfolgt in der ersten Sitzung der Lehrveranstalltung.	
Literature: • Lean-Garcia, A., Widjaja, I.: Communication Networks, McGraw-Hill, Boston, 2004 • Tanenbaum, A. S.: Computernetzwerke, Pearson Studium, München, 4. Aufl., 2003 • Kurose, J., Ross, K.W.: Computernetzwerke – ein Top-Down-Ansatz mit Schwerpunkt Internet, Pearson Studium, München, 2014 • Comer, D.: Computernetzwerke und Internets, Pearson Studium, München, 2004 Weitere Angaben und Erläuterungen erfolgen in der 1. Vorlesung.	
2. Datenkommunkation **Mode of Delivery:** Practicals	**2,00 Weekly Contact Hours**

Lecturers: Prof. Dr. Udo Krieger, Scientific Staff Informatik, insbesondere Kommunikationsdienste, Telekommunikationssysteme und Rechnernetze
Language: German/English
Frequency: every winter semester

Contents:
Es werden Grundkenntnisse der Datenkommunikation und die systematische

Analyse der dabei verwendeten Algorithmen mit Hilfe eines interaktiven Übungskonzeptes aus Haus- und Laboraufgaben vermittelt. Vorlesungsbegleitend werden diese Übungsaufgaben zu folgenden Themen bearbeitet:

- Netzentwurfsprinzipien
- OSI-Protokolle
- TCP/IP-Protokollstapel
- Netzelemente
- Datenübertragungssicherungsschicht
- Medienzugriffsschicht

Die Studierenden lernen, gegebene Implementierungen der vorgestellten

Datenkommunikationsverfahren mathematisch und kommunikationstechnisch zu analysieren, durch Messungen ihr Leistungsverhalten zu überprüfen und Vor- bzw. Nachteile der Lösungen zu bewerten.
Die Bekanntgabe der Lehrsprache erfolgt in der ersten Sitzung der

Lehrveranstaltung.

Literature:

- Lean-Garcia, A., Widjaja, I.: Communication Networks, McGraw-Hill, Boston, 2004
- Tanenbaum, A. S.: Computernetzwerke, Pearson Studium, München, 4. Aufl., 2003
- Kurose, J., Ross, K.W.: Computernetzwerke – ein Top-Down-Ansatz mit Schwerpunkt Internet, Pearson Studium, München, 2014
- Comer, D.: Computernetzwerke und Internets, Pearson Studium, München, 2004

Weitere Literatur wird in der Übung benannt.

Examination
Written examination / Duration of Examination: 90 minutes
Description:
Die Inhalte der Vorlesung sowie die Aufgabenstellungen, Lösungen und Erkenntnisse der Übung, die Haus- und Laboraufgaben beinhaltet, werden in Form einer Klausur geprüft.

Im Verlauf des Semesters können durch die Bearbeitung der Laboraufgaben der Übung und die erfolgreiche Bewertung der entsprechenden Teilleistungen eine maximale Anzahl von Bonuspunkten erworben werden. Diese Bonuspunkte werden bei der Notenvergabe des Moduls berücksichtigt, wobei das Bestehen der Modulprüfung die Voraussetzung für die Berücksichtigung dieser individuell erbrachten Bonuspunkte ist. Die Berechnungs-, Vergabe- und Anrechnungsmodalitäten der Bonuspunkteregelung werden zu Beginn der Lehrveranstaltung festgelegt und den Studierenden zur Kenntnis gebracht. Diese

Bonuspunkte stellen eine freiwillige Zusatzleistung dar. Das Bestehen der Modulprüfung ist auch ohne diese Zusatzleistung möglich. Das Erreichen der Note 1.0 ist ebenfalls ohne die Erbringung dieser Zusatzleistung möglich. Die Bekanntgabe der Prüfungssprache erfolgt in der ersten Sitzung der Lehrveranstalltung. Zulässige Hilfsmittel der Prüfung: • Taschenrechner ohne vollständige alphanumerische Tastatur und Grafikdisplay	

Module KTR-GIK-M Foundations of Internet Communication *Grundbausteine der Internet-Kommunikation*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium

(since WS16/17)
Person responsible for module: Prof. Dr. Udo Krieger

Contents:

The course provides an introduction to the theoretical foundations of important technical issues related to the fundamentals of Internet communication, the data link layer, routing and transport protocols in IP networks, as well as advanced topics such as real-time communication and security in IP networks. The implementation of the learnt concepts in terms of predetermined configuration tasks in the communication laboratory by small teams of students constitutes the tutorial part of the course. For this purpose, guidelines, technical instructions, and tools will be provided.

The implementation tasks include the configuration and testing of computer networks in the laboratory setting. Operating system and required software components like Wireshark, Atheris and Vyatta software router will be provided. The basic handling of the hardware and software itself will be perfomed by the students as part of their individual intellectual efforts within te couse.

Learning outcomes:

The important skill to provide a qualified assessment of current communicaton technologies and corresponding practical knowledge can only be acquired by team-oriented processes subject to time constraints and the clear specification of technical and administrative objectives. In the course Foundations of Internet Communication and its tutorials in the router laboratory students will learn to work independently with a high level of responsibility as self-confident member of a successful team.

It is the objective of the course that the students acquire practical knowledge on modern data communication in Internet and learn how communication concepts can be developed, implemented and judged with th highest level of expertise.

The course is open to bachelor students in their transition phase to the master prgram. It attempts to prepare for the job in communication industry related fields. Master students in the first semester and exchange students from abroad are invited to join the course.

Remark:

The module can be selected by exchange students and master students
speaking only English.

The workload is composed of the following items:

- participation in lectures, tutorials in the laboratory, laboratory meetings: 45 hours
- preparation, execution, post-processing of lectures and tutorials in the laboratory: 100 hours
- preparation of the examination: 35 hours

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**
• data communication similar to module KTR-Datkomm-B • fundamental knowledge on programming in JAVA (or C++) • working knowledge on LINUX is recommended, but not assumed	governed by examination regulations (StuFPO)

Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended Module Data communication (KTR-Datkomm-B) - recommended Module Algorithms and Data Structures (MI-AuD-B) - recommended		
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Foundations of Internet Communication **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Udo Krieger **Language:** English/German **Frequency:** every summer semester	**4,00 Weekly Contact Hours**
Learning outcome: The important skill to provide a qualified assessment of current communicaton technologies and corresponding practical knowledge can only be acquired by team-oriented processes subject to time constraints and the clear specification of technical and administrative objectives. In the course Foundations of Internet Communication and its tutorials in the router laboratory students will learn to work independently with a high level of responsibility as self-confident member of a successful team. It is the objective of the course that the students acquire practical knowledge on modern data communication in Internet and learn how communication concepts can be developed, implemented and judged with th highest level of expertise. The course is open to bachelor students in their transition phase to the master prgram. It attempts to prepare for the job in communication industry related fields. Master students in the first semester and exchange students from abroad are invited to join the course.	
Contents: The course provides an introduction to the theoretical foundations of important technical issues related to the fundamentals of Internet communication, the data link layer, routing and transport protocols in IP networks, as well as advanced topics such as real-time communication and security in IP networks. The implementation of the learnt concepts in terms of predetermined configuration tasks in the communication laboratory by small teams of students constitutes the tutorial part of the course. For this purpose, guidelines, technical instructions, and tools will be provided. The implementation tasks include the configuration and testing of computer networks in the laboratory setting. Operating system and required software components like Wireshark, Atheris and Vyatta software router will be provided. The basic handling of the hardware and software itself will be perfomed by the students as part of their individual intellectual efforts within the couse. The organization of the laboratories is following the framework of industry. It comprises definition, preparation, implementation and presentation phases. An incremental processing is performed like in industrial projects. It means	

• a segmentation into specific work packages,

• its division into tasks and subtasks including milestones
• the presentation of intermediate results
• a final report with presentation
Further laboratories related to current research issues in "Future Generation Internet" will be integrated into the course on demand. Details are discussed in the first lecture.
An actual list of studied topics and related references are presented in the first lecture.
The language of the course wil be announced during the first lecture.

Literature:
Foundations:

• J. Liebeherr, M. Elzarki: Mastering Networks, An Internet Lab Manual, Pearson Education, Boston, 2004.
Further references related to specific workpackages:
• Kurose, J., Ross, K.W.: Computer Networking – a Top-Down Approach, Addison-Wesley, 2013 .
• Tanenbaum, A. S.: Computer Networks, Pearson Education, 2010.
• Leon-Garcia, A., Widjaja, I.: Communication Networks, McGraw-Hill, Boston, 2nd ed. 2004.
• Flaig, G., u.a.: Internet-Telefonie, Open source Press, München, 2006.
An up-to-date list is provided by the course.

Examination
Coursework Assignment and Colloquium / Duration of Examination: 30 minutes
Duration of Coursework: 4 months
Description:
The evaluation of the course will take place after completion of all lectures within the examination cycle. It is based on following items:
• assessment of the chapters composed by the candidate in the final course report about all workpackages written by a team of students
• presentation and explanation of specific tasks and outcomes of laboratories by an individual colloquium lasting 30 minutes

The evaluation rules of these components will be announced during the first lecture. The overall individual grading has to reach the level "satisfactory/ ausreichend (4.0)" to pass the examination of the module.

The language of the examination wil be announced during the first lecture.

Module KTR-MAKV-M Modeling and Analysis of Communication Networks and Distributed Systems *Modellierung und Analyse von Kommunikationsnetzen und Verteilten Systemen*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium

(since WS17/18)
Person responsible for module: Prof. Dr. Udo Krieger

Contents:
The course deals with the analysis and performance evaluation of complex distributed systems such as telecommunication systems, computer networks and complex networks as well as cloud computing systems. The latter are transformed to abstract system-theoretical models and their associated parameters. The models are used to analyze the system behavior, and to predict relevant performance metrics such as utilization, throughput, waiting and response times of request, person or data flows in distributed systems or social networks. Such predictions have great importance regarding economic or technical design and decision processes in future generation networks and their distributed service architectures.

The course presents the modeling of distributed systems and discusses associated description methods such as relevant load and machine models. The system-theorectical analysis of these models and the included resource assignment and management strategies are sketched based on simple analytic methods like Markov chains, algebraic and numerical solution methods for queueing models.

Learning outcomes:
It is the objective of the course to teach students the fundamentals of measurement, analysis, and performance evaluation methods in modern computer and communication networks, and distributed systems. Students will learn how they can apply the underlying system-theoretical monitoring, modeling, and analysis techniques to a given technical context. The application of the sketched models and methods is illustrated by exercises covering views of distributed systems with a realistic characteristic. Students are encouraged to apply a given methodology to new technical contexts and scientific tasks.

Remark:
The module can be selected by exchange students and master students speaking only English.

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
• solid knowledge of calculus (like Mathematik I) and linear algebra (like Mathematik für Informatik 2) • basic knowledge of probability theory and statistics • programming experience in JAVA (or C++)	governed by examination regulations (StuFPO)

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Modeling and Analysis of Communication Networks and Distributed Systems **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Udo Krieger	**4,00 Weekly Contact Hours**

Language: English/German
Frequency: every summer semester

Learning outcome:
It is the objective of the course to teach students the fundamentals of

measurement, analysis, and performance evaluation methods in modern computer and communication networks, and distributed systems. Students will learn how they can apply the underlying system-theoretical monitoring, modeling, and analysis techniques to a given technical context. The application of the sketched models and methods is illustrated by exercises covering views of distributed systems with a realistic characteristic. Students are encouraged to apply a given methodology to new technical contexts and scientific tasks.

Contents:
The course deals with the analysis and performance evaluation of complex

distributed systems such as telecommunication systems, computer networks and complex networks. The latter are transformed to abstract system-theoretical models and their associated parameters. The models are used to analyze the system behavior, and to predict relevant performance metrics such as utilization, throughput, waiting and response times of request, person or data flows in distributed systems or social networks. Such predictions have great importance regarding economic or technical design and decision processes in future generation networks and their distributed service architectures.
The course presents the modeling of distributed systems and discusses

associated description methods such as relevant load and machine models.
The system-theorectical analysis of these models and the included resource assignment and management strategies are sketched based on simple analytic methods like Markov chains, algebraic and numerical solution methods for queueing models, and simulative analysis schemes.
The content of the lectures is illustrated by exercises and laboratories covering

important performance aspects in high-speed networks and distributed systems.
Knowledge and skills to perform an efficient system analysis, system monitoring, and performance evaluation will be trained in this manner. The independent processing of tasks, the qualified presentation and critical discussion of the outcomes by teams of students is part of the course. It improves the technical understanding and provides means to work as project leader in industry on those topics.
The language of the course wil be announced during the first lecture.

Literature:

- G. Bolch, S. Greiner, H. de Meer, K. S. Trivedi: Queueing Networks and Markov Chains. Wiley, 2nd ed., 2006.
- R. Nelson: Probability, Stochastic Processes, and Queueing Theory. Springer, 1995.

A list of further references is presented in the first lecture.

Examination
Oral examination / Duration of Examination: 30 minutes
Description:

30 minutes oral examination related to the technical topics of all lectures and practicals. The language of the examination wil be announced during the first lecture.	

Module KTR-MMK-M Multimedia Communication in High Speed Networks *Multimedia-Kommunikation in Hochgeschwindigkeitsnetzen*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS17/18) Person responsible for module: Prof. Dr. Udo Krieger	

Contents:

Based on the foundations of data communication, this advanced course of the master program presents the design of high-speed networks (HSN) and the advanced protocol elements of the signaling and user plane that are required to implement new real-time and multimedia services. It includes the digital switching technologies and protocol stacks of HSNs, the quality-of-service architectures, as well as the traffic management protocols of these next generation IP networks. The extension of the TCP/IP protocol stack to realize communication relations among mobile or stationary end systems that are supported by quality-of-service guarantees and associated improved switching concepts are discussed in detail by lectures of the course.

These lectures focus on effective access technologies and new transport and QoS-architectures in the core network like Diffserv, MPLS and GMPLS. Further, enhancement of IPv4 by IPv6 switching and the extension of TCP by moern multipath concepts such as MPTCP and SCTP are presented. Advanced QoS-management concepts, effective resource and traffic management schemes like buffer management by RED, RIO or schedluing by WFQ, are discuessed, too. Furthermore, we present new architectures for next generation networks (NGNs) such as software-defined networks and information-centric networks.

Modern multimedia service architectures with interactive applications for third to fourth generation Internet like Web applications based on HTTP 2.0, WebRTC, peer-to-peer VoIP and media streaming applications are sketched.

The course can be supplemented by the module Foundations of Internet Communcation (KTR-GIk-M) with its instructive tasks executed in the router laboratory, by master seminars and projects or a master thesis on related topics in next generation networks.

Learning outcomes:

The students will be enabled to work independently according to the highest scientific standards on design and analysis tasks associated with high-speed network protocols. They will learn about the fundamentals of multimedia communication in high-speed networks and the systematic analysis of the applied communication algorithms by means of an interactive tutorial concept. They will assess the implementations of existing network protocols and to evaluate their performance by means of a measurement analysis with Wireshark and other tools. The processing of the design, assessment, measurement, and implementation tasks will be performed by teams of students. Thus, learning effective teamwork is part of the course.

Remark:

The module can be selected by exchange students and master students speaking only English.

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:** governed by examination regulations (StuFPO)

• successful examination in data communication similar to module KTR-Datkomm-B and substantial knowledge of related technical concepts • knowledge in progamming with JAVA (or C++) Module Advanced Java Programming (DSG-AJP-B) - recommended Module Data communication (KTR-Datkomm-B) - recommended	

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Multimedia Communication in High Speed Networks **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Udo Krieger **Language:** English/German **Frequency:** every summer semester	**4,00 Weekly Contact Hours**
Learning outcome: The students will be enabled to work independently according to the highest scientific standards on design and analysis tasks associated with high-speed network protocols. They will learn about the fundamentals of multimedia communication in high-speed networks and the systematic analysis of the applied communication algorithms by means of an interactive tutorial concept. They will assess the implementations of existing network protocols and to evaluate their performance by means of a measurement analysis with Wireshark and other tools. The processing of the design, assessment, measurement, and implementation tasks will be performed by teams of students. Thus, learning effective teamwork is part of the course.	
Contents: Based on the foundations of data communication, this advanced course of the masters programme presents the design of high-speed networks (HSN) and the advanced protocol elements of the signaling and user plane that are required to implement new real-time and multimedia services. It includes the digital switching technologies and protocol stacks of HSNs, the quality-of-service architectures, as well as the traffic management protocols of these next generation IP networks. The extension of the TCP/IP protocol stack to realize communication relations among mobile or stationary end systems that are supported by quality-of-service guarantees and associated improved switching concepts are discussed in detail by lectures of the course. These lectures focus on effective access technologies and new transport and QoS-architectures in the core network like Diffserv, MPLS and GMPLS. Further, the enhancement of IPv4 by IPv6 switching and the extension of TCP by modern multipath concepts such as MPTCP and SCTP are presented. Advanced QoS-management concepts, effective resource and traffic management schemes like buffer management by RED, RIO or schedluing by weighted fair queueing (WFQ), are discussed, too. Furthermore, we present new architectures for next generation networks (NGNs) such as software-defined networks and information-centric networks.	

Modern multimedia service architectures with interactive applications for third to fourth generation Internet like Web applications based on HTTP 2.0, WebRTC, peer-to-peer VoIP and media streaming applications are sketched. The content of the lectures is illustrated by exercises and laboratories covering important aspects of the protocol stacks in high-speed networks. The independent processing of tasks, the qualified presentation and critical discussion of the outcomes by teams of students is part of the course. It improves the technical understanding and provides means to work as project leader in industry on those topics. The course can be supplemented by the module Foundations of Internet Communcation (KTR-GIK-M) with its instructive tasks executed in the router laboratory, by master seminars and projects or a master's thesis on related topics in next generation networks. The language of the course wil be announced during the first lecture. **Literature:** • Kurose, J., Ross, K.W.: Computernetzwerke – ein Top-Down-Ansatz mit Schwerpunkt Internet, Pearson Studium, München, 2013. • Kurose, J.F., Ross, K.W.: Computer Networking, A Top-Down Approach Featuring the Internet, Pearson Addison-Wesley, 7th ed., 2017. • Leon-Garcia, A., Widjaja, I.: Communication Networks, McGraw-Hill, Boston, 2nd ed. 2004. • Comer, D.: Computernetzwerke und Internets, Pearson Studium, München, 2001. Weitere Literatur wird in der Vorlesung benannt.	
Examination Oral examination / Duration of Examination: 30 minutes **Description:** 30 minutes oral examination related to the technical topics of all lectures and practicals. The language of the examination wil be announced during the first lecture.	

Module KTR-MfI-2 Mathematics for Computer Science 2 (Linear Algebra) *Mathematik für Informatik 2 (Lineare Algebra)*		6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS18/19) Person responsible for module: Prof. Dr. Udo Krieger		
Contents: Die Lehrveranstaltung stellt mathematische Grundlagen der Informatik bereit und ist dem Pflichtbereich der Modulgruppe A1 "Mathematische Grundlagen" für Angewandte Informatik/Software Systems Science zugeordnet. Der besondere Bezug zur Angewandten Informatik bzw. Software Systems Science wird in den Vorlesungsbeispielen und Übungen herausgearbeitet. Es werden grundlegende Methoden und Algorithmen der Gruppen- und Ringtheorie, der linearen Algebra, der Matrizenalgebra, der Lösungstheorie linearer Gleichungssysteme, der Eigenwerttheorie sowie spezifische Anwendungen der Informatik vorgestellt.		
Learning outcomes: Die Studierenden lernen, die grundlegende Methoden und Algorithmen der Lineare Algebra anzuwenden und spezifische Anwendungen der Angewandten Informatik als Probleme der linearen Algebra zu erkennen, zu formulieren und mit Hilfe geeigneter Verfahren zu lösen.		
Remark: Das Modul stellt die Grundlagen für Studierende der Angewandten Informatik und Software Systems Science sowie Studierdende im Nebenfach verwandter Bachelorstudiengänge der Fakultät WIAI bereit. Der Arbeitsaufwand gliedert sich grob wie folgt: • Teilnahme an Präsenzveranstaltungen (Vorlesung, Übung, Laborbesprechungen): 45 Stunden • Vor- und Nachbereitung von Vorlesungen und Übungen: 100 Stunden • Prüfungsvorbereitung: 35 Stunden		
prerequisites for the module: none		
Recommended prior knowledge: Schulkenntnisse auf dem Niveau eines Mathematik-Vorkurses Module Mathematik-Vorkurs-Bachelorstudium (KTR-MVK-B) - recommended		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:** 1. - 2.	**Minimal Duration of the Module:** 1 Semester

Module Units	
Mathematik für Informatik 2 (Lineare Algebra) **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Udo Krieger **Language:** German **Frequency:** every summer semester **Contents:** Die Lehrveranstaltung stellt mathematische Grundlagen der Informatik bereit und ist dem Pflichtbereich der Modulgruppe A1 "Mathematische Grundlage" für Angewandte Informatik/Software Systems Science zugeordnet. Es werden	**4,00 Weekly Contact Hours**

grundlegende Methoden und Algorithmen der Gruppen- und Ringtheorie, der linearen Algebra, der Matrizenalgebra, der Lösungstheorie linearer Gleichungssysteme, der Eigenwerttheorie sowie spezifische Anwendungern der Informatik vorgestellt. **Literature:** • A. Steger: Diskrete Strukturen 1, Springer, Heidelberg, 2002. • G. Golub, C.F. van Loan: Matrix Computations, 3ed., Johns Hopkins, 1996. • D. Hachenberger: Mathematik für Informatiker, Pearson, 2008. • J. Liesen, V. Mehrmann: Lineare Algebra, Springer, Bachelorkurs Mathematik, 2. Auflage, 2015. • B. Pareigis: Linear Algebra für Informatiker, Springer, 2000. • M.P.H. Wolff u.a.: Mathematik für Informatik und Bioinformatik, Springer, 2004. • Weitere Literatur wird in der Vorlesung benannt.	
Examination Written examination / Duration of Examination: 90 minutes **Description:** Schriftliche Prüfung zu Inhalten der Vorlesung und Übungen im Umfang von 90 Minuten. Zugelassene Hilfsmittel werden in der Lehrveranstaltung bekannt gegeben.	

<table>
<tr><td>Module KTR-Mobi-M Mobile Communication
Mobilkommunikation</td><td>6 ECTS / 180 h
45 h Präsenzzeit
135 h Selbststudium</td></tr>
<tr><td colspan="2">(since WS17/18)
Person responsible for module: Prof. Dr. Udo Krieger</td></tr>
<tr><td colspan="2">Contents:
The course presents the fundamentals of mobile communication. We sketch the underlying standards, system architectures and their realizations as well as current research and development trends. Due to the complexity of the field the course can only present some basic important aspects of those mobile communication systems that exhibit the strongest growth in the markets and affect all busieness areas of the information societies at most. The course will focus on the technical system and design perspectives regarding the service architectures and local or wide area mobile communication networks.

The following topics are discussed in detail:
• technical foundation of wireless transmission
• media access control protocols
• resource management protocols in mobile communication networks (including resource assignment strategies at the radio layer, handoff management, error control protocols, scheduling etc.)

• mobility support at the network layer by mobile IP
• transport protocols and their enhancements
• wirelss LANs and their development (IEEE802.11 standards, WiMAX etc.)
• wireless wide area networks based on TDMA technology (GSM basics and protocols, GPRS)
• data communication in wireless wide area networks (UMTS, HSPA, LTE, LTE-A etc.)
• service architectures for mobile networks (including Android programming and WebRTC architectures)</td></tr>
<tr><td colspan="2">Learning outcomes:
The students are encouraged to independent scientific work. They learn the fundamentals of mobile communication and are trained to analyze the applied protocols and communication algorithms in a systematic manner. Students are instructed to investigate the sketched mobile communication protocols by measurements using Wireshark and other tools, to evaluate their performance, and to develop new protocol elements. The processing of design, programming, and performance assessment tasks by teams of students and the effective arrangement of workgroups is part of the training.</td></tr>
<tr><td colspan="2">Remark:
The module can be selected by exchange students and master students
speaking only English.</td></tr>
<tr><td colspan="2">prerequisites for the module:
none</td></tr>
<tr><td>Recommended prior knowledge:
• substantial knowledge of the foundations of data communication similar to module KTR-Datkomm-B
• good knowledge of programming in JAVA (or C++)
• knowledge of algorithms and data structures similar to module MI-AuD-B

Module Advanced Java Programming (DSG-AJP-B) - recommended
Module Data communication (KTR-Datkomm-B) - recommended</td><td>Admission requirements:
governed by examination regulations (StuFPO)</td></tr>
</table>

Module Algorithms and Data Structures (MI-AuD-B) - recommended		
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Mobile Communication Course **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Udo Krieger **Language:** English/German **Frequency:** every winter semester	**4,00 Weekly Contact Hours**
Learning outcome: The students are encouraged to independent scientific work. They learn the fundamentals of mobile communication and are trained to analyze the applied protocols and communication algorithms in a systematic manner. Students are instructed to investigate the sketched mobile communication protocols by measurements using Wireshark and other tools, to evaluate their performance, and to develop new protocol elements. The processing of design, programming, and performance assessment tasks by teams of students and the effective arrangement of workgroups is part of the training.	
Contents: The course presents the fundamentals of mobile communication. We sketch the underlying standards, system architectures and their realizations as well as current research and development trends. Due to the complexity of the field the course can only present some basic important aspects of those mobile communication systems that exhibit the strongest growth in the markets and affect all busieness areas of the information societies at most. The course will focus on the technical system and design perspectives regarding the service architectures and local or wide area mobile communication networks. The following topics are discussed in detail: • technical foundation of wireless transmission • media access control protocols • resource management protocols in mobile communication networks (including resource assignment strategies at the radio layer, handoff management, error control protocols, scheduling etc.) • mobility support at the network layer by mobile IP • transport protocols and their enhancements • wirelss LANs and their development (IEEE802.11 standards, WiMAX etc.) • wireless wide area networks based on TDMA technology (GSM basics and protocols, GPRS) • data communication in wireless wide area networks (UMTS, HSPA, LTE, LTE-A etc.) • service architectures for mobile networks (including Android programming and WebRTC architectures) The content of the lectures is illustrated by exercises and laboratories covering important aspects of the protocol stacks in mobile networks. The independent	

processing of tasks, the qualified presentation and critical discussion of the outcomes by teams of students is part of the course. It improves the technical understanding and provides means to work as project leader in industry on those topics. The course can be supplemented by the module Foundations of Internet Communcation (KTR-GIK-M) with its instructive tasks executed in the router laboratory, by master seminars and projects or a master's thesis on related topics in next generation networks. The language of the course wil be announced during the first lecture. **Literature:** • Schiller, J.: Mobile Communications. Pearson-Education, Munich, 2004. • Walke, B.: Mobile Radio Networks, Wiley, 2002. • Pahlavan, K., Krishnamurthy, P.: Principles of Wireless Networks, A Unified Approach. Prentice Hall, 2002. • Pahlavan, K., Krishnamurthy, P.: Networking Fundamentals: Wide, Local and Personal Area Communications, Wiley, 2009. • Holma, H., Toskala, A.: LTE for UMTS, Evolution to LTE-Advanced, 2. ed, Wiley, 2011.	
Examination Oral examination / Duration of Examination: 30 minutes **Description:** 30 minutes oral examination covering all topics of the lectures and practicals. The language of the examination wil be announced during the first lecture.	

Module KTR-Proj Project Communication Networks and Services *Projekt Kommunikationsnetze und -dienste*	6 ECTS / 180 h 40 h Präsenzzeit 140 h Selbststudium
(since WS17/18) Person responsible for module: Prof. Dr. Udo Krieger	

Contents:

Important skills regarding the planning, development and implementation of new communication technologies, their advanced services, and the related protocols in next generation networks can only be learnt by team oriented development projects subject to stringent time and resource constraints, and clear development objectives, similar to an industrial project environment.Following these lines, the course will provide fundamental insights on the functionality of modern service architectures and communication principles of next generation Internet and its development.

After a short training phase and based on an autonomous working mode, students will learn by a teamwork project to solve advanced communication tasks and to implement new communication services associated with current research issues of the professorship. The basic network equipment, network operating systems, software and development tools will be provided in the laboratory. Handling hardware and software will be learnt by the students independently as part of the project after a guidance phase. All development steps and results will be documented by a corresponding written report and oral presentations of the results.

Actual topics will be announced on the web page of the module. The related specification of the development tasks and their milestones will be done in cooperation with the supervisor.

Learning outcomes:

The students are encouraged to a scientific working mode aftr a short guidance phase. They learn how to plan, develop and implement multimedia services and communication protocols in existing and future generation networks. They are trained to efficiently implement the applied protocols and to analyze the performance of the communication algorithms in a systematic manner. Students are instructed to investigate their developed protocol code elements by measurements and other tools, to evaluate their performance, and to develop improved protocol units. The processing of design, programming, and performance assessment tasks by teams of students and the effective arrangement of the group work is part of the training. It is the objective to gain practical experience on QoS-based multimedia communication and to develop the skills to implement and evaluate network components of modern service architectures.

The project follows scientific standards and deals with research issues of the professorship. The overall objective is to develop skills and knowledge required for a successful career in industry or research in the field of communication engineering.

Remark:

The module can be selected by exchange students and master students
speaking only English.

prerequisites for the module:

none

Recommended prior knowledge:	Admission requirements:
• good programming skills in JAVA (or C++)	

• good knowledge in data communication, similar to module KTR-Datkomm-B Module Data communication (KTR-Datkomm-B) - recommended		governed by examination regulations (StUFPO)
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Projekt Kommunikationsnetze und-dienste **Mode of Delivery:** **Lecturers:** Prof. Dr. Udo Krieger **Language:** English/German **Frequency:** every winter semester **Learning outcome:** The details are sketched previously in the module description. **Contents:** Important skills regarding the planning, development and implementation of new commmunication technologies, their advanced services, and the related protocols of communication networks can only be learnt by team oriented development projects subject to stringent time and resource constraints, and clear development objectives, similar to an industrial project environment. The students will get insight on the service and network architectures of next generation Internet. The main objective is the realization of development tasks applying accumulated knowledge on communication networks. After a short training phase and based on an autonomous working mode, students will learn by a teamwork project to solve advanced communication development tasks and to implement new communication services associated with current research issues of the professorship. The organization of the project is following the framework of industry. It comprises definition, preparation, implementation and presentation phases. An incremental processing is performed like in industrial projects. It means • a segmentation into specific work packages, • its division into tasks and subtasks including milestones • the presentation of intermediate results • a final report with presentation and an individual colloquium to defend the outcome. Research and development tasks are related to current research issues in "Future Generation Networks" and will be integrated into the module. An actual list of studied topics and related references are presented in the first lecture. **Literature:** A reference list will be provided in the first meeting of the project.	**4,00 Weekly Contact Hours**
Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:**	

Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** The results of teamwork and individual work phases which are reflected by the written project report and the associated presentations of the project results will be evaluated. The outcome must be completed within 4 months. The final assessment of the examination includes the corresponding chapters of the project report composed by the candidate and the evaluation of an individual colloquium of the candidate lasting 30 minutes. All contributions must be achieved within the same semester. A regular participation in all units of the module is required to be admitted to the final examination.	

Module KTR-SSSProj-B KTR Bachelor Project Software Systems Science *KTR Bachelorprojekt Software Systems Science*	12 ECTS / 360 h 70 h Präsenzzeit 290 h Selbststudium

(since WS18/19)
Person responsible for module: Prof. Dr. Udo Krieger

Contents:

Wichtige Fertigkeiten bei der Anwendung neuer Kommunikationstechnologien und zur Entwicklung neuer Kommunikationsdienste sind nur durch die Vermittlung praktischer Fähigkeiten und Erfahrungen in team-orientierten Prozessen unter Zeit- und Zielvorgaben industrienah erlernbar. Die Studierenden werden in der Lehrveranstaltung in einem angeleiteten, aber ansonsten eigenverantwortlich durchgeführten teamorientierten Arbeitsprozess aktuelle Entwicklungsaufgaben aus dem Forschungsbereich der Professur für Informatik bearbeiten.

Learning outcomes:

Die Lehrveranstaltung vermittelt Einblicke in die Entwicklung neuer Dienstarchitekturen und Netztechnologien aus dem Bereich des Internets der nächsten Generation.

Ziel ist der Erwerb praktischer Fertigkeiten auf dem Gebiet der IP-gestützten, qualitätsgesicherten Multimediakommunikation und die Fähigkeit, Lösungsvorschläge moderner Dienstarchitekturen im Internet der Zukunft sicher beurteilen zu können.

Studierende sollen ein vertieftes Verständnis der bei der Durchführung von Software-Projekten im Bereich Kommunikationsnetze und -dienste auftretenden konzeptionellen und praktischen Probleme wie auch von erfolgsversprechenden Lösungsansätzen dieser Probleme erhalten. Da dies anhand der intensiven Bearbeitung eines Themas aus dem Forschungsbereich der Professur für Informatik in Kleingruppen oder einzeln geschieht, gewinnen die Studierenden wichtige Erfahrungen in der Durchführung kleinerer, forschungsorientierter Projekte von der Grobkonzeption über die Detailplanung bis hin zur Umsetzung und Dokumentation der Ergebnisse in wissenschaftlich ausgerichteten Arbeitsberichten und in der professionellen Präsentation dieser Ergebnisse.

Remark:

Dieses Modul erstreckt sich über 2 Semester und umfasst
2x6=12 ECTS und 2x4=8 SWS.

Der Arbeitsaufwand beträgt insgesamt 360 Std., welche sich grob wie folgt gliedern:
• 30 Std. Recherche, Planung und Teilnahme am Planungsworkshop
• 40 Std. Teilnahme an Projekttreffen, einschließlich Tutorien
• 180 Std. Durchführung des Projekts (Projektarbeit)
• 50 Std. Erstellung des Zwischenberichts (Hausarbeit)
• 60 Std. Erstellung des Abschlussberichts, Erstellung und
Präsentation der Projektergebnisse (Hausarbeit und Kolloquium)

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**

• gute Kenntnisse in Mathematik für Informatiker 2 • mindestens gute JAVA (oder C/C++) Kenntnisse • Kenntnisse der Datenkommunikation im Umfang von KTR-Datkomm-B oder vergleichbare Kenntnisse werden empfohlen • grundlegende methodische Kenntnisse zur Planung und Durchführungvon Softwareprojekten, z.B. im Umfang des Moduls "Software EngineeringLab" (SWT-SWL-B), werden empfohlen. Module Introduction to Parallel and Distributed Programming (DSG-PKS-B) - recommended Module Data communication (KTR-Datkomm-B) - recommended Module Mathematics for Computer Science 2 (Linear Algebra) (KTR-MfI-2) - recommended	none

Frequency: every semester	**Recommended semester:** 4.	**Minimal Duration of the Module:** 2 Semester

Module Units

Bachelorprojekt Software Systems Science — **8,00 Weekly Contact Hours**

Mode of Delivery:
Lecturers: Prof. Dr. Udo Krieger
Language: German/English
Frequency: every semester

Contents:

Die Lehrveranstaltung vermittelt Einblicke in die Entwicklung neuer

Dienstarchitekturen und Netztechnologien aus dem Bereich des Internets der nächsten Generation. Im Mittelpunkt steht die eigenständige, teamorientierte praktische Umsetzung eines Entwicklungsauftrages unter Verwendung des erworbenen Wissens einzelner Lehrveranstaltungen des Fachgebiets der Professur für Informatik.
Die Betriebssystem-Grundausstattung und erforderliche Software-Werkzeuge

wie Vyatta-Router, Wireshark, Atheris und RapidStream werden bereitgestellt. Grundlagen der Handhabung werden von den Studierenden im Projekt selbst erarbeitet.
Die Lehrveranstaltung erstreckt sich über 2 konsekutive Semester. Die

Organisation der Arbeiten erfolgt in einem industrienahen Projektrahmen aus Definitions-, Vorbereitungs-, Implementierungs- und Präsentationsphasen.
Dabei soll, wie in realen Projekten üblich, eine inkrementelle Vorgehensweise durchgeführt werden, d.h:

- Unterteilung der Arbeiten in Arbeitspakete (laboratories/work packages),
- ihre Untergliederung in Aufgaben (tasks) und Teilaufgaben (subtasks) mit Meilensteinen
- und der Darlegung von Zwischenergebnissen in einem Zwischenbericht nach dem 1. Semester sowie
- einem Abschlussbericht mit Abschlusspräsentation der Arbeitsergebnisse in einem Kolloquium im 2. Semester.

Es werden Entwicklungsaufgaben zu aktuellen Forschungsfragen im "Future Generation Internet" bearbeitet. Details werden auf der Webseite der Lehrveranstaltung angekündigt. Eine aktuelle Liste der bearbeiteten Themen der Lehrveranstaltung wird in der 1. Besprechung bereitgestellt. Die Bekanntgabe der Lehrsprache erfolgt in der ersten Sitzung der Lehrveranstalltung.	

Examination Coursework Assignment / Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Die Lehrveranstaltung erstreckt sich über 2 konsekutive Semester. Es werden die Leistungen der als Gruppen- oder Einzelarbeit ausgeführten individuellen schriftlichen Ausarbeitung der Projektaufgaben mit einer Bearbeitungsdauer von 6 Monaten im 1. Semester bewertet. Die Bearbeitungsdauer der Hausarbeit beträgt 6 Monate. Die Bekanntgabe der Prüfungssprache sowie der Gewichtung der Prüfungsleistungen erfolgt in der ersten Sitzung der Lehrveranstalltung.	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Die Lehrveranstaltung erstreckt sich über 2 konsekutive Semester. Es werden die Leistungen der als Gruppen- oder Einzelarbeit ausgeführten individuellen schriftlichen Ausarbeitung der Projektaufgaben und ihrer Präsentation im 2. Semester sowie die Ergebnisse einer abschließenden, individuellen Kolloquiumssprüfung bewertet. Die Dauer des Kolloquiums beträgt 30 Minuten. Die Bearbeitungsdauer der 2. Hausarbeit beträgt 6 Monate. Alle Teilleistungen müssen in jedem Semester erfolgreich absolviert werden. Die Gewichtung der Prüfungsleistungen wird zu Beginn des Semesters bekannt gegeben.	

Module KTR-SSSProj-M KTR Master Project Software Systems Science *KTR Masterprojekt Software Systems Science*	9 ECTS / 270 h 70 h Präsenzzeit 200 h Selbststudium
(since WS17/18) Person responsible for module: Prof. Dr. Udo Krieger	
Contents: Important skills regarding the planning, development and implementation of new commmunication technologies, their advanced services, and the related protocols in next generation networks can only be learnt by team oriented development projects subject to stringent time and resource contraints, and clear development objectives, similar to an industrial project environment. After a short training phase and based on an autonomous working mode, students will learn by a teamwork project to solve advanced communication tasks and to implement new communication services associated with current research issues of the professorship. Actual topics will be announced on the web page of the module.	
Learning outcomes: The students are encouraged to independent scientific work. They learn how to plan, develop and implement new advanced multimedia services and communication protocols in next generation networks. They are trained to efficiently implement the applied protocols and to analyze the performance of the communication algorithms in a systematic manner. Students are instructed to investigate their developed protocol code elements by measurements and other tools, to evaluate their performance, and to develop improved protocol units. The processing of design, programming, and performance assessment tasks by teams of students and the effective arrangement of the groupwork is part of the training. The project follows scientific standards and deals with research issues of the professorship. The overall objective is to develop skills and knowledge required for a successful career in industry or research in the field of communication engineering.	
Remark: The module can be selected by exchange students and master students speaking only English.	
prerequisites for the module: A bachelor degree in computer science, computer engineering or mathematics is required. Students must be enroled in the masters degree programme "M.Sc. International Software Systems Science".	
Recommended prior knowledge: • good knowledge in mathematics and statistics, similar to module Mathematik für Informatiker 2 • good programming skills in JAVA (or C++) • good knowledge in data communication, similar to module KTR-Datkomm-B • solid methodological know-how in planning and execution of software projects, similar to the module "Software Engineering Lab" (SWT-SWL-B) Module Introduction to Parallel and Distributed Programming (DSG-PKS-B) - recommended Module Data communication (KTR-Datkomm-B) - recommended	**Admission requirements:** governed by examination regulations (StuFPO)

Module Mathematics for Computer Science 2 (Linear Algebra) (KTR-MfI-2) - recommended Module Software Engineering Lab (SWT-SWL-B) - recommended	

Frequency: every semester	**Recommended semester:** 2.	**Minimal Duration of the Module:** 1 Semester

Module Units	
KTR Master Project Software Systems Science **Mode of Delivery:** **Lecturers:** Prof. Dr. Udo Krieger **Language:** English/German **Frequency:** every semester **Learning outcome:** The details are sketched previously. **Contents:** Important skills regarding the planning, development and implementation of new commmunication technologies, their advanced services, and the related protocols in next generation networks can only be learnt by team oriented development projects subject to stringent time and resource contraints, and clear development objectives, similar to an industrial project environment. After a short training phase and based on an autonomous working mode, students will learn by a teamwork project to solve advanced communication tasks and to implement new communication services associated with current research issues of the professorship. The organization of the project is following the framework of industry. It comprises definition, preparation, implementation and presentation phases. An incremental processing is performed like in industrial projects. It means • a segmentation into specific work packages, • its division into tasks and subtasks including milestones • the presentation of intermediate results • a final report with presentation and an individual colloquium to defend the outcome. Research and development tasks are related to current research issues in "Future Generation Internet" and will be integrated into the module. An actual list of studied topics and related references are presented in the first lecture. The language of the course wil be announced during the first lecture. **Literature:** A reference list will be provided in the first meeting of the project.	**6,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung	

Description: The course duration is one semester. The assessment of the module covers the results of the project report, written either as groupwork or on an individual basis by the student, the project presentation, and the final colloquium arranged on an individual basis. The language of the course and its examination is announced during the first lecture.	

Module KTR-Sem-B Bachelor Seminar Communication Systems and Computer Networks *Bachelorseminar zu Kommunikationssystemen und Rechnernetzen*		3 ECTS / 90 h 20 h Präsenzzeit 70 h Selbststudium
(since WS10/11) Person responsible for module: Prof. Dr. Udo Krieger		
Contents: Die Studierenden lernen, aktuelle Fragestellungen aus dem Themenfeld der Komunikationsnetze und -dienste anhand der Fachliteratur unter Anleitung wissenschaftlich zu bearbeiten und das erworbene Wissen in systematischer Form schriftlich und mündlich darzulegen.		
Learning outcomes: Die Studierenden lernen, aktuelle Fragestellungen aus dem Themenfeld der Komunikationsnetze und -dienste anhand der Fachliteratur unter Anleitung wissenschaftlich zu bearbeiten und das erworbene Wissen in systematischer Form schriftlich und mündlich darzulegen.		
Remark: Der Arbeitsaufwand gliedert sich grob wie folgt: • Präsenzveranstaltungen inkl. Themenvergabe und Besprechungen mit dem Betreuer: 20 Stunden • Bearbeitung des Fachthemas und schriftliche Darstellung: 54 Stunden • Erarbeitung der Präsentation: 16 Stunden		
prerequisites for the module: none		
Recommended prior knowledge: Module gemäß der folgenden Spezifikation Module Data communication (KTR-Datkomm-B) - recommended Module Algorithms and Data Structures (MI-AuD-B) - recommended		**Admission requirements:**
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelorseminar KTR-Bachelor **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Udo Krieger **Language:** German/English **Frequency:** winter and summer semester, on demand	**2,00 Weekly Contact Hours**
Learning outcome: Die Studierenden lernen, aktuelle Fragestellungen aus dem Themenfeld der Komunikationsnetze und -dienste anhand der Fachliteratur unter Anleitung wissenschaftlich zu bearbeiten und das erworbene Wissen in systematischer Form schriftlich und mündlich darzulegen.	
Contents: Es werden aktuelle Fragestellungen aus dem Bereich der Kommunikationstechnik und Rechnernetze unter Anleitung bearbeitet . Die aktuelle Themenliste wird auf der Webseite bereitgestellt.	

Die Bekanntgabe der Lehrsprache erfolgt in der ersten Sitzung der Lehrveranstalltung. Die schriftliche Ausarbeitung erfolgt in LATEX, die mündliche Darstellung im Rahmen einer Powerpoint-, LATEX-Beamer oder PDF-Präsentation auf Basis der schriftlichen Ausarbeitung in möglichst freier, logisch korrekter, verständlicher Form. **Literature:** Die aktuelle Literaturliste wird bei der Vorbesprechung bereitgestellt.	
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Die Gesamtnote ergibt sich zu gleichen Teilen aus der Bewertung der schriftlichen Ausarbeitung (mit Bearbeitungsdauer von maximal 4 Monaten) und des Referats und muss mit mindestens ausreichend bewertet sein. Die Bekanntgabe der Prüfungssprache erfolgt in der ersten Sitzung der Lehrveranstalltung.	

<table>
<tr><td colspan="2">Module KTR-Sem-M Master Seminar Communication Systems and Computer Networks
Hauptseminar zu Kommunikationssystemen und Rechnernetzen</td><td>3 ECTS / 90 h</td></tr>
<tr><td colspan="3">(since WS10/11)
Person responsible for module: Prof. Dr. Udo Krieger</td></tr>
<tr><td colspan="3">Contents:
Die Studierenden sollen auf eine Master- oder Diplomarbeit bzw. eine anschließende industrielle oder wissenschaftliche Tätigkeit im Bereich Kommunikatinsnetze und verteilte Systeme vorbereitet werden.</td></tr>
<tr><td colspan="3">Learning outcomes:
Die Studierenden sollen auf eine Master- oder Diplomarbeit bzw. eine anschließende industrielle oder wissenschaftliche Tätigkeit im Bereich Kommunikatinsnetze und verteilte Systeme vorbereitet werden.</td></tr>
<tr><td colspan="3">Remark:
Der Arbeitsaufwand gliedert sich grob wie folgt:
• Präsenzveranstaltungen inkl. Themenvergabe und Besprechungen mit dem Betreuer: 20 Stunden
• Bearbeitung des Fachthemas und schriftliche Darstellung: 54 Stunden
• Erarbeitung der Präsentation: 16 Stunden</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
• Zulassung zum einem Masterstudiengang
• erfolgreiche Teilnahme an der Lehrveranstslatung Datenkommunikation (KTR-Datkomm-B) (oder einer Veranstaltung vergleichbaren Inhalts)
• weitere fortgeschrittene Kenntnisse aus dem Bereich Kommunikationssystme und Rechnernetze gemäß der thematischen Spezifikation des Hauptseminares
Module Data communication (KTR-Datkomm-B) - recommended</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>Hauptseminar KTR-Master
Mode of Delivery: Advanced seminar
Lecturers: Prof. Dr. Udo Krieger
Language: German/English
Frequency: winter and summer semester, on demand
Learning outcome:
Die Studierenden sollen auf eine Master- oder Diplomarbeit bzw. eine
anschließende industrielle oder wissenschaftliche Tätigkeit im Bereich Kommunikatinsnetze und verteilte Systeme vorbereitet werden.
Contents:
Das Hauptseminar wird jeweils aktuelle Fragestellungen aus dem Bereich der stationären und mobilen Kommunikationsnetze und der</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

Kommunikationsdienste, die im World Wide Web oder von Web-Architekturen mit Dienstegütedifferenzierung angeboten werden, behandeln. Die Bereitstellung leistungsfähiger Plattformen zum Transport multimedialer Datenströme haben einen sehr wettbewerbsorientierten Markt für neue TCP/ IP-basierte Kommunikationsdienste mit zugesicherter Dienstgüte und neuen Anwendungsarchitekturen hervorgebracht. Besondere Bedeutung hat dabei die Entwicklung einer universellen Architektur für "Future Generation Internet" mit Dienstgütedifferenzierung und Mobilitätsunterstützung. Der Erfolg neuer Dienste hängt in entscheidendem Maße von ihrer Implementierung auf adequaten Transport-, Middleware- und Serviceplattformen ab. Im Seminar sollen die systemtheoretischen Grundlagen dieses schnell wachsenden Gebietes anhand der Fachliteratur erarbeitet werden. Ziel ist das selbständige Erlernen neuer Methoden aus einer Schnittmenge der Kommunikationstechnologie, der Theorie Verteilter Systeme und den Grundlagen der Informatik und die systematische Vorbereitung auf eine industrielle oder wissenschaftliche Tätigkeit. Die Teilnahme an einem Hauptseminar bildet i.A. eine solide Grundlage zur Anfertigung einer Diplom- oder Masterarbeit an der Professur für Informatik oder in Zusammenarbiet mit nationalen oder internationalen externen Partnern, z.B. T-Systems Detecon, Siemens, IBM Research oder Yahoo Research sowie KMUs. Die Bekanntgabe der Lehrsprache erfolgt in der ersten Sitzung der Lehrveranstalltung. **Literature:** Die aktuelle Literaturliste wird in der Vorbesprechung bereitgestellt.	
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Die Gesamtnote ergibt sich zu gleichen Teilen aus der Bewertung der schriftlichen Ausarbeitung (mit Bearbeitungsdauer von maximal 4 Monaten) und des Referats und muss mit mindestens ausreichend bewertet sein. Die Bekanntgabe der Prüfungssprache erfolgt in der ersten Sitzung der Lehrveranstalltung.	

Module KogSys-GAI-B Gender Aspects in Computer Science *Genderaspekte in der Informatik*	3 ECTS / 90 h 15 h Präsenzzeit 75 h Selbststudium
(since WS19/20) Person responsible for module: Prof. Dr. Ute Schmid	

Contents:

In der Veranstaltung werden theoretische Ansätze und empirische Befunde zu geschlechtsspezifischen Aspekten in der Informatik behandelt, beispielsweise: Geschlechtsstereotype und Studienfachwahl, Informatik in der Schule, Image der Informatik, Einfluss von Rollenmodellen, Barrieren für berufliche Weiterentwicklung. Ein ausgewählter Aspekt kann praktisch bearbeitet werden, beispielsweise: Entwicklung eines Unterrichtsmoduls zur Informatik, Entwickeln einer Image-Kampagne, empirische Erhebung und Analyse.

Learning outcomes:

Einblick in Forschungsfragestellungen im Bereich Genderstudies, Verständnis sozialwissenschaftlicher Theorien und empirischer Forschungsmethoden, Kenntnis von Maßnahmen zur Förderung von Mädchen und Frauen in der Informatik, Einblick in Methoden der Evaluationsforschung.

Remark:

Das Seminar findet teilweise gemeinsam mit dem Seminar Genderaspekte in der Wirtschaftsinformatik statt, das im Bachelor Wirtschaftsinformatik im Fachgebiet SNA angeboten wird.

Der Arbeitsaufwand von 90 Stunden gliedert sich in etwa wie folgt:

21 Std. Teilnahme an den Präsenzveranstaltungen
24 Std. Literaturarbeit, inklusive Vorbereitung von Kurzpräsentationen
30 Std. Konzeption und Umsetzung des Praxisteils
15 Std. Erstellung der schriftlichen Ausarbeitung

prerequisites for the module:

none

Recommended prior knowledge: keine Einschränkung		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Genderaspekte in der Informatik **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Ute Schmid **Language:** German **Frequency:** every summer semester **Contents:** siehe Modulbeschreibung **Literature:** wird in der Veranstaltung bekannt gegeben	**2,00 Weekly Contact Hours**

Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 4 months **Description:** Referat mit schriftlicher Hausarbeit zu dem im Seminar bearbeiteten Thema.	

Module KogSys-KogMod-M Cognitive Modelling *Kognitive Modellierung*	6 ECTS / 180 h

(since WS19/20)
Person responsible for module: Prof. Dr. Ute Schmid

Contents:
This course introduces into cognitive psychological basics and empiric research methods and gives an overview of approaches for areas of application of the simulation of cognitive processes with computer models.

Learning outcomes:
Students will be able to:

- name and explain research goals in the area of cognitive science
- enumerate and explain methods of cognitive modelling
- discuss and implement specific methods of cognitive modelling in detail
- enumerate and describe cognitive psychology methods
- name, explain, and apply empirical research methods, especially of the experimental cognitive science

Remark:
The default language of instruction in this course is German. However, the lectures and/or tutorials may be delivered in English if there are participating students who prefer English over German. All course materials (lecture slides and tutorial notes) as well as the exam are available in English.

The workload can be split as follows:
22.5 h lecture sessions + 30 h follow-up over 15 weeks + 22.5 h practice sessions + 75 h practice over 15 weeks + 30 h exam preparation

prerequisites for the module:
none

Recommended prior knowledge: Knowledge appropriate to the module KogSys-IA-B.		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Lectures Cognitive Modelling **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Ute Schmid **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: Basic concepts of cognitive modelling; cognitive architectures (ACT-R, Clarion, PSI); Psychological basics and cognitive models for specific content areas especially memory and knowledge representation, learning, reasoning, cognition; Basics of empirical research methods, especially hypothesis testing experiments; Areas of cognitive model applications, especially: Intelligent tutor systems, user adaptive systems.	

Literature: Sun, R. (Ed., 2008). The Cambridge Handbook of Computational Psychology; Müsseler, J. (Ed., 2008). Allgemeine Psychologie (2. Auflage). Bortz, J. (1984). Lehrbuch der empirischen Forschung.	
2. Practices Cognitive Modelling **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Ute Schmid, Scientific Staff Angewandte Informatik, insb. Kognitive Systeme **Language:** German/English **Frequency:** every winter semester **Contents:** In depth practice of empirical research methods on the basis of an exemplarily conducted empirical study. Approaches for cognitive modelling will be practically implemented on the base of concrete modelling tasks with chosen approaches. **Literature:** Sun, R. (Ed., 2008). The Cambridge Handbook of Computational Psychology; Müsseler, J. (Ed., 2008). Allgemeine Psychologie (2. Auflage).	**2,00 Weekly Contact Hours**
Examination Oral examination / Duration of Examination: 20 minutes **Description:** As opening of the exam conversation a five minute presentation should be held in agreement with the examiner. The presentation topic should deepen one of the aspects covered in the lecture or expand one lecture topic. Afterwards questions on lecture and exercise topics will be asked.	

Module KogSys-ML-M Machine Learning *Lernende Systeme (Machine Learning)*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Ute Schmid		
Contents: In this course advanced concepts and methods of machine learning are introduced in the context of symbolic, neuronal, and statistical algorithms.		
Learning outcomes: Students will be able to: • name research goals of machine learning • name and explain research questions of machine learning • name and explain basic concepts of classification learning • name symbolic, neuronal, and statistic algorithms of classification learning and apply them on given data • evaluate the fitness of algorithms for classification learning on given data • name, explain, and apply special procedures of machine learning • name and explain basic concepts of human learning • discuss connections between human learning and machine learning		
Remark: The default language of instruction in this course is German. However, the lectures and/or tutorials may be delivered in English if there are participating students who prefer English over German. Most course materials (lecture slides and tutorial notes) are available in English. The workload can roughly be split as follows: 22.5 h lecture sessions + 30 h follow-up over 15 weeks 22.5 h practice sessions + 75 h practice over 15 weeks 30 h exam preparation		
prerequisites for the module: none		
Recommended prior knowledge: Module Mathematics for Computer Scientists 1 (propositional- and first-order logic) (GdI-MfI-1) Module Algorithms and Data Structures (MI-AuD-B)		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture s Machine Learning **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Ute Schmid **Language:** German/English **Frequency:** every winter semester **Learning outcome:** see above	**2,00 Weekly Contact Hours**

Contents: In this course well-known symbolical, statistical, and neuronal approaches of machine learning are introduced in details and relations to human learning are discussed. Core topics are: decision tree algorithms, multi-layer perceptrons, instance-based learning, inductive logic programming, genetic algorithms, Bayesian learning, kernel methods, Support Vector Machines, inductive program synthesis, and reinforcement learning. The language of this course is anounced in the first lecture. **Literature:** Mitchell, Machine Learning	
2. Practices Machine Learning **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Angewandte Informatik, insb. Kognitive Systeme **Language:** German/English **Frequency:** every winter semester **Learning outcome:** see above **Contents:** Deepening of methods and techniques from the lecture partly with programming tasks and applications in RapidMiner. **Literature:** see lecture	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** In the exam 90 points can be reached. The exam is passed if 40 percent are reached. During the semester exercise sheets will be handed out. For their voluntary processing one or two weeks are available. The solutions of exercise sheets will be evaluated. If the exam is passed the evaluation of the exercise sheets will be taken into account for the calculation of the grade. It is possible to reach a 1.0 without points of the exercise sheets. Legal aids: Hand written and printed materials, a calculator without alphanumeric keypad and graphic display. The language of this exam is anounced in the first lecture.	

Module KogSys-Proj-B Bachelor Project Cognitive Systems *Bachelor-Projekt Kognitive Systeme*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Ute Schmid		
Contents: Based on the knowledge and skills from lectures and exercises of the subject cognitive systems a scientific question is processed in small groups. Competences of scientific working in the research area cognitive systems and skills in teamwork will be acquired.		
Learning outcomes: Students will be able to: • relate concrete research questions to the state of the art • design and formulate research questions and research objectives • name and explain research methods in the area of cognitive systems • name and explain fundamental principles of assessment and evaluation of research objectives • implement a problem solution or conception • execute and evaluate an empirical study according to instructions • present of algorithms and procedures formally • handle a scientific question in team • present research results orally or written		
Remark: The default language in this course is German. However, the sessions can be in English if there are participating students who prefer English over German. Background material (e.g. research papers, handbooks) for this course is available in English. The workload can be split as follows: 20 h individual appointments with lecturer 30 h literature studies (including algorithms and systems) 80 h design and realisation of the project task 10 h presentation preparation 40 h writing of the project report The written reports/seminar essay and the presentation may be delivered in English or in German.		
prerequisites for the module: none		
Recommended prior knowledge: Knowledge according to the following modules: Module Intelligent Agents (KogSys-IA-B) Module Foundations of Cognitive Computer Science (KogSys-KogInf-Psy)		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Project Cognitive Systems **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Ute Schmid, Scientific Staff Angewandte Informatik, insb. Kognitive Systeme **Language:** German/English **Frequency:** every semester **Contents:** In the project small groups of students (2-3) handle changing topics from the area of cognitive systems that are related to current research work of the group. Scientific working in the area of cognitive systems will thereby be exemplarily executed: working up relevant literature to anchoring of the topic according to the state of the art, realisation in form of the implementation of an algorithm, the evaluation of algorithms or systems based on chosen problems or the empirical investigation of a cognitive question. Representation of the results in form of a scientific publication, presentation, and defence of the work within a colloquium. **Literature:** wird in der Veranstaltung bekanntgegeben	**4,00 Weekly Contact Hours**
Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Realisation of the project task, documentation in form of a scientific publication as homework. The weighting of homework and colloquium will be announced at the beginning of the lecture by the lecturer.	

<table>
<tr><td colspan="2">Module KogSys-Proj-M Master Project Cognitive Systems
Master-Projekt Kognitive Systeme</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS19/20)
Person responsible for module: Prof. Dr. Ute Schmid</td></tr>
<tr><td colspan="3">Contents:
Based on the knowledge and skills from lectures and exercises of the subject cognitive systems a scientific question is processed in small groups. Competences of scientific working in the research area cognitive systems and skills in teamwork will be acquired.</td></tr>
<tr><td colspan="3">Learning outcomes:
Students will be able to:
• relate concrete research questions to the state of art
• design and precisely formulate research questions and research objectives
• name, explain, and evaluate research methods in the area of cognitive systems
• name and explain principles of assessment and evaluation of research objectives
• implement a problem solution or conception
• execute and evaluate an empirical study according to instructions
• present algorithms and procedures precisely and formally
• handle a scientific question in team
• present research results orally or written</td></tr>
<tr><td colspan="3">Remark:
The default language in this course is German. However, the sessions can be in English if there are participating students who prefer English over German. Background material (e.g. research papers, handbooks) for this course is available in English.

The workload can be split as follows:
20 h individual appointments with lecturer
30 h literature studies (including algorithms and systems)
80 h design and realisation of the project task
10 h presentation preparation
40 h writing of the project report
The written reports/seminar essay and the presentation may be delivered in English or in German.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Module cognitive modelling (KogSys-KogMod-M)
Module Machine Learning (KogSys-ML-M)</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>Project Cognitive Systems
Mode of Delivery: Practicals</td><td>4,00 Weekly Contact Hours</td></tr>
</table>

Lecturers: Prof. Dr. Ute Schmid, Scientific Staff Angewandte Informatik, insb. Kognitive Systeme **Language:** German/English **Frequency:** every summer semester **Contents:** In the master project small groups of students (2-3) handle changing topics from the area of cognitive systems that are related to current research work of the group. Scientific working in the area of cognitive systems will thereby be exemplarily executed: working up relevant literature for anchoring of the topic according to the state of art, realisation in form of the implementation of an algorithm, the evaluation of algorithms or systems based on chosen problems or the empirical investigation of a cognitive question. Representation of the results in form of a scientific publication, presentation, and defence of the work within a colloquium. **Literature:** wird in der Veranstaltung bekanntgegeben	
Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Realisation of project task, documentation in form of a scientific publication as homework. The weighting of homework and colloquium will be announced at the beginning of the lecture by the lecturer.	

Module MI-AuD-B Algorithms and Data Structures *Algorithmen und Datenstrukturen*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium

(since SS19)
Person responsible for module: Prof. Dr. Andreas Henrich

Contents:
Grundlegende Algorithmen (z. B. Suchen, Sortieren, einfache Graphalgorithmen) und Datenstrukturen (z. B. Listen, Hashtabellen, Bäume, Graphen) werden vorgestellt. Konzepte der Korrektheit, Komplexität und Algorithmenkonstruktion werden betrachtet.

Learning outcomes:
Das Modul vermittelt die Kompetenz, die Qualität von Datenstrukturen und Algorithmen im Hinblick auf konkrete Anforderungen einzuschätzen und ihre Implementierung in einem Programm umzusetzen. Daneben sollen grundlegende Kompetenzen im Bereich der Algorithmenkonstruktion erworben werden. Durch die Übung soll auch Sicherheit im Umgang mit objektorientierten Entwicklungsmethoden und Standardbibliotheken erworben und Teamarbeit geübt werden.

Remark:
Der **Arbeitsaufwand** für dieses Modul gliedert sich grob wie folgt:

- Vorlesung: 22,5 Stunden (entspricht den 2 SWS Vorlesung)
- Vor- und Nachbereitung der Vorlesung (inkl. Recherche und Studium zusätzlicher Quellen): ca. 30 Stunden
- Semesterbegleitendes Üben, Bearbeiten alter Klausuraufgaben, … zum Vorlesungsstoff: ca. 30 Stunden (inkl. 7,5 Stunden [= 1/3] der 2 SWS Übungsbetrieb)
- Bearbeiten der 6 Teilleistungen: insgesamt ca. 60 Stunden (inkl. 15 Stunden [= 2/3] der 2 SWS Übungsbetrieb)
- Klausurvorbereitung und Klausur: ca. 37,5 Stunden (basierend auf dem bereits im obigen Sinne erarbeiteten Stoff)

prerequisites for the module:
none

Recommended prior knowledge: Grundlegende Kenntnisse in Informatik und Programmierung (insbesondere auch Java-Programmierung), wie sie z. B. in den Modulen DSG-EiAPS-B und DSG-JaP-B vermittelt werden. Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended Module Programming in Java (DSG-JaP-B) - recommended	**Admission requirements:** none

Frequency: every summer semester	**Recommended semester:** 2.	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Algorithmen und Datenstrukturen **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Andreas Henrich **Language:** German	**2,00 Weekly Contact Hours**

Frequency: every summer semester **Contents:** Die Vorlesung betrachtet die klassischen Bereiche des Themengebiets Algorithmen und Datenstrukturen: • Einleitung • Listen • Hashverfahren • Bäume • Graphen • Sortieren • Algorithmenkonstruktion **Literature:** Als begleitende Lektüre wird ein Standardlehrbuch über Algorithmen und Datenstrukturen empfohlen. Beispiele wären: • Saake, Gunter; Sattler, Kai-Uwe: Algorithmen und Datenstrukturen: Eine Einführung mit Java, ISBN: 978-3864901362, 5. Aufl. 2013, 576 Seiten, dpunkt.lehrbuch • Ottmann, Thomas; Widmayer, Peter: Algorithmen und Datenstrukturen, ISBN: 978-3827428035, 5. Aufl. 2012, 800 Seiten, Spektrum, Akademischer Verlag	
2. Algorithmen und Datenstrukturen **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Medieninformatik **Language:** German **Frequency:** every summer semester **Contents:** In der Übung werden folgende Aspekte betrachtet: • Verständnis und Nutzung von Algorithmen • Aufwandsbestimmung für Algorithmen • Implementierung von Algorithmen und Datenstrukturen • Nutzung von Bibliotheken • Anwendung von Prinzipien zur Algorithmenkonstruktion **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** **Gegenstand** der Klausur sind alle Inhalte von Vorlesung und Übung (einschließlich der Teilleistungen; siehe unten). In der **Klausur** können 90 Punkte erzielt werden.	

Zusätzlich zur Prüfungsdauer wird eine **Lesezeit** von 15 Minuten gewährt, um die zu bearbeitenden Aufgaben im Rahmen der Wahlmöglichkeiten auswählen zu können. Im Semester werden studienbegleitend 6 **Teilleistungen** (schriftliche Hausarbeiten) in der Übung ausgegeben und besprochen, deren Abgabe freiwillig ist. Für jede Teilleistung stehen in der Regel 2 Wochen als Bearbeitungszeit zur Verfügung. Die abgegebenen Lösungen zu den Teilleistungen werden bewertet. Pro Teilleistung können maximal 2 Punkte erzielt werden. Ist die Klausur bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die bei der Bearbeitung der Teilleistungen erreichten Punkte (maximal 12 Punkte) als Bonuspunkte angerechnet. Eine 1,0 ist dabei auch ohne Punkte aus der Bearbeitung der Teilleistungen erreichbar.	

Module MI-CGuA-M Computer Graphics and Animation *Computergrafik und Animation*		6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS19/20) Person responsible for module: Prof. Dr. Andreas Henrich		
Contents: Im Modul werden alle Stufen der Grafikpipeline betrachtet. Dabei werden Fragen der Modellierung und Fragen des Rendering behandelt. Die Modellierung wird exemplarisch mit verschiedenen Verfahren konzeptionell und in der Umsetzung betrachtet.		
Learning outcomes: Studierende sollen die Modelle und Methoden der Computergrafik verstehen. Sie sollen die Stärken und Schwächen der Modelle sowie ihre Einsatzmöglichkeiten einschätzen können und die mathematischen Grundlagen hierzu beherrschen. Dabei steht die Befähigung zur zielgerichteten Nutzung entsprechender Komponenten im Vordergrund. Studierende können nach Abschluss des Moduls mit entsprechenden Systemen virtuelle Welten gestalten.		
Remark: Die Lehrveranstaltungen werden in **Deutsch** durchgeführt. Zahlreiche Quellen und Dokumentationen der Systeme sind aber auf **Englisch**. Der **Arbeitsaufwand** für dieses Modul gliedert sich grob wie folgt: • Vorlesung: 22,5 Stunden (entspricht den 2 SWS Vorlesung) • Vor- und Nachbereitung der Vorlesung (inkl. Recherche und Studium zusätzlicher Quellen): ca. 30 Stunden • Semesterbegleitendes Üben, Bearbeiten von Rechenaufgaben, Umsetzung von Beispielen, Erstellen von 3D-Modellen und Virtuellen Welten: ca. 90 Stunden (inkl. 22,5 Stunden für die 2 SWS Übungsbetrieb) • Prüfungsvorbereitung und Prüfung: ca. 37,5 Stunden (basierend auf dem bereits im obigen Sinne erarbeiteten Stoff)		
prerequisites for the module: none		
Recommended prior knowledge: Grundkenntnisse in Medieninformatik, wie sie z. B. in der Einführung in die Medieninformatik vermittelt werden. Kenntnisse in der Programmierung (z. B. in C++ oder Java). Kenntnisse in linearer Algebra. Module Mathematics for Computer Science 2 (Linear Algebra) (KTR-MfI-2) - recommended Module Algorithms and Data Structures (MI-AuD-B) - recommended Module Introduction to Media Informatics (MI-EMI-B) - recommended		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>1. Computergrafik und Animation
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Andreas Henrich
Language: German
Frequency: every winter semester
<hr>Contents:
Die Veranstaltung beschäftigt sich mit allen wichtigen Aspekten

der dreidimensionalen Computergrafik und behandelt dabei die mathematischen Grundlagen ebenso wie die Umsetzung in Werkzeugen zur Animationsentwicklung. Damit werden die Grundlagen für eine gezielte Nutzung dieser Werkzeuge bei der Erstellung von Animationen und virtuellen Welten gelegt.
Der Inhalt der Veranstaltung orientiert sich am Standardwerk von Watt:
• mathematische Grundlagen der Computergrafik,
• Beschreibung und Modellierung von dreidimensionalen Objekten,
• Darstellung und Rendering,
• die Grafik-Pipeline,
• Reflexionsmodelle,
• Beleuchtung,
• die Radiosity-Methode,
• Techniken des Ray Tracings,
• Volumen-Rendering,
• Farben in Computergrafiken,
• Image-Based Rendering und Foto-Modellierung,
• Computeranimation.
<hr>Literature:
• Watt, Alan: 3D-Computergrafik , 3. Auflage, Pearson Studium, 2001
• Steve Marschner; Peter Shirley: Fundamentals of Computer Graphics, Fourth Edition, Taylor & Francis Ltd., 2016</td><td>2,00 Weekly Contact Hours</td></tr>
<tr><td>2. Computergrafik und Animation
Mode of Delivery: Practicals
Lecturers: Scientific Staff Medieninformatik
Language: German
Frequency: every winter semester
<hr>Contents:
Praktische Übungen zum Vorlesungsstoff einschließlich der Berechnung und

Programmierung von Beispielen mit aktuellen Systemen.
<hr>Literature:
siehe Vorlesung</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

<table>
<tr><td>Examination
Written examination / Duration of Examination: 90 minutes
Description:</td><td></td></tr>
</table>

Gegenstand der Klausur sind alle Inhalte von Vorlesung und Übung (einschließlich der Teilleistungen; siehe unten). In der **Klausur** können 90 Punkte erzielt werden. Zusätzlich zur Prüfungsdauer wird eine **Lesezeit** von 15 Minuten gewährt, um die zu bearbeitenden Aufgaben im Rahmen der Wahlmöglichkeiten auswählen zu können. Im Semester werden studienbegleitend 3 **Teilleistungen** (schriftliche Hausarbeiten) in der Übung ausgegeben und besprochen, deren Abgabe freiwillig ist. Für jede Teilleistung stehen in der Regel 4 Wochen als Bearbeitungszeit zur Verfügung. Die abgegebenen Lösungen zu den Teilleistungen werden bewertet. Pro Teilleistung können maximal 4 Punkte erzielt werden. Ist die Klausur bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die bei der Bearbeitung der Teilleistungen erreichten Punkte (maximal 12 Punkte) als Bonuspunkte angerechnet. Eine 1,0 ist dabei auch ohne Punkte aus der Bearbeitung der Teilleistungen erreichbar.	

<table>
<tr><td colspan="2">Module MI-EMI-B Introduction to Media Informatics
Einführung in die Medieninformatik</td><td>6 ECTS / 180 h
45 h Präsenzzeit
135 h Selbststudium</td></tr>
<tr><td colspan="3">(since WS17/18)
Person responsible for module: Prof. Dr. Andreas Henrich</td></tr>
<tr><td colspan="3">Contents:
This course deals with media and media formats. Among that are XML for structured text, SVG and VRML for 2D- and 3D-graphics and animation, JPEG, GIF and PNG for images, PCM, MP3 for audio, as well as MPEG for video. Besides the formats the corresponding fundamentals are examined, like color- and perception-models and engineering-like development of (multi-)media systems. The intention is to teach practical skills with the mentioned formats and with the development of concepts for coding- and compression-techniques. For this, the course, which generally wants to give a broad overview of the domain, looks at selected topics in more detail. Examples for this are JPEG and MP3.</td></tr>
<tr><td colspan="3">Learning outcomes:
Studierende sollen zu den verschiedenen Medientypen Beispielformate kennenlernen. Sie sollen die eingesetzten Kompressionsverfahren sowie die dahinter stehenden Philosophien verstehen und die praktischen Einsatzmöglichkeiten einschätzen können. Ferner sollen sie konzeptuelle Kenntnisse und praktische Erfahrungen im Umgang mit Medienobjekten sammeln und z. B. die Erstellung und Bearbeitung von Medientypen wie Text, Bild, Audio und Video selbständig durchführen können.</td></tr>
<tr><td colspan="3">Remark:
All exams (basic and advanced) may be taken in English. Lectures and tutorials are offered in German.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Grundkenntnisse in Informatik (können auch durch den parallelen Besuch eines einführenden Moduls zur Informatik erworben werden)</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>1. Einführung in die Medieninformatik
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Andreas Henrich
Language: German
Frequency: every winter semester<hr>Contents:
Im Rahmen dieser Vorlesung werden nach einer Einführung in das Thema

grundlegende Medien und Medienformate betrachtet. Hierzu zählen Bilder, Audio, Texte und Typografie, Video, 2D- und 3D-Grafik.
Neben den Formaten werden die entsprechenden Grundlagen wie Farbmodelle und Wahrnehmungsmodelle betrachtet. Ziel ist dabei, praktische Fähigkeiten im Umgang mit den genannten Formaten zu vermitteln und die Konzepte von Kodierungs- und Kompressionsverfahren zu erarbeiten. Hierzu geht die Veranstaltung, die einen breiten Überblick über das Gebiet geben soll, an</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

einzelnen ausgewählten Stellen stärker in die Tiefe. Zu nennen sind dabei insbesondere die Medientypen Text, Bild, Audio, Video und 2D-Vektorgrafik. **Literature:** • Malaka, Rainer; Butz, Andreas; Hussmann, Heinrich: Medieninformatik: Eine Einführung. Pearson Studium; 1. Auflage, 2009 • Chapman, Nigel; Chapman Jenny: Digital Multimedia (2nd Edition), John Wiley & Sons, Ltd, 2004 • Henning, Peter A.: Taschenbuch Multimedia , 3. Auflage, Fachbuchverlag Leipzig im Carl Hanser Verlag, 2003 • weitere Literatur wird in der Veranstaltung bekannt gegeben	
2. Einführung in die Medieninformatik **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Medieninformatik **Language:** German **Frequency:** every winter semester **Contents:** Die Inhalte der Vorlesung Einführung in die Medieninformatik werden in den Übungen vertieft und praktisch umgesetzt. Insbesondere werden Kodierungs- und Kompressionsverfahren nachvollzogen, Medienobjekte erstellt und bearbeitet und der Umgang mit einfachen Werkzeugen (z. B. zur Bildbearbeitung) eingeübt. **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** **Gegenstand** der Klausur sind alle Inhalte von Vorlesung und Übung (einschließlich der Teilleistungen; siehe unten). In der **Klausur** können 90 Punkte erzielt werden. Zusätzlich zur Prüfungsdauer wird eine **Lesezeit** von 15 Minuten gewährt, um die zu bearbeitenden Aufgaben im Rahmen der Wahlmöglichkeiten auswählen zu können. Im Semester werden studienbegleitend 3 **Teilleistungen** (schriftliche Hausarbeiten) in der Übung ausgegeben und besprochen, deren Abgabe freiwillig ist. Für jede Teilleistung stehen in der Regel 4 Wochen als Bearbeitungszeit zur Verfügung. Die abgegebenen Lösungen zu den Teilleistungen werden bewertet. Pro Teilleistung können maximal 4 Punkte erzielt werden. Ist die Klausur bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die bei der Bearbeitung der Teilleistungen erreichten Punkte (maximal 12 Punkte) als Bonuspunkte angerechnet. Eine 1,0 ist dabei auch ohne Punkte aus der Bearbeitung der Teilleistungen erreichbar.	

Module MI-IR-M Information Retrieval (Foundations, Models and Applications) *Information Retrieval (Grundlagen, Modelle und Anwendungen)*		6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS18/19) Person responsible for module: Prof. Dr. Andreas Henrich		
Contents: Die typischen Inhalte eines Information Retrieval Moduls vom Verständnis des Informationsbedürfnisses bis zur Implementierung von Suchmaschinen werden besprochen. Schwerpunkte liegen dabei auf IR-Modellen, der Formulierung von Anfragen, der Analyse und Repräsentation von Texten, der Ergebnisdarstellung sowie der Evaluierung von IR-Systemen.		
Learning outcomes: Studierende sollen Aufgabenstellung, Modelle und Methoden des Information Retrieval kennen. Dabei soll die Fähigkeit zur Nutzung und zur Mitwirkung bei der Konzeption von Suchlösungen für Internet- und Intranet-Applikationen vermittelt werden. Ebenso sollen die grundsätzlichen Implementierungstechniken und ihre Vor- und Nachteile verstanden werden.		
Remark: Die Lehrveranstaltungen werden in **Deutsch** durchgeführt. Zahlreiche Quellen und Dokumentationen der Systeme sind aber auf **Englisch**. Der Arbeitsaufwand von insgesamt 180 Std. gliedert sich in etwa in: • Vorlesung: 22,5 Stunden (entspricht den 2 SWS Vorlesung) • Vor- und Nachbereitung der Vorlesung (inkl. Recherche und Studium zusätzlicher Quellen): ca. 30 Stunden • Semesterbegleitendes Üben, Bearbeiten alter Klausuraufgaben, … zum Vorlesungsstoff: ca. 30 Stunden (inkl. 7,5 Stunden [= 1/3] der 2 SWS Übungsbetrieb) • Bearbeiten der 3 Teilleistungen: insgesamt ca. 60 Stunden (inkl. 15 Stunden [= 2/3] der 2 SWS Übungsbetrieb) • Prüfungsvorbereitung und Prüfung: ca. 37,5 Stunden (basierend auf dem bereits im obigen Sinne erarbeiteten Stoff)		
prerequisites for the module: none		
Recommended prior knowledge: Gundlegende Kenntnisse in Java, Algorithmen und Datenstrukturen sowie linearer Algebra. Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended Module Algorithms and Data Structures (MI-AuD-B) - recommended Module Database Systems (MOBI-DBS-B) - recommended		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Information Retrieval **Mode of Delivery:** Lectures	**2,00 Weekly Contact Hours**

Lecturers: Prof. Dr. Andreas Henrich **Language:** German **Frequency:** every winter semester **Contents:** Gegenstand des Information Retrieval (IR) ist die Suche nach Dokumenten. Traditionell handelt es sich dabei im Allgemeinen um Textdokumente. In neuerer Zeit kommt aber verstärkt auch die Suche nach multimedialen Dokumenten (Bilder, Audio, Video, Hypertext-Dokumente) hinzu. Ferner hat das Gebiet des Information Retrieval insbesondere auch durch das Aufkommen des WWW an Bedeutung und Aktualität gewonnen. Die Veranstaltung betrachtet die wesentlichen Modelle des Information Retrieval und Algorithmen zu ihrer Umsetzung. Auch Fragen der Evaluierung von IR-Systemen werden betrachtet. Folgende Bereiche werden betrachtet: • Suchmaschinen und Information Retrieval: Konzepte und Grundlagen • Die Architektur einer Suchmaschine • Die Evaluierung von Suchmaschinen • Retrieval-Modelle • Indexstrukturen, Algorithmen und Datenstrukturen für IR • Umgang mit Text(dokumenten) • Anfragen / Benutzerschnittstellen / Interaktion • Crawls and Feeds – oder: Was wird wann indexiert? • Suche für Bilder und andere Medientypen **Literature:** Die Veranstaltung orientiert sich an: • Croft, W Bruce; Metzler, Donald; Strohman, Trevor (2010, erschienen 2009): Search engines. Information retrieval in practice. Boston: Addison-Wesley. Als ergänzende Quelle und zum Nachschlagen wird empfohlen: • Henrich, Andreas: Lehrtext "Information Retrieval 1 (Grundlagen, Modelle und Anwendungen)", http://www.uni-bamberg.de/minf/ir1_buch/ Weitere Bücher zum Thema (z. B.): • Baeza-Yates, Ricardo; Ribeiro-Neto, Berthier: Modern Information Retrieval, Addison Wesley; Auflage: 2ed edition, Boston, MA, USA, 2010	
2. Information Retrieval **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Medieninformatik **Language:** German **Frequency:** every winter semester **Contents:** praktische Übungen zum Vorlesungsstoff einschließlich der Programmierung kleiner IR-Systeme **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** **Gegenstand** der Klausur sind alle Inhalte von Vorlesung und Übung (einschließlich der Teilleistungen; siehe unten). In der **Klausur** können 90 Punkte erzielt werden. Zusätzlich zur Prüfungsdauer wird eine **Lesezeit** von 15 Minuten gewährt, um die zu bearbeitenden Aufgaben im Rahmen der Wahlmöglichkeiten auswählen zu können. Im Semester werden studienbegleitend 3 **Teilleistungen** (schriftliche Hausarbeiten) in der Übung ausgegeben und besprochen, deren Abgabe freiwillig ist. Für jede Teilleistung stehen in der Regel 4 Wochen als Bearbeitungszeit zur Verfügung. Die abgegebenen Lösungen zu den Teilleistungen werden bewertet. Pro Teilleistung können maximal 4 Punkte erzielt werden. Ist die Klausur bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die bei der Bearbeitung der Teilleistungen erreichten Punkte (maximal 12 Punkte) als Bonuspunkte angerechnet. Eine 1,0 ist dabei auch ohne Punkte aus der Bearbeitung der Teilleistungen erreichbar.	

<table>
<tr><td colspan="2">Module MI-Proj-B Media Informatics Project [Bachelor]
Projekt zur Medieninformatik [Bachelor]</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS16/17)
Person responsible for module: Prof. Dr. Andreas Henrich</td></tr>
<tr><td colspan="3">Contents:
Aufbauend auf den in den Vorlesungen und Übungen des Faches Medieninformatik erworbenen Kenntnissen und Fertigkeiten wird in diesem Projekt für ein Anwendungsszenario ein System konzipiert und implementiert. Die Arbeit erfolgt im Team. Die Themen werden den Bereichen Web-Anwendungen bzw. Multimediale Systeme entnommen.</td></tr>
<tr><td colspan="3">Learning outcomes:
Die Kompetenz zur systematischen Entwicklung von Systemen in einem arbeitsteiligen Team wird vertieft. Kompetenzen in den Bereichen Anforderungsermittlung, Systemdesign, Implementierung, Evaluation und Dokumentation werden vermittelt. Ferner werden durch die Arbeit im Team Kompetenzen im Bereich Teamfähigkeit gestärkt.</td></tr>
<tr><td colspan="3">Remark:
Die Lehrveranstaltung wird in Deutsch durchgeführt. Zahlreiche Quellen und Dokumentationen sind aber auf Englisch verfasst.

Der Arbeitsaufwand für dieses Modul gliedert sich in folgende Bereiche:
• Teilnahme an einführenden Präsenzveranstaltungen
• Teilnahme an (Gruppen-)Besprechungen und Zwischenpräsentationen
• Bearbeitung der Projektaufgabenstellung allein und im Team
• Vor- und Nachbereitung von Projektbesprechungen und -präsentationen
• Prüfungsvorbereitung und Prüfung

Die Aufwände können dabei in Abhängigkeit von der Aufgabenstellung und der in der Gruppe abgestimmten Aufgabenverteilung unter den Gruppenmitgliedern sehr unterscheidlich auf die Bereiche verteilt sein.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
none
Module Introduction to Media Informatics (MI-EMI-B) - recommended
Module Web Technologies (MI-WebT-B) - recommended</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>Projekt zur Medieninformatik
Mode of Delivery: Practicals
Lecturers: Prof. Dr. Andreas Henrich, Scientific Staff Medieninformatik
Language: German
Frequency: every winter semester
Contents:</td><td>4,00 Weekly Contact Hours</td></tr>
</table>

Im Projekt werden wechselnde Projektthemen zu den Inhalten der Lehrveranstaltungen im Bereich der Medieninformatik bearbeitet. Dabei sind im Regelfall Aspekte mehrerer Lehrveranstaltungen relevant, so dass sich Teams mit Studierenden, die unterschiedliche Lehrveranstaltungen besucht haben, gut ergänzen. Die in einem Projektpraktikum bearbeitete Aufgabenstellung geht dabei deutlich über den Umfang einer normalen Übungsaufgabe hinaus und wird in kleinen Gruppen bearbeitet. Das erarbeitete Ergebnis wird dokumentiert und in einer Abschlusspräsentation vorgestellt.	
Literature: wird in der Veranstaltung bekannt gegeben	

Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 6 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Hausarbeit (Dokumentation und Reflexion des Projektes und des Projektverlaufes) sowie ca. 20 Min. Kolloquium zum Projektergebnis und zum Projektverlauf (in der Regel im Rahmen eines Gruppenkolloquiums)	

Module MI-Proj-M Media Informatics Project *Projekt zur Medieninformatik*		6 ECTS / 180 h
(since WS18/19) Person responsible for module: Prof. Dr. Andreas Henrich		
Contents: Aufbauend auf den in den Vorlesungen und Übungen des Faches Medieninformatik erworbenen Kenntnissen und Fertigkeiten wird in diesem Projekt für ein Anwendungsszenario ein System konzipiert und implementiert. Die Arbeit erfolgt im Team. Die Themen werden den Bereichen Web-Anwendungen bzw. Suchsysteme entnommen.		
Learning outcomes: Im Projekt werden die Kompetenzen im Bereich der Systementwicklung ebenso weiterentwickelt wie die Kompetenzen in der Projektdurchführung und in der Gruppenarbeit. Das Projekt [Master] unterscheidet sich dabei von der Projektarbeit im Bachelorstudiengang (MI-Proj-B) durch die Komplexität der Aufgabe und den direkten Bezug zu aktuellen wissenschaftlichen Arbeiten des Lehrstuhls.		
Remark: Die Lehrveranstaltung wird in **Deutsch** durchgeführt. Zahlreiche Quellen und Dokumentationen sind aber auf **Englisch** verfasst. Der Arbeitsaufwand für dieses Modul gliedert sich in folgende Bereiche: • Teilnahme an einführenden Präsenzveranstaltungen • Teilnahme an (Gruppen-)Besprechungen und Zwischenpräsentationen • Bearbeitung der Projektaufgabenstellung allein und im Team • Vor- und Nachbereitung von Projektbesprechungen und -präsentationen • Prüfungsvorbereitung und Prüfung Die Aufwände können dabei in Abhängigkeit von der Aufgabenstellung und der in der Gruppe abgestimmten Aufgabenverteilung unter den Gruppenmitgliedern unterscheidlich auf die Bereiche verteilt sein.		
prerequisites for the module: none		
Recommended prior knowledge: none Module Introduction to Media Informatics (MI-EMI-B) - recommended Module Information Retrieval 1 (Foundations, Models and Applications) (MI-IR1-M) - recommended Module Web Technologies (MI-WebT-B) - recommended		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Projekt zur Medieninformatik [Master] **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Andreas Henrich, Scientific Staff Medieninformatik **Language:** German **Frequency:** every summer semester	**4,00 Weekly Contact Hours**

Contents: Im Projekt werden wechselnde Projektthemen zu den Inhalten der Lehrveranstaltungen im Bereich der Medieninformatik bearbeitet. Dabei sind im Regelfall Aspekte mehrerer Lehrveranstaltungen relevant, so dass sich Teams mit Studierenden, die unterschiedliche Lehrveranstaltungen besucht haben, gut ergänzen. Die in einem Projektpraktikum bearbeitete Aufgabenstellung geht dabei deutlich über den Umfang einer normalen Übungsaufgabe hinaus und wird in kleinen Gruppen bearbeitet. Das erarbeitete Ergebnis wird dokumentiert und in einer Abschlusspräsentation vorgestellt.	
Literature: wird in der Veranstaltung bekannt gegeben	

Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Hausarbeit (Dokumentation und Reflexion des Projektes und des Projektverlaufes) sowie ca. 20 Min. Kolloquium zum Projektergebnis und zum Projektverlauf (in der Regel im Rahmen eines Gruppenkolloquiums)	

Module MI-Sem-B Media Informatics Seminar [Bachelor] *Bachelorseminar zur Medieninformatik*		3 ECTS / 90 h
(since WS12/13) Person responsible for module: Prof. Dr. Andreas Henrich		
Contents: Aufbauend auf den in den Vorlesungen und Übungen des Faches Medieninformatik erworbenen Kenntnissen und Fertigkeiten wird in diesem Seminar die eigenständige Erarbeitung und Präsentation von Themengebieten auf Basis der Literatur verfolgt.		
Learning outcomes: Im Seminar werden die Fähigkeiten im Bereich der kritischen und systematischen Literaturrecherche und -betrachtung ebenso weiterentwickelt wie die Kompetenzen in der Präsentation von Fachthemen (schriftlich und im Vortrag) sowie deren Diskussion.		
Remark: Die Lehrveranstaltung wird in **Deutsch** durchgeführt. Zahlreiche Quellen und Dokumentationen sind aber auf **Englisch** verfasst. Der **Arbeitsaufwand** für dieses Modul gliedert sich typischerweise in folgende Bereiche: • Teilnahme an den Präsenzveranstaltungen (Themenvergabe, Besprechungen, Präsentationen): ca. 20 Stunden • Literaturrecherche ...: ca. 25 Stunden • Vorbereitung der Präsentation: ca. 15 Stunden • Erstellen der schriftlichen Ausarbeitung: ca. 30 Stunden		
prerequisites for the module: none		
Recommended prior knowledge: Kenntnisse entsprechend den unten angegebenen Modulen. Details werden in jedem Semester in der Vorbesprechung oder der Vorankündigung bekannt gegeben. Module Algorithms and Data Structures (MI-AuD-B) - recommended Module Introduction to Media Informatics (MI-EMI-B) - recommended Module Web Technologies (MI-WebT-B) - recommended		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelorseminar Medieninformatik **Mode of Delivery:** Introductory seminar **Lecturers:** Prof. Dr. Andreas Henrich, Scientific Staff Medieninformatik **Language:** German **Frequency:** every summer semester **Contents:**	**2,00 Weekly Contact Hours**

Im Seminar werden wechselnde aktuelle Forschungsthemen zu den Inhalten der Lehrveranstaltungen bearbeitet. Dabei sind im Regelfall Aspekte mehrerer Lehrveranstaltungen relevant. **Literature:** wird jeweils zu Beginn der Veranstaltung bekannt gegeben	
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes **Description:** Hausarbeit und Referat zu dem im Seminar vom Teilnehmer bzw. von der Teilnehmerin bearbeiteten Thema, inkl. Diskussion	

Module MI-Sem-M Media Informatics Seminar [Master] *Masterseminar zur Medieninformatik*	3 ECTS / 90 h

(since WS12/13)
Person responsible for module: Prof. Dr. Andreas Henrich

Contents:
Aufbauend auf den in den Vorlesungen und Übungen des Faches Medieninformatik erworbenen Kenntnissen und Fertigkeiten wird in diesem Seminar die eigenständige Erarbeitung und Präsentation von Themengebieten auf Basis der Literatur verfolgt.

Learning outcomes:
Im Seminar werden die Fähigkeiten im Bereich der kritischen und systematischen Literaturrecherche und -betrachtung ebenso weiterentwickelt wie die Kompetenzen in der Präsentation von Fachthemen (schriftlich und im Vortrag) sowie deren Diskussion. Gegenüber dem Seminar für Bachelor unterscheidet sich das Seminar für Master durch den höheren wissenschaftlichen Anspruch der Themenstellungen und der erwarteten Hausarbeit sowie der Präsentation.

Remark:
Die Lehrveranstaltung wird in **Deutsch** durchgeführt. Zahlreiche Quellen und Dokumentationen sind aber auf **Englisch** verfasst.

Der **Arbeitsaufwand** für dieses Modul gliedert sich typischerweise in folgende Bereiche:

- Teilnahme an den Präsenzveranstaltungen (Themenvergabe, Besprechungen, Präsentationen): ca. 20 Stunden
- Literaturrecherche ...: ca. 25 Stunden
- Vorbereitung der Präsentation: ca. 15 Stunden
- Erstellen der schriftlichen Ausarbeitung: ca. 30 Stunden

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
Kenntnisse entsprechend den unten angegebenen Modulen. Die tatsächlich inhaltlich erforderlichen Voraussetzungen richten sich dabei nach dem im aktuellen Semester betrachteten Themenfeld. Module Algorithms and Data Structures (MI-AuD-B) - recommended Module Introduction to Media Informatics (MI-EMI-B) - recommended Module Information Retrieval 1 (Foundations, Models and Applications) (MI-IR1-M) - recommended Module Web Technologies (MI-WebT-B) - recommended	none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Masterseminar Medieninformatik **Mode of Delivery:** Key competence **Lecturers:** Prof. Dr. Andreas Henrich, Scientific Staff Medieninformatik **Language:** German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**

Contents: Im Seminar werden wechselnde aktuelle Forschungsthemen zu den Inhalten der Lehrveranstaltungen bearbeitet. Dabei sind im Regelfall Aspekte mehrerer Lehrveranstaltungen relevant. **Literature:** wird in der Veranstaltung bekannt gegeben	
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes **Description:** Schriftliche Ausarbeitung sowie Vortrag zu dem im Seminar vom Teilnehmer bzw. von der Teilnehmerin bearbeiteten Thema; inkl. Diskussion	

Module MI-WebT-B Web Technologies *Web-Technologien*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS17/18) Person responsible for module: Prof. Dr. Andreas Henrich	

Contents:

Nach einer Betrachtung der Grundlagen werden die verschiedenen Ebenen der Entwicklung von Web-Anwendungen von HTML und CSS über JavaScript und entsprechende Bibliotheken bis hin zur Serverseite und Frameworks oder Content Management Systemen betrachtet. Aspekte der Sicherheit von Web-Anwendungen werden ebenfalls angesprochen.

Learning outcomes:

Studierende sollen methodische, konzeptuelle und praktische Fähigkeiten und Fertigkeiten zur Erstellung von Web-Applikationen erwerben. Besonderes Augenmerk wird dabei auf Web 2.0 Technologien gelegt. Die Studierenden sind nach Abschluss des Moduls in der Lage, Web-Anwendungen selbständig mit gängigen Frameworks und Techniken zu entwickeln.

Remark:

Die Lehrveranstaltungen werden in **Deutsch** durchgeführt. Zahlreiche Quellen und Dokumentationen der Systeme sind aber auf **Englisch**.

Der **Arbeitsaufwand** für dieses Modul gliedert sich grob wie folgt:

- Vorlesung: 22,5 Stunden (entspricht den 2 SWS Vorlesung)
- Vor- und Nachbereitung der Vorlesung (inkl. Recherche und Studium zusätzlicher Quellen): ca. 30 Stunden
- Semesterbegleitendes Üben, Bearbeiten alter Klausuraufgaben, ... zum Vorlesungsstoff: ca. 30 Stunden (inkl. 7,5 Stunden [= 1/3] der 2 SWS Übungsbetrieb)
- Bearbeiten der 3 Teilleistungen: insgesamt ca. 60 Stunden (inkl. 15 Stunden [= 2/3] der 2 SWS Übungsbetrieb)
- Prüfungsvorbereitung und Prüfung: ca. 37,5 Stunden (basierend auf dem bereits im obigen Sinne erarbeiteten Stoff)

prerequisites for the module:

none

Recommended prior knowledge: Grundkenntnisse der Informatik und zu Medienformaten, wie Sie z. B. in den unten angegebenen Modulen erworben werden können. Insbesondere sind auch Kenntnisse in einer imperativen oder objektorientierten Programmiersprache erforderlich. Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B) - recommended Module Introduction to Media Informatics (MI-EMI-B) - recommended	**Admission requirements:** none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Web-Technologien **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Andreas Henrich **Language:** German **Frequency:** every summer semester **Contents:** Die Veranstaltung betrachtet die Aufgabenfelder, Konzepte und Technologien zur Entwicklung von Web-Anwendungen. Folgende Bereiche bilden dabei die Schwerpunkte der Veranstaltung: • Das Web: Einführung, Architektur, Protokoll ... • Sprachen zur Beschreibung von Webseiten: HTML & CSS • Client-Side Scripting: Basics, AJAX, Bibliotheken • Server-Side Scripting: PHP und weiterführende Konzepte • Frameworks • Sicherheit von Web-Anwendungen • CMS, LMS, SEO & Co. **Literature:** aktuelle Literatur wird in der Veranstaltung bekannt gegeben	**2,00 Weekly Contact Hours**
2. Web-Technologien **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Medieninformatik **Language:** German **Frequency:** every summer semester **Contents:** praktische Aufgaben zum Stoff der Vorlesung **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**

Examination

Written examination / Duration of Examination: 90 minutes

Description:

Gegenstand der Klausur sind alle Inhalte von Vorlesung und Übung (einschließlich der Teilleistungen; siehe unten).

In der **Klausur** können 90 Punkte erzielt werden.

Zusätzlich zur Prüfungsdauer wird eine **Lesezeit** von 15 Minuten gewährt, um die zu bearbeitenden Aufgaben im Rahmen der Wahlmöglichkeiten auswählen zu können.

Im Semester werden studienbegleitend 3 **Teilleistungen** (schriftliche Hausarbeiten) in der Übung ausgegeben und besprochen, deren Abgabe freiwillig ist. Für jede Teilleistung stehen in der Regel 4 Wochen als Bearbeitungszeit zur Verfügung. Die abgegebenen Lösungen zu den Teilleistungen werden bewertet. Pro Teilleistung können maximal 4 Punkte erzielt werden. Ist die

Klausur bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die bei der Bearbeitung der Teilleistungen erreichten Punkte (maximal 12 Punkte) als Bonuspunkte angerechnet. Eine 1,0 ist dabei auch ohne Punkte aus der Bearbeitung der Teilleistungen erreichbar.	

Module MOBI-ADM-M Advanced Data Management *Advanced Data Management*		6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since SS19 to WS19/20) Person responsible for module: Prof. Dr. Daniela Nicklas		
Contents: With the rapid growth of the internet and more and more observable processes, many data sets became so large that they cannot be processed with traditional database methods any more. This modul covers advanced data management and integration techniques (also known under the term “big data”) that are useful when dealing with very large data sets.		
Learning outcomes: The students will understand the challenges of big data, and will be able to apply some of the new techniques to deal with it.		
Remark: The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German. The written reports/seminar essay and the presentation may be delivered in English or in German.		
prerequisites for the module: none		
Recommended prior knowledge: Foundations of relational databases, relational algebra and SQL; e.g. from Modul SEDA-DMS-B: Data management systems		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Advanced Data Management **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Daniela Nicklas **Language:** English **Frequency:** every summer semester **Contents:** The lecture will cover various algorithms for clustering, association rule mining, or page ranking and their scalable processing using map and reduce methods, data integration, data cleansing and entity recognition. The exercises will be built upon the Hadoop framework. The language of the course will be announced in the first lecture. **Literature:** L. Wiese, Advanced Data Management, For SQL, NoSQL, Cloud and Distributed Databases. Berlin, Boston: De Gruyter, 2015	**2,00 Weekly Contact Hours**
2. Practicals Advanced Data Management **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Daniela Nicklas	**2,00 Weekly Contact Hours**

Language: English **Frequency:** every summer semester **Contents:** see Lectures The language of the course will be announced in the first lecture.	
Examination Oral examination / Duration of Examination: 15 minutes **Description:** The language of the exam will be announced in the first lecture.	

Examination Written examination / Duration of Examination: 60 minutes **Description:** Mündliche Prüfung oder Schriftliche Prüfung (wird zu Beginn des Semesters durch Ankündigung in der Veranstaltung festgelegt). Die Prüfungssprache ist Englisch.	

Module MOBI-DSC-M Data Streams and Complex Event Processing *Data Streams and Complex Event Processing*		6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS19/20) Person responsible for module: Prof. Dr. Daniela Nicklas		
Contents: The management of data streams and foundations of event processing: Applications, systems, query languages, continuous query processing, and security in distributed data stream management systems. The modul covers the following topics: Architectures of data stream management systems; Query languages; Data stream processing; Complex event processing; Security in data stream management systems; Application of data stream management systems		
Learning outcomes: Understand the challenges of data stream management and complex event processing Recognize and link basic building blocks of data stream management tasks in different frameworks and systems Develop and program queries on data streams and event streams in different query languages to process data streams and detect event patterns Understand basic implementation techniques for data stream operators Understand the main security challenges and solutions in data stream management systems		
prerequisites for the module: none		
Recommended prior knowledge: Foundations of relational databases, relational algebra and SQL; e.g. from Modul MOBI-DBS-B: Database Systems		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Data Streams and Complex Event Processing **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Daniela Nicklas **Language:** English **Frequency:** every winter semester **Learning outcome:** Understand the challenges of data stream management and complex event processing Recognize and link basic building blocks of data stream management tasks in different frameworks and systems Develop and program queries on data streams and event streams in different query languages to process data streams and detect event patterns Understand basic implementation techniques for data stream operators	**2,00 Weekly Contact Hours**

Understand the main security challenges and solutions in data stream management systems **Contents:** The management of data streams and foundations of event processing: Applications, systems, query languages, continuous query processing, and security in distributed data stream management systems. The modul covers the following topics: Architectures of data stream management systems; Query languages; Data stream processing; Complex event processing; Security in data stream management systems; Application of data stream management systems	
Examination Oral examination / Duration of Examination: 15 minutes **Description:** Mündliche Prüfung oder Schriftliche Prüfung (wird zu Beginn des Semesters durch Ankündigung in der Veranstaltung festgelegt). Die Prüfungssprache ist Englisch.	

Examination Written examination / Duration of Examination: 60 minutes **Description:** Mündliche Prüfung oder Schriftliche Prüfung (wird zu Beginn des Semesters durch Ankündigung in der Veranstaltung festgelegt). Die Prüfungssprache ist Englisch.	

Module MOBI-MSS-B Mobility in Software Systems *Mobility in Software Systems*		6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since SS19 to SS20) Person responsible for module: Prof. Dr. Daniela Nicklas		
Contents: This modul covers architectures, implementation techniques and algorithms for mobile software systems and software systems that manage mobility. This includes client-side aspects (mobile applications like location-based services), server-side aspects (data management of moving objects), and aspects of distribution (data communication). In addition, since many mobile software systems deal with sensitive information like the location of users, aspects of location privacy are covered.		
Learning outcomes: The students will understand the challenges of mobility in software systems, and will be able to apply techniques and methods to realize such systems.		
Remark: The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German. The written reports/seminar essay and the presentation may be delivered in English or in German.		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge about relational databases, relational algebras and SQL (e.g. from module SEDA-DMS-B: Datenmanagementsysteme)		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Mobility in Software Systems **Mode of Delivery:** Lectures and Practicals **Language:** English **Frequency:** every winter semester **Learning outcome:** The students will understand the challenges of mobility in software systems, and will be able to apply techniques and methods to realize such systems. **Contents:** The language of the course will be announced in the first lecture.	**4,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** The language of the exam will be announced in the first lecture.	

Module MOBI-PRAI-B Bachelor Project Mobile Software Systems (AI) *Bachelor Project Mobile Software Systems (AI)*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Daniela Nicklas		
Contents: Applications of in mobile software systems, which are taken from current research activities in mobile, context-aware systems and data stream management, are carried out in part individually and in part in small teams of students, from conception, via theoretical and/or practical realization, to evaluation. In particular, the project concerns the development of sound concepts pertaining to the task to be addressed under the given project constraints. This requires studying the current research literature and relevant approaches on the project's topic. An example of a project task would be the conceptual development, the prototypic implementation, and the case-study-driven evaluation of a small sensor-based, mobile system, which would require knowledge from the modul MOBI-DSC Data streams and event processing. The tasks in the project will be tailored to Bachelor level.		
Learning outcomes: Studierende sollen ein vertieftes Verständnis der bei der Durchführung von praktischen, arbeitsteilig organisierten, Softwareprojekten auftretenden Probleme wie auch von erfolgversprechenden Lösungsansätzen zu diesen Problemen erhalten. Da dies anhand der intensiven Bearbeitung eines Themas aus dem Forschungsbereich der praktischen Informatik geschieht, gewinnen die TeilnehmerInnen wichtige Erfahrungen mit der Durchführung kleinerer, forschungsorientierter Projekte von der Grobkonzeption über die Detailplanung bis hin zur Umsetzung und Dokumentation der Ergebnisse in einem wissenschaftlich ausgerichteten Arbeitsbericht.		
Remark: The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German. The written reports/seminar essay and the presentation may be delivered in English or in German.		
prerequisites for the module: none		
Recommended prior knowledge: Programmierkenntnisse sowie grundlegende methodische Kenntnisse zur Planung und Durchführung von Softwareprojekten, z. B. erworben im Modul "Software Engineering Lab" (SWT-SWL-B), und zum wissenschaftlichen Arbeiten, z. B. erworben im Modul "Wissenschaftliches Arbeiten in der Informatik" (IAIWAI-B).		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelor project Mobile Software Systems (AI) **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Daniela Nicklas	**4,00 Weekly Contact Hours**

Language: English/German **Frequency:** every summer semester **Contents:** Projektdurchführung	
Examination Coursework Assignment and Colloquium **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Prüfung Hausarbeit mit Kolloquium Production of a written report on the software project carried out (Assignment/ Hausarbeit). Discussion of this project report and of the developed artefacts in the context of the wider project topic (Colloquium/Kolloquium).	

Module MOBI-PRAI-M Master Project Mobile Software Systems (AI) *Master Project Mobile Software Systems (AI)*	6 ECTS / 180 h

(since WS19/20)
Person responsible for module: Prof. Dr. Daniela Nicklas

Contents:
Applications of in mobile software systems, which are taken from current research activities in mobile, context-aware systems and data stream management, are carried out in part individually and in part in small teams of students, from conception, via theoretical and/or practical realization, to evaluation. In particular, the project concerns the development of sound concepts pertaining to the task to be addressed under the given project constraints. This requires studying the current research literature and relevant approaches on the project's topic.

An example of a project task would be the conceptual development, the prototypic implementation, and the case-study-driven evaluation of a small sensor-based, mobile system, which would require knowledge from the modul MOBI-DSC Data streams and event processing.

The tasks in the project will be tailored to Master level.

Learning outcomes:
Students will deepen their knowledge regarding the conceptual problems that arise when carrying out theoretical and/or practical research on software projects, and regarding approaches to possible solutions. Since this will be done by means of the intensive conduct of a research topic in Mobile Software Systems, students will gain important experience in carrying out research-oriented projects, from project planning, to the abstract and concrete design, to the realization, to the documentation of results in a scientific project report.

Remark:
The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German.

The written reports/seminar essay and the presentation may be delivered in English or in German.

prerequisites for the module:
none

Recommended prior knowledge: Foundations of relational databases, relational algebra and SQL; e.g. from Modul SEDA-DMS-B: Data management systems		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Master project Mobile Software Systems (AI) **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Daniela Nicklas **Language:** English/German **Frequency:** every winter semester **Contents:** The language of the course will be announced in the first lecture.	**4,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** The language of the exam will be announced in the first lecture.	

Module MOBI-PRS-B Bachelor Project Mobile Software Systems (SoSySc) *Bachelor Project Mobile Software Systems (SoSySc)*	12 ECTS / 360 h
(since WS19/20) Person responsible for module: Prof. Dr. Daniela Nicklas	

Contents:

Applications of in mobile software systems, which are taken from current research activities in mobile, context-aware systems and data stream management, are carried out in part individually and in part in small teams of students, from conception, via theoretical and/or practical realization, to evaluation. In particular, the project concerns the development of sound concepts pertaining to the task to be addressed under the given project constraints. This requires studying the current research literature and relevant approaches on the project's topic.

An example of a project task would be the conceptual development, the prototypic implementation, and the case-study-driven evaluation of a small sensor-based, mobile system, which would require knowledge from the modul MOBI-DSC Data streams and event processing.

The tasks in the project will be tailored to Bachelor level.

Learning outcomes:

Studierende sollen ein vertieftes Verständnis der bei der Durchführung von Softwaresystem-Projekten auftretenden konzeptionellen und praktischen Probleme wie auch von erfolgsversprechenden Lösungsansätzen zu diesen Problemen erhalten. Da dies anhand der intensiven Bearbeitung eines Themas aus dem Forschungsbereich von mobilen Softwaresystemen in Kleingruppen – oder ggf. auch einzeln – geschieht, gewinnen die Studierenden wichtige Erfahrungen in der Durchführung kleinerer, forschungsorientierter Projekte von der Grobkonzeption über die Detailplanung bis hin zur Umsetzung und Dokumentation der Ergebnisse in wissenschaftlich ausgerichteten Arbeitsberichten und in der Präsentation dieser Ergebnisse.

Remark:

The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German.

The written reports/seminar essay and the presentation may be delivered in English or in German.

prerequisites for the module:

none

Recommended prior knowledge: Programmierkenntnisse sowie grundlegende methodische Kenntnisse zur Planung und Durchführung von Softwareprojekten, z. B. erworben im Modul "Software Engineering Lab" (SWT-SWL-B), und zum wissenschaftlichen Arbeiten, z. B. erworben im Modul "Wissenschaftliches Arbeiten in der Informatik" (IAIWAI-B).	**Admission requirements:** none

Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 2 Semester

Module Units	
Bachelor project Mobile Software Systems (SoSySc) **Mode of Delivery:** Practicals	**8,00 Weekly Contact Hours**

Lecturers: Prof. Dr. Daniela Nicklas **Language:** English/German **Frequency:** every semester	
Contents: The language of the course will be announced in the first lecture.	

Examination Coursework Assignment and Colloquium **prerequisites for module examination:** regelmäßige Teilnahme an der Lehrveranstaltung **Description:** The language of the exam will be announced in the first lecture.	

Module MOBI-PRS-M Master Project Mobile Software Systems (SoSySc) *Master Project Mobile Software Systems (SoSySc)*		9 ECTS / 270 h
(since WS19/20) Person responsible for module: Prof. Dr. Daniela Nicklas		
Contents: Applications of in mobile software systems, which are taken from current research activities in mobile, context-aware systems and data stream management, are carried out in part individually and in part in small teams of students, from conception, via theoretical and/or practical realization, to evaluation. In particular, the project concerns the development of sound concepts pertaining to the task to be addressed under the given project constraints. This requires studying the current research literature and relevant approaches on the project's topic. An example of a project task would be the conceptual development, the prototypic implementation, and the case-study-driven evaluation of a small sensor-based, mobile system, which would require knowledge from the modul MOBI-DSC Data streams and event processing. The tasks in the project will be tailored to Master level.		
Learning outcomes: Students will deepen their knowledge regarding the conceptual problems that arise when carrying out theoretical and/or practical research and software projects, and regarding approaches to possible solutions. Since this will be done by means of the intensive conduct of a research topic in Mobile Software Systems, students will gain important experience in carrying out research-oriented projects, from project planning, to the abstract and concrete design, to the realization, to the documentation of results in a scientific project report.		
Remark: The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German. The written reports/seminar essay and the presentation may be delivered in English or in German.		
prerequisites for the module: none		
Recommended prior knowledge: Foundations of relational databases, relational algebra and SQL; e.g. from Modul SEDA-DMS-B: Data management systems		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Master Project Mobile Software Systems (SoSySc) **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Daniela Nicklas **Language:** English/German **Frequency:** every summer semester **Contents:**	**6,00 Weekly Contact Hours**

Conduct of the project, accompanied by regular meetings between students and lecturer. The language of the course will be announced in the first lecture.	
Examination Coursework Assignment and Colloquium **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Production of a written report on the software project carried out (Assignment/ Hausarbeit). Discussion of this project report and of the developed artefacts in the context of the wider project topic (Colloquium/Kolloquium). The language of the exam will be announced in the first lecture.	

<table>
<tr><td>Module PSI-AdvaSP-M Advanced Security and Privacy
Advanced Security and Privacy</td><td>6 ECTS / 180 h
45 h Präsenzzeit
135 h Selbststudium</td></tr>
<tr><td colspan="2">(since SS18)
Person responsible for module: Prof. Dr. Dominik Herrmann</td></tr>
<tr><td colspan="2">Contents:
Information security and privacy are relevant in almost all information systems today. Many real-world use cases have complex security and privacy requirements involving multiple parties. Often there are multiple stakeholders with different, sometimes even contradictory interests. For instance, some use cases call for a solution that allows a service provider to process sensitive data without learning its content. In other cases it is not the content but some meta information such as location and usage intensity that has to be protected. And then there are scenarios where seemingly harmless pieces of data can be used to disclose or infer very personal pieces of information about an individual.

This module covers advanced techniques for information security and privacy that can be used to satisfy the complex requirements of practical systems. It builds upon the basic concepts in information security that are introduced in the module "Introduction to Security and Privacy" (PSI-IntroSP-B).</td></tr>
<tr><td colspan="2">Learning outcomes:
This module is designed to bring students towards the research boundaries in the field of security and privacy technologies by covering a selection of contemporary topics in depth. The focus of the module is on technical safeguards that can be used by system designers and users to enforce properties such as confidentiality and integrity. Moreover, sophisticated attacks on security and privacy are explained.

Successful students will be able to explain attack strategies and defenses discussed in recent research papers. They will also be able to analyze whether a particular attack or defense is relevant in a specific scenario. Finally, they will be able to implement selected attacks and defenses with a programming language of their choice.</td></tr>
<tr><td colspan="2">Remark:
This module is taught in English. It consists of a lecture and tutorials. During the course of the tutorials there will be theoretical and practical assignments (task sheets). Assignments and exam questions can be answered in English or German.

Lecture and tutorials are partially taught in form of a paper reading class. Participants are expected to read the provided literature in advance and participate in the discussions.

Workload breakdown:
• Lecture: 22.5 hours (2 hours per week)
• Tutorials: 22.5 hours (2 hours per week)
• Preparation and studying during the semester: 30 hours
• Assignments: 67.5 hours
• Preparation for the exam (including the exam itself): 37.5 hours</td></tr>
<tr><td colspan="2">prerequisites for the module:
none</td></tr>
<tr><td>Recommended prior knowledge:
Participants should be familiar with basic concepts in information security and privacy, which can be acquired, for instance, by taking the module "Introduction to Security and Privacy" (PSI-IntroSP-B).</td><td>Admission requirements:
none</td></tr>
</table>

This includes basic knowledge about the commonly used security terminology, common types of malware and attacks, buffer overflows and related attacks, cryptography, network security, web security, and concepts of privacy. Moreover, participants should have practical experience with at least one scripting or programming language such as Python or Java.		
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Advanced Security and Privacy **Mode of Delivery:** Lectures **Language:** English/German **Frequency:** every summer semester **Learning outcome:** cf. module description **Contents:** Selected topics: • Cryptographic methods and protocols, e.g., homomorphic encryption, attribute-based credentials, secure multi-party computation, zero-knowledge proofs, format-preserving and identity-based encryption, group signatures, and proxy re-encryption. • Attacks on privacy in datasets and communications (inference techniques, online tracking) • Privacy engineering and privacy enhancing technologies (e.g., Tor) • Usable security and privacy • Other current topics in privacy and security Some parts of the lecture are aligned with current events and recently published research. The selected topics are therefore subject to change. **Literature:** Selected books: • R. Anderson: Security Engineering • A. Shostack: Threat Modelling • J.-P. Aumasson: Serious Cryptography • W. Stallings: Computer Security: Principles and Practice • B. Schneier et al.: Cryptography Engineering • J. Erickson: Hacking: The Art of Exploitation • J. Katz & Y. Lindell: Introduction to Modern Cryptography • L. Cranor & S. Garfinkel: Security and Usability	**2,00 Weekly Contact Hours**
2. Tutorials for Advanced Security and Privacy **Mode of Delivery:** Practicals **Language:** English/German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** The content that is relevant for the exam consists of the content presented in the lecture and tutorials (including the assignments) as well as the content of the discussed papers. The maximum number of points that can be achieved in the exam is 100. Participants that solve all assignments correctly can collect up to 20 bonus points. Details regarding the number of assignments, the number of points per assignment, and the type of assignments will be announced in the first lecture. If the points achieved in the exam are sufficient to pass the exam on its own (generally, this is the case when at least 50 points have been obtained), the bonus points will be added to the points achieved in the exam. The grade 1.0 can be achieved without the bonus points.	

Module PSI-EDS-B Ethics for the Digital Society *Ethics for the Digital Society*		3 ECTS / 90 h
(since WS19/20) Person responsible for module: Prof. Dr. Dominik Herrmann		
Contents: This module introduces students to fundamental concepts of ethics and their application to techniques that shape the digital society. It discusses the influence of current and upcoming technologies and their implications from an ethical perspective. The lecture is accompanied by a series of case studies, which focus on a concrete problem that is to be analyzed by the participants. Topics include decision making in autonomous systems and systems that employ so-called artificial intelligence, the reliability and dependability of computer systems, and privacy aspects of information systems.		
Learning outcomes: Participants will be able to reflect on their actions as a scientist as well as a computer professional. They learn how to evaluate the trade-offs that are inherent in new technologies and how to design information systems in ways that support the needs of a digital society. Successful participants will obtain the ability to apply ethical thinking to novel problems and potential solutions.		
Remark: The module is taught in English unless all participants are fluent in Germen. There may be a small number of guest lectures that is taught in German. During the semester multiple case studies will be published. Participants will be asked to submit essays discussing ethical aspects of those case studies. Essays will be peer-reviewed by other participants.		
prerequisites for the module: keine		
Recommended prior knowledge: keine		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Ethics for the Digital Society **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Dominik Herrmann **Language:** English/German **Frequency:** every winter semester **Learning outcome:** cf. module description **Contents:** cf. module description **Literature:** • Ibo van de Poel and Lamber Royakkers: Ethics, Technology, and Engineering – an Introduction • Jay Quinn: Ethics for the Information Age • Herman T. Tavani: Ethics and Technology: Controversies, Questions, and	**1,50 Weekly Contact Hours**

Strategies for Ethical Computing	

Examination Written examination / Duration of Examination: 60 minutes **Description:** The exam questions will be in English. The questions can be answered in English or German. The content that is relevant for the exam consists of the content presented in the lecture and in the case studies. The maximum number of points that can be achieved in the exam is 100. Participants that submit all case study essays can collect up to 10 bonus points. Details regarding the number of assignments, the number of points per assignment, and the type of assignments will be announced in the first lecture. If the points achieved in the exam are sufficient to pass the exam on its own (generally, this is the case when at least 50 points have been obtained), the bonus points will be added to the points achieved in the exam. The grade 1.0 can be achieved without the bonus points.	

Module PSI-EiRBS-B Introduction to Computer Architecture and Operating Systems *Einführung in Rechner- und Betriebssysteme*	6 ECTS / 180 h

(since WS19/20)
Person responsible for module: Prof. Dr. Dominik Herrmann

Contents:

Das Modul bietet einen ersten Einblick in die Informatik der Systeme. Neben einer an Systemen ausgerichteten Einführung in die Informatik behandelt die Veranstaltung die Aufgaben und Architekturmerkmale sowie die wesentlichen Komponenten von Rechner- und Betriebssystemen. Behandelt werden insbesondere der Aufbau und die Funktionsweise eines minimalen Rechners (Aussagenlogik, Gatter, Speicherbausteine) sowie die Darstellung von Daten im Rechner und ihre Speicherung und Verarbeitung. Darüber hinaus werden die wesentlichen Komponenten der Systemsoftware (Prozess- und Ressource-Scheduling, Speicherverwaltung, Hintergrundspeicher, I/O-Handhabung) erläutert und deren Zusammenspiel mit der Rechnerarchitektur aufgezeigt. Die Themen werden anhand von Modellen, marktgängigen Programmiersprachen (insbes. Java, Python, C) und aktuellen Rechner- und Betriebssystemen (insbes. Linux) behandelt. Abschließend wird ein erster Einblick in Rechnernetze und Aspekte der Systemsicherheit gegeben.

Learning outcomes:

Studierende haben einen ersten Überblick über die Gebiete der Informatik und kennen die grundlegenden Begriffe und Methoden der Informatik sowie die wichtigsten in der Informatik verwendeten Techniken. Die Studierenden haben ein grundlegendes Verständnis zustandsbasierter Systeme und der darin möglichen Abläufe (Prozesse). Zusätzlich kennen sie den Aufbau moderner Rechner- und Betriebssysteme und die dabei zur Anwendung kommenden Informatiktechniken.

Remark:

Der Arbeitsaufwand von 180 Std. verteilt sich ausgehend von einem 15 Arbeitswochen dauernden Semester in etwa wie folgt:

- 22.5 Std. Vorlesungsteilnahme
- 22.5 Std. Übungsteilnahme
- 60 Std. Bearbeiten von wöchentlichen Übungsaufgaben (d.h. ca. 4 Std./Woche)
- 30 Std. Vor- und Nachbereitung (Literatur, Recherchen usw.) von Vorlesung und Übung (d.h. ca. 1.5 Std./Woche ohne Bearbeiten der Übungsaufgaben)
- 45 Std. Vorbereitung auf und Zeit für die Abschlussklausur (unter Annahme der o.g. Arbeitsaufwände während des Semesters)

Bei diesem Angaben handelt es sich um Empfehlungen; es besteht weder in Vorlesung noch Übung Anwesenheitspflicht. Der Gesamtaufwand für das Modul ist aber nur einzuhalten, wenn die o.g. Empfehlung in etwa eingehalten wird.

prerequisites for the module:

none

Recommended prior knowledge: Es sind keine Vorkenntnisse erforderlich. Insbesondere wird keine Erfahrung mit Linux und Programmiersprachen vorausgesetzt.		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Einführung in Rechner- und Betriebssysteme **Mode of Delivery:** Lectures **Language:** German **Frequency:** every summer semester **Contents:** vgl. Modulbeschreibung **Literature:** Zum Bereich Rechnerarchitektur und Betriebssysteme gibt es eine ganze Reihe guter einführender Bücher, die aber alle über den in der Vorlesung behandelten Stoff hinausgehen. Deshalb ist die folgende Liste nur als Hinweis auf ergänzende Literatur gedacht. Die Veranstaltung kann auch ohne diese Bücher erfolgreich absolviert werden. Darüber hinaus wird ein ausführliches Skript zur Verfügung gestellt. • Tanenbaum, A.S./Austin, T.: Structured Computer Organization. Addison-Wesley, 2012 (6th) • Murdocca, M./Heuring, V.P.: Computer Architecture and Organization. Prentice Hall 2007 (1th) • Tanenbaum, A.S.: Moderne Betriebssysteme. Pearson Studium 2009 (3rd) • Silberschatz, A./Gagne, G./Galvin, P B.: Operating Systems Concepts. John Wiley and Sons, 2012 (9th)	**2,00 Weekly Contact Hours**
2. Einführung in Rechner- und Betriebssysteme (Übung) **Mode of Delivery:** Practicals **Language:** German **Frequency:** every summer semester **Contents:** In der Übung werden die wichtigsten Konzepte der Vorlesung an theoretischen und praktischen Beispielen (anhand eines Linux-Systems) veranschaulicht und durch die Besprechung von typischen Aufgaben zum jeweiligen Thema, die den Studierenden regelmäßig zum freiwilligen Üben angeboten werden, vertieft. Dabei wird insbesondere Wert auf die Vorstellung von Lösungen durch die Studierenden und deren Diskussion in der Übungsgruppe gelegt.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** Gegenstand der Klausur sind die Inhalte der Vorlesung, des Skripts, der Übungen und der Teilleistungen (s. unten). In der Klausur können maximal 100 Punkte erreicht werden. Im Semester werden studienbegleitend 5 Teilleistungen (schriftlich zu bearbeitende Aufgabenstellungen) in der Übung ausgegeben und besprochen, deren Abgabe freiwillig ist. Für jede Teilleistung stehen in der Regel 2 Wochen als Bearbeitungszeit zur Verfügung. Die abgegebenen Lösungen zu den Teilleistungen werden bewertet. Pro Teilleistung können maximal 3 Punkte erzielt	

werden. Ist die Klausur bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die bei der Bearbeitung der Teilleistungen erreichten Punkte (maximal 15 Punkte) als Bonuspunkte angerechnet. Die Note 1,0 ist dabei auch ohne Punkte aus der Bearbeitung der Teilleistungen erreichbar.	

<table>
<tr><td>Module PSI-IntroSP-B Introduction to Security and Privacy
Introduction to Security and Privacy</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="2">(since WS19/20)
Person responsible for module: Prof. Dr. Dominik Herrmann</td></tr>
<tr><td colspan="2">Contents:
This module introduces students to the most fundamental concepts in the fields of information security and the protection of privacy. It provides a broad overview over the most relevant topics from a technical perspective. The focus lies on practical issues that have to be considered when professional and personal information systems are built and operated.</td></tr>
<tr><td colspan="2">Learning outcomes:
Successful students will know the mathematical background behind basic cryptographic primitives and be able to explain fundamental concepts of information security and privacy, including classical attacks and defenses. They will be able to apply their knowledge when implementing simple attack programs and configuring security properties of selected systems.</td></tr>
<tr><td colspan="2">Remark:
This module is taught in English. It consists of a lecture and tutorials. During the course of the tutorials there will be theoretical and practical assignments (task sheets). Assignments and exam questions can be answered in English or German.

Workload breakdown:
• Lecture: 22.5 hours (2 hours per week)
• Tutorials: 22.5 hours (2 hours per week)
• Preparation and studying during the semester: 30 hours
• Assignments: 67.5 hours
• Preparation for the exam (including the exam itself): 37.5 hours</td></tr>
<tr><td colspan="2">prerequisites for the module:
none</td></tr>
<tr><td>Recommended prior knowledge:
It is strongly recommended to take this module only after successful completion of PSI-EiRBS-B, which lays the foundation for PSI-IntroSP-B. To be successful in PSI-IntroSP-B, participants should already be familiar with fundamentals of computer architecture (binary representation of strings and numbers in computers, bitwise operators like XOR, operation of a CPU, basics of assembly language), operating systems (memory layout and process management), and computer networks (basic IP routing and addressing, TCP/IP connection establishment). Finally, basic familiarity with the Linux command line is recommended.

Moreover, basic familiarity with common web technologies (HTTP, HTML, JavaScript) as well as relational database systems and SQL is recommended. Finally, participants should have working knowledge in at least one programming language (e.g., Python, C, or Java) so that they can write small tools for automation purposes on demand.</td><td>Admission requirements:
none</td></tr>
</table>

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Introduction to Security and Privacy **Mode of Delivery:** Lectures **Language:** English **Frequency:** every winter semester **Learning outcome:** cf. module description **Contents:** Selected topics • Security Terminology (protection goals, attacker and attack types) • Authentication and Authorization Fundamentals • Software Security in C and Assembler (e.g., buffer overflows, selected defenses) • Cryptography (e.g., historic ciphers, symmetric and asymmetric systems, Diffie-Hellman key exchange, TLS protocol) • Network Security (spoofing, denial of service, authentication protocols, intrusion detection systems) • Web Security (attacks and defenses related to the OWASP Top 10 including SQL injections and Cross Site Scripting) • Privacy and Techniques for Data Protection (re-identification risks, anonymization networks, k-anonymity, the idea of differential privacy) **Literature:** Selected books: • A. Shostack: Threat Modelling • W. Stallings: Computer Security: Principles and Practice • J. Erickson: Hacking: The Art of Exploitation	**2,00 Weekly Contact Hours**
2. Introduction to Security and Privacy **Mode of Delivery:** Practicals **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** The content that is relevant for the exam consists of the content presented in the lecture and tutorials (including the assignments). The maximum number of points that can be achieved in the exam is 100. Participants that solve all assignments correctly can collect up to 20 bonus points. Details regarding the number of assignments, the number of points per assignment, and the type of assignments will be announced in the first lecture. If the points achieved in the exam are sufficient to pass the exam on its own	

(generally, this is the case when at least 50 points have been obtained), the bonus points will be added to the points achieved in the exam. The grade 1.0 can be achieved without the bonus points. Assignments and exam questions can be answered in English or German.	

Module PSI-ProjectCAD-M Project Complex Attacks and Defenses *Project Complex Attacks and Defenses*	9 ECTS / 270 h

(since SS18)
Person responsible for module: Prof. Dr. Dominik Herrmann

Contents:

Breaking into information systems is exciting, but impractical due to ethical and legal concerns. However, offensive competences and adversarial thinking are essential to build secure systems. In this project students will get the opportunity to acquire practical security skills in a dedicated training environment.

The goal of this project is to build and extend the "Insekta" platform. This web-based tool provides a frontend for virtual machines that can be used to study selected topics in security and privacy on one's own and at one's own pace.

This project is offered together with PSI-ProjectPAD, which focuses on conceptually simpler attacks and defenses.

The participants of the project familiarize themselves with security weaknesses in information systems and apply this knowledge to develop vulnerable services which others can use for training. To this end, participants form groups, read about attacks and defenses in textbooks and research papers, and discuss various options to implement them. Instructors will provide extensive and on-demand support to enable the participants to implement a vulnerable service that can be exploited to learn about a particular vulnerability.

Besides implementing vulnerable services, the participants prepare training materials, which consist of questions and tasks to test one's knowledge as well as step-by-step instructions. These training materials may also contain interactive elements for an improved learning experience.

The project also takes into account attacks on privacy, e.g., re-identifying individuals in anonymized datasets and communication networks, tracking users on the Internet, inferring sensitive attributes from seemingly harmless data traces, as well as mitigations, e.g., depersonalization strategies and differential privacy mechanisms. Here, practical activities consist in the preparation of datasets and scripts for analysis.

Learning outcomes:

Successful students will be able to describe attacks and defenses from textbooks and research papers in easily understandable form. They will also be able to carry out selected attacks in practice and implement defenses with a programming language of their choice.

Remark:

This project is taught in English, unless all participants are fluent in German. The workload of this project is equivalent to 270 hours.

Workload breakdown:

- 20 hrs: Getting familiar with the platform
- 50 hrs: Reading papers and researching security vulnerabilities
- 20 hrs: Preparing the talk (including time for attendance of other talks)
- 90 hrs: Implementing the vulnerable service and defenses
- 90 hrs: Writing training material and documentation

Note that there is another project (PSI-ProjectPAD) with a workload equivalent to 180 hours.

prerequisites for the module: none		
Recommended prior knowledge: This project is primarily intended for students in master programs. Students in bachelor programs can participate, if they are qualified. Participants should be familiar with basic concepts in information security and privacy, which can be acquired, for instance, by taking the module "Introduction to Security and Privacy" (PSI-IntroSP-B). This includes basic knowledge about the commonly used security terminology, common types of malware and attacks, buffer overflows and related attacks, cryptography, network security, web security, and concepts of privacy. Moreover, participants should have practical experience with at least one scripting or programming language such as Python or Java. Experience with Linux environments, web technologies, and network protocols is recommended.		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Project Complex Attacks and Defenses **Mode of Delivery:** Practicals **Language:** English/German **Frequency:** every semester	**6,00 Weekly Contact Hours**
Learning outcome: cf. module description	
Contents: Potential topics include: • web security (injection flaws and other issues mentioned in the OWASP Top 10) • network security (such as DNS cache poisoning and rebinding attacks) • security issues in C programs (buffer overflows, etc.) • cryptography (low-level attacks on ciphers, high-level attacks on protocols, e.g., TLS) • business logic failures • misconfigurations • attacks on availability (denial of service) • attacks on privacy (such as inference, tracking, re-identification, fingerprinting) • privacy defenses (such as k-anonymity, related concepts, differential privacy)	
Literature: Literature will be announced at the beginning of the project.	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 3 months **prerequisites for module examination:** Regular attendance at project meetings. **Description:** The module examination consists of two parts: Firstly, the participants submit a written report (in English) that includes the source code of the vulnerable service and the training material. Secondly, the participants give a talk in which they defend their work (in English; in German if all participants are fluent in German) by presenting theoretical and practical aspects of their vulnerable service as well as relevant mitigations. The maximum number of points that can be achieved in the module examination is 100. Optionally, participants can submit intermediary results (in English) to collect up to 20 bonus points. If the module examination is passed on its own (generally, this is the case when at least 50 points are obtained), the bonus points will be added to the points achieved in the module examination. The grade 1.0 can be achieved without the bonus points. Details regarding the number of optional submissions during the semester, their type, the points per submission, and the respective deadlines will be announced in the first session of the project.	

Module PSI-ProjectPAD Project Practical Attacks and Defenses *Project Practical Attacks and Defenses*	6 ECTS / 180 h
(since SS18) Person responsible for module: Prof. Dr. Dominik Herrmann	

Contents:

Breaking into information systems is exciting, but impractical due to ethical and legal concerns. However, offensive competences and adversarial thinking are essential to build secure systems. In this project students will get the opportunity to acquire practical security skills in a dedicated training environment.

The goal of this project is to build and extend the "Insekta" platform. This web-based tool provides a frontend for virtual machines that can be used to study selected topics in security and privacy on one's own and at one's own pace.

This project is offered together with PSI-ProjectCAD-M, which focuses on conceptually more complex attacks and defenses.

The participants of the project familiarize themselves with security weaknesses in information systems and apply this knowledge to develop vulnerable services which others can use for training. To this end, participants form groups, read about attacks and defenses in textbooks and research papers, and discuss various options to implement them. Instructors will provide extensive and on-demand support to enable the participants to implement a vulnerable service that can be exploited to learn about a particular vulnerability.

Besides implementing vulnerable services, the participants prepare training materials, which consist of questions and tasks to test one's knowledge as well as step-by-step instructions. These training materials may also contain interactive elements for an improved learning experience.

The project also takes into account attacks on privacy, e.g., re-identifying individuals in anonymized datasets and communication networks, tracking users on the Internet, inferring sensitive attributes from seemingly harmless data traces, as well as mitigations, e.g., depersonalization strategies and differential privacy mechanisms. Here, practical activities consist in the preparation of datasets and scripts for analysis.

Learning outcomes:

Successful students will be able to describe attacks and defenses from textbooks and research papers in easily understandable form. They will also be able to carry out selected attacks in practice and implement defenses with a programming language of their choice.

Remark:

This project is taught in English, unless all participants are fluent in German. The workload of this project is equivalent to 180 hours.

Workload breakdown:

- 10 hrs: Getting familiar with the platform
- 30 hrs: Reading papers and researching security vulnerabilities
- 15 hrs: Preparing the talk (including time for attendance of other talks)
- 70 hrs: Implementing the vulnerable service and defenses
- 55 hrs: Writing training material and documentation

Note that there is another project (PSI-ProjectCAD-M) with a workload equivalent to 270 hours.

<table>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Students in bachelor and master programs can participate in this project.

Participants should be familiar with basic concepts in information security and privacy, which can be acquired, for instance, by taking the module "Introduction to Security and Privacy" (PSI-IntroSP-B). This includes basic knowledge about the commonly used security terminology, common types of malware and attacks, buffer overflows and related attacks, cryptography, network security, web security, and concepts of privacy.

Moreover, participants should have practical experience with at least one scripting or programming language such as Python or Java. Experience with Linux environments, web technologies, and network protocols is recommended.</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>Project Practical Attacks and Defenses
Mode of Delivery: Practicals
Language: English/German
Frequency: every semester<hr>Learning outcome:
cf. module description<hr>Contents:
Potential topics include:
web security (injection flaws and other issues mentioned in the OWASP Top 10)
network security (such as DNS cache poisoning and rebinding attacks)
security issues in C programs (buffer overflows, etc.)
cryptography (low-level attacks on ciphers, high-level attacks on protocols, e.g., TLS)
business logic failures
misconfigurations
attacks on availability (denial of service)
attacks on privacy (such as inference, tracking, re-identification, fingerprinting)
privacy defenses (such as k-anonymity, related concepts, differential privacy)
<hr>Literature:
Literature will be announced at the beginning of the project.</td><td>4,00 Weekly Contact Hours</td></tr>
</table>

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 3 months **prerequisites for module examination:** Regular attendance at project meetings. **Description:** The module examination consists of two parts: Firstly, the participants submit a written report (in English) that includes the source code of the vulnerable service and the training material. Secondly, the participants give a talk in which they defend their work (in English; in German if all participants are fluent in German) by presenting theoretical and practical aspects of their vulnerable service as well as relevant mitigations. The maximum number of points that can be achieved in the module examination is 100. Optionally, participants can submit intermediary results (in English) to collect up to 20 bonus points. If the module examination is passed on its own (generally, this is the case when at least 50 points are obtained), the bonus points will be added to the points achieved in the module examination. The grade 1.0 can be achieved without the bonus points. Details regarding the number of optional submissions during the semester, their type, the points per submission, and the respective deadlines will be announced in the first session of the project.	

Module PSI-ProjectSP-M Project Security and Privacy *Project Security and Privacy*		9 ECTS / 270 h
(since SS18) Person responsible for module: Prof. Dr. Dominik Herrmann		
Contents: In this project participants work independently on problems related to current research activities of the Privacy and Security in Information Systems Group. Instructors will provide guidance and supervision.		
Learning outcomes: Successful students will be able to independently work on research problems in security and privacy. They will also be able to implement tools and/or analyze data in order to answer a research question. Finally, they will be able to present their work in a talk and document their approach and results in a written report.		
Remark: This project is taught in English unless all participants are fluent in German. The workload of this project is equivalent to 270 hours. Workload breakdown: • 60 hrs: Getting familiar with the problem and preliminaries: reading related work, and understanding potentially existing source code • 20 hrs: Preparing the talk (including time for attendance of other talks) • 110 hrs: Implementing tools and/or analyzing data • 80 hrs: Writing final report with approach and methods		
prerequisites for the module: none		
Recommended prior knowledge: Participants should have advanced knowledge and practical skills in information security and privacy, which can be acquired, for instance, in the module PSI-IntroSP-B and a security-related seminar or project. Depending on the actual topic participants may be expected to be familiar with commonly used security terminology, common types of malware and attacks, buffer overflows and related attacks, cryptography, network security, web security, and concepts of privacy. Moreover, participants should have practical experience with at least one scripting or programming language such as Python or Java. Alternatively, participants should have strong skills in empirical data collection and data analytics (statistics and/or machine learning). Experience with Linux environments, web technologies, and network protocols is recommended.		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Project Security and Privacy **Mode of Delivery:** Practicals **Language:** English/German	**6,00 Weekly Contact Hours**

Frequency: every semester

Learning outcome:
cf. module description

Contents:
Potential topics include

- empirical studies, either manually (surveying security properties of systems) or automatically (e.g., web crawls),
- creating scanning tools and platforms where results can be published in a meaningful way (e.g., PrivacyScore.org),
- analyzing data sets for aspects of security and privacy, and
- implementing cryptographic or anonymization techniques in a secure fashion, e.g., for encrypted storage in cloud services.

Literature:
Literature will be announced at the beginning of the project.

Examination
Coursework Assignment and Colloquium / Duration of Examination: 30 minutes
Duration of Coursework: 3 months
prerequisites for module examination:
Regular attendance at project meetings.
Description:
The module examination consists of two parts: Firstly, the participants submit a written report (in English) that includes the source code, datasets, and analysis scripts. Secondly, the participants give a talk in which they defend their work (in English; in German if all participants are fluent in German) by presenting related work, their approach, and results. The maximum number of points that can be achieved in the module examination is 100.

Optionally, participants can submit intermediary results (in English) to collect up to 20 bonus points. If the module examination is passed on its own (generally, this is the case when at least 50 points are obtained), the bonus points will be added to the points achieved in the module examination. The grade 1.0 can be achieved without the bonus points. Details regarding the number of optional submissions during the semester, their type, the points per submission, and the respective deadlines will be announced in the first session of the project.

Module PSI-SSSProject-B Software Systems Science Project: Security and Privacy *Software Systems Science Project: Security and Privacy*	12 ECTS / 360 h

(since WS18/19)
Person responsible for module: Prof. Dr. Dominik Herrmann

Contents:
This project is specifically offered for Software Systems Science students. The participants of the project familiarize themselves with security and privacy issues that arise during the development of information systems.

Potential tasks during the project include the development of training scenarios for the Insekta platform, designing and/or participating in "build it – break it – fix it" challenges, and contributing to ongoing research activities of members of the Privacy and Security in Information Systems Group. Typically, participants work on their project in small groups. They carry out required research (mostly) on their own, reading about attacks and defenses in textbooks and research papers. Instructors will provide extensive and on-demand support to enable the participants.

Students who are interested in this project may approach a member of the PSI group in order to learn about currently available topics.

Learning outcomes:
Successful students will be able to explain attacks and defenses from textbooks and research papers. They will also be able to carry out selected attacks in practice and implement defenses with a programming language of their choice.

Remark:
This project is taught in English, unless all participants are fluent in German. The workload of this project is equivalent to 360 hours (spread over two semesters).

Workload breakdown:

- 20 hrs: Getting familiar with the task, obtaining preliminary knowledge
- 60 hrs: Reading papers and researching security vulnerabilities
- 30 hrs: Preparing the talks (including time for attendance of other talks)
- 200 hrs: Implementation
- 50 hrs: Writing project report

Note that there are other projects (PSI-ProjectCAD-M, PSI-ProjectPAD, PSI-ProjectSP-M) with different workloads.

prerequisites for the module:
none

Recommended prior knowledge: Participants should be familiar with basic concepts in information security and privacy, which can be acquired, for instance, by taking the module "Introduction to Security and Privacy" (PSI-IntroSP-B). This includes basic knowledge about the commonly used security terminology, common types of malware and attacks, buffer overflows and related attacks, cryptography, network security, web security, and concepts of privacy.	**Admission requirements:** none

Moreover, participants should have practical experience with at least one scripting or programming language such as Python or Java. Experience with Linux environments, web technologies, and network protocols is recommended.		
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 2 Semester

Module Units	
Software Systems Science Project: Security and Privacy **Mode of Delivery:** Practicals **Language:** English/German **Frequency:** every semester **Learning outcome:** cf. module description **Contents:** cf. module description **Literature:** Literature will be announced at the beginning of the project.	**8,00 Weekly Contact Hours**

Examination Coursework Assignment / Duration of Coursework: 3 months **prerequisites for module examination:** Regular attendance **Description:** The module examination consists of two module examination segments. The respective weights of the two module examination segments will be announced at the beginning of the semester in which the project starts. The first segment of the module examination consists of a written report (in English) that includes any source code, datasets, and analysis scripts. The maximum number of points that can be achieved in this part of the module examination is 100. Optionally, participants can submit intermediary results (in English) to collect up to 20 bonus points. If this part of the module examination is passed on its own (generally, this is the case when at least 50 points are obtained), the bonus points will be added to the points achieved in this part of the module examination. The grade 1.0 can be achieved without the bonus points. Details regarding the number of optional submissions during the semester, their type, the points per submission, and the respective deadlines will be announced in the first session of the project.	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 3 months **prerequisites for module examination:**	

Regular attendance **Description:** The module examination consists of two module examination segments. The respective weights of the two module examination segments will be announced at the beginning of the semester in which the project starts. The second segment of the module examination consists of two parts: Firstly, the participants submit a written report (in English) that includes any source code, datasets, and analysis scripts. Secondly, the participants give a talk in which they defend their work (in English; in German if all participants are fluent in German) by presenting related work, their approach, and results. The maximum number of points that can be achieved in the module examination is 100. Optionally, participants can submit intermediary results (in English) to collect up to 20 bonus points. If this part of the module examination is passed on its own (generally, this is the case when at least 50 points are obtained), the bonus points will be added to the points achieved in this part of the module examination. The grade 1.0 can be achieved without the bonus points. Details regarding the number of optional submissions during the semester, their type, the points per submission, and the respective deadlines will be announced in the first session of the project.	

Module PSI-Sem-B Seminar Security and Privacy Foundations *Seminar Security and Privacy Foundations*		3 ECTS / 90 h
(since SS20) Person responsible for module: Prof. Dr. Dominik Herrmann		
Contents: This seminar covers various topics related to information security and privacy. A list of available topics will be published on the website of the Privacy and Security in Information Systems Group before the first session of the seminar. Participants will form small groups and work on one of the topics.		
Learning outcomes: Participants will learn to search for, read, and discuss scientific literature in the subject area of information security and privacy. They will also learn how to write scientific texts and how to present their findings.		
Remark: This seminar will be offered in English unless all participants speak German.		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge in the area of computer science (e.g. as covered in the module EiRBS) are helpful, but not required.		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Seminar Security and Privacy Foundations **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Dominik Herrmann **Language:** English/German **Frequency:** every summer semester **Learning outcome:** cf. module description **Contents:** cf. module description **Literature:** Relevant literature will be provided when the topics are assigned.	**2,00 Weekly Contact Hours**

Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 3 months **prerequisites for module examination:** Continuous attendance in the project sessions is mandatory, cf. §9 (10) APO. **Description:** Participants write a seminar thesis and give a talk summarizing their findings.	

Module PSI-Sem-M Seminar Research Topics in Security and Privacy *Seminar Research Topics in Security and Privacy*		3 ECTS / 90 h
(since WS18/19) Person responsible for module: Prof. Dr. Dominik Herrmann		
Contents: This seminar provides in-depth coverage of advanced topics in one of the fields of information security and privacy. Participants form small groups and research in scientific sources (books and essays). While participants are expected to perform the actual research independently and mostly on their own, the instructors provide extensive support throughout the seminar. There will several sessions on topics such as how to approach a topic, how to find relevant literature, how to read a paper efficiently, how to write a seminar report, and how to give a good talk. The goals of the seminar are achieved by asking participants to perform manageable chunks of work throughout the semester (such as summarizing literature in a survey, reviewing the survey of another group, writing a draft of the term paper, reviewing the draft of another group, etc.). They will receive timely feedback both by their peers and by the instructors. The actual topics are subject to change. A list of available topics is made available before the first session in UnivIS or on the website of the Privacy and Security in Information Systems Group.		
Learning outcomes: The participants learn to find, read, and summarize scientific texts. They also learn to assess statements and to discuss them critically. Finally, they learn to write scientific texts and to present their results in a talk. Students who participate in the optional peer review will also learn techniques to give useful feedback to others as well as how to accept feedback for one's own work.		
Remark: The default language in this seminar is English, unless all participants are fluent in German.		
prerequisites for the module: none		
Recommended prior knowledge: Participants should have basic knowledge in software engineering, foundations of computing, operating systems, and networks. Knowledge in information security and privacy (obtained, e.g., in PSI-IntroSP-B and by having completed a seminar or thesis in the field of information security) is strongly recommended.		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Seminar Research Topics in Security and Privacy **Mode of Delivery:** Seminar **Language:** English/German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**

Contents:
cf. module description

Literature:

- Alley: The Craft of Scientific Writing
- Anderson: Security Engineering
- Pfleeger et al.: Security in Computing
- Stallings & Brown: Computer Security: Principles and Practice
- Strunk & White: The Elements of Style

Other relevant literature is presented in the first session.

Examination
Seminar paper and presentation / Duration of Examination: 30 minutes
Duration of Coursework: 3 months
prerequisites for module examination:
Continuous attendance in the project sessions is mandatory, cf. §9 (10) APO.
Description:
The module examination consists of two parts, a term paper (in English) and a talk (in English; in German if all participants are fluent in German). The maximum number of points that can be achieved in the module examination is 100. Details regarding the number of points that can be achieved in the talk and in the report will be announced in the first session of the project.

Optionally, participants can submit intermediary results (in English) such as surveys, written reviews for the work of other participants, and a draft of the term paper. Participants can thereby earn 20 bonus points. If the module examination is passed on its own (generally, this is the case when at least 50 points are obtained), the bonus points will be added to the points achieved in the module examination. The grade 1.0 can be achieved without the bonus points.

Module SEDA-PT-B Methods on Presentation, Conversation and Discussion *Methoden der Präsentation, Gesprächsführung und Diskussion*		3 ECTS / 90 h
(since SS19) Person responsible for module: Prof. Dr. Sven Overhage		
Contents: An Beispielen von Präsentationen, Einzelgesprächen und Diskussionen sollen • persönliche Wirkung auf einzelne und Gruppen • formale und gruppendynamische Abläufe und • inhaltliche Darstellungsformen bewusst gemacht und zielbezogen für Präsentationen, für Gespräche und für Diskussionen geübt werden.		
Learning outcomes: Die persönliche Wirkung auf Einzelpersonen und Gruppen kennen lernen und verbessern; Inhalte sachlich verständlich, didaktisch ansprechend und adressatengerecht präsentieren; Kurzvorträge, Gespräche und Diskussionen führen und trainieren.		
Remark: Das Modul wird als Blockveranstaltung abgehalten.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Methoden der Präsentation, Gesprächsführung und Diskussion **Mode of Delivery:** Lectures and Practicals **Lecturers:** Dr. Ulrich Jentzsch **Language:** German **Frequency:** every winter semester **Contents:** Das Seminar ist als Training konzipiert. Methodisch kommen Einzel- und Gruppenübungen sowie Gruppenarbeiten zur Anwendung. Die persönlichen Verhaltensaspekte werden durch Videoaufzeichnungen dokumentiert und anschließend kommentiert.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 60 minutes	

<table>
<tr><td colspan="2">Module SME-Phy-B Physical Computing
Physical Computing</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS17/18)
Person responsible for module: Prof. Dr. Diedrich Wolter</td></tr>
<tr><td colspan="3">Contents:
Sensors allow a system embedded in the physical world to observe its surrounding and to gain a model of its current context. This course is aimed at providing an overview of the opportunities and challenges in the area of physical computing, a topic in the vicinity of intelligent interaction, embedded systems, and smart environments.
Two points are especially addressed: first, gaining understanding of and experience with sensor systems and, second, surveying techniques for interpreting sensor data in order to recognize actions or events.

In context of this course students program an embedded sensor platform and study algorithms for interpreting sensor data:
model-based interpretation of uncertain data
recognition of actions and events using Markov models
sensor fusion using the Kalman filter</td></tr>
<tr><td colspan="3">Learning outcomes:
gain insight into programming embedded systems
gain experience with low-level programming
acquire overview of sensor technology and applications
acquire knowledge of techniques for interpreting sensor data
evaluate applicability of sensors and algorithms for recognizing actions and events</td></tr>
<tr><td colspan="3">Remark:
The main language of instruction in this course is German. Lectures and tutorials may be delivered in English on demand.</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Basic programming skills are highly recommended (e.g., obtained in module MI-AuD-B), additional knowledge of the C programming language (e.g., module SWT-IPC-B) would be a plus.</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every summer semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>1. Physical Computing tutorial and lab
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Diedrich Wolter
Language: German
Frequency: every summer semester<hr>Learning outcome:
siehe Modulbeschreibung<hr>Contents:</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

practical exercises according to module description **Literature:** wird in der ersten Vorlesung bekanntgegeben	
2. lecture Physical Computing **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Diedrich Wolter **Language:** German **Frequency:** every summer semester **Learning outcome:** siehe Modulbeschreibung **Contents:** see module description **Literature:** will be announced in the lecture	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes	

Module SME-Projekt-B Bachelor's project on Smart Environments

Bachelorprojekt zu Smart Environments

6 ECTS / 180 h
50 h Präsenzzeit
130 h Selbststudium

(since WS18/19)
Person responsible for module: Prof. Dr. Diedrich Wolter

Contents:
This module addresses applications of methods from the topic area Smart Environments in context of a software development project. To this end, a smart system will be develop to tackle a practical application problem, focusing on the software development. Among the methods used, artificial intelligence techniques play an important role.

Learning outcomes:
- gain skills to identify relevant methods to solve a practical problem
- gain competence to apply a basic method to a practical problem
- gain experience with problems that can arise applying a basic method to a practical problem
- improve programming skills
- learn to evaluate utility of approaches with respect to practical problems
- learn to present results in a scientific paper and defend the work in a colloquium

Remark:
The language of instruction in this course is German. However, all course materials are available in Englisch. Term papers and presentations may be delivered in either German or English.

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
Basic skills in computer science, especially programming skills are highly recommended.	none

Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

Übung Bachelorprojekt zu Smart Environments	**4,00 Weekly Contact Hours**

Mode of Delivery: Practicals
Lecturers: Prof. Dr. Diedrich Wolter
Language: German/English
Frequency: every winter semester

Learning outcome:
siehe Modulbeschreibung

Contents:
The topic of the current project will tackled in small teams. In a problem-based manner, skills in scientific work and software development will be practised.

Literature:
will be announced in first meeting

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Umsetzung der Projektaufgabe, Dokumentation in Form eines wissenschaftlichen Aufsatzes als Hausarbeit sowie Präsentation im Kolloquium. Die Bekanntgabe der Prüfungssprache erfolgt in der ersten Sitzung der Lehrveranstaltung.	

Module SME-Projekt-M master project on smart environments *Masterprojekt zu Smart Environments*		6 ECTS / 180 h 50 h Präsenzzeit 130 h Selbststudium
(since WS17/18) Person responsible for module: Prof. Dr. Diedrich Wolter		
Contents: This module addresses applications of advanced methods from the topic area Smart Environments. To this end, a smart system will be develop to tackle a practical application problem, focusing on the software development. • research relevant literature • develop own state-of-the-art approach • system realization by implementation • evaluation of system and its components • presentation of results		
Learning outcomes: • gain skills to apply advanced methods from Smart Environments • evaluate utility of approaches with respect to practical problems • learn self-determined organisation of projects • get acquainted with problems arising bridging theory and practice • improve software development skills		
Remark: The main language in this course is English. Meetings may be held in German if all participating students are fluent in German. Presentations and term papers may be delivered in English or German.		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge in computer science (especially programming skills) is highly recommended, knowledge in Artificial Intelligence (AI) or Smart Environments helpful.		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Masterprojekt zu Smart Environments **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Diedrich Wolter **Language:** German/English **Frequency:** every summer semester **Learning outcome:** siehe Modulbeschreibung **Contents:**	**4,00 Weekly Contact Hours**

Im Master-Projekt werden wechselnde Themen aus dem Gebiet Smart Environments in Kleingruppen bearbeitet. Problem-basiert wird dabei wissenschaftliches Arbeiten und das Entwickeln eigener Lösungsansätze geübt.	
Literature: wird in der Lehrveranstaltung vorgestellt	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Umsetzung der Projektaufgabe, Dokumentation in Form eines wissenschaftlichen Aufsatzes als Hausarbeit. Die Prüfungssprache wird während der ersten Sitzung der Lehrveranstaltung bekanntgegeben.	

Module SME-STE-M Introduction to Knowledge Representation: Space, Time, Events *Introduction to Knowledge Representation: Space, Time, Events*	6 ECTS / 180 h

(since WS17/18)
Person responsible for module: Prof. Dr. Diedrich Wolter

Contents:
This course gives an introduction to the area of knowledge representation, a sub-discipline of computer science in general and artificial intelligence in particular.

Knowledge representation is involved with identifying means to represent practical problems and according background knowledge as data structures, and to develop reasoning algorithms to solve these problems.

This course puts a spotlight on symbolic techniques to represent knowledge involving a spatio-temporal component as is typical for many practical real-world problems.

Contents:

- fundamental concepts: knowledge, abstractions, relations, logics
- syntax and semantics, formalization of knowledge
- representation and reasoning
- qualitative algebras and constraint calculi
- constraint-based reasoning
- spatial logics
- complexity and tractable subclasses

Learning outcomes:

- gain overview of formalisms for representing spatio-temporal logics
- gain skills to represent spatio-temporal knowledge symbolically
- gain overview of reasoning problems and learn to identify approaches for solving them
- learn to apply constraint-based reasoning methods
- learn to identify computational complexity of reasoning problems

Remark:
The main language of instruction in this course is English. Exams may be taken in either English or German. The lectures and tutorials may be delivered in German if all participating students are fluent in German.

prerequisites for the module:
none

Recommended prior knowledge: Basic knowledge in computer science is recommended, for example obtained in a computer science bachelor's curriculum.		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Introduction to Knowledge Representation: Space, Time, Events **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Diedrich Wolter	**2,00 Weekly Contact Hours**

Language: English/German **Frequency:** every winter semester **Learning outcome:** see description of module **Contents:** see description of module **Literature:** will be announced in first lecture	
2. Practicals Introduction to Knowledge Representation: Space, Time, Events **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Diedrich Wolter **Language:** German **Frequency:** every winter semester **Contents:** practical exercises according to the lecture	**2,00 Weekly Contact Hours**

Examination Oral examination / Duration of Examination: 20 minutes **Description:** oral examination 20 minutes about lectures and practicals	

Module SME-Sem-B Bachelor seminar on Smart Environments *Bachelorseminar zu Smart Environments*		3 ECTS / 90 h
(since WS14/15) Person responsible for module: Prof. Dr. Diedrich Wolter		
Contents: Selected topics within the area of Smart Environments are covered. Topics in this area relate to application areas such as interactive systems as well as to computer science areas such as Artificial Intelligence.		
Learning outcomes: Competences in scientific work will be acquired, in particular systematic literature research, structuring of complex topics, and (comparative) evaluation. Presentation skills to communicate specialized topics as well as scientific writing will be trained.		
Remark: The main language of instruction in this course is German. Presentations and reports may also be delivered in English.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** Semester

Module Units	
Bachelorseminar zu Smart Environments **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Diedrich Wolter **Language:** German/English **Frequency:** every winter semester **Learning outcome:** see description of module **Contents:** see description of module **Literature:** will be announced in first meeting	**2,00 Weekly Contact Hours**

Examination Internship report / Duration of Examination: 30 minutes	

Module SME-Sem-M master seminar on Smart Environments *Masterseminar zu Smart Environments*		3 ECTS / 90 h
(since SS14) Person responsible for module: Prof. Dr. Diedrich Wolter		
Contents: Selected topics within the area of Smart Environments are covered. Topics will relate to computer science areas such as Artificial Intelligence and knowledge representation.		
Learning outcomes: Competences in scientific work will be acquired, in particular systematic literature research, structuring of complex topics, and (comparative) evaluation of complex approaches. Presentation skills to communicate specialized topics as well as scientific writing will be trained.		
Remark: The main language of instruction in this course is English. However, the meetings may be held in German if all participating students are fluent in German. The written reports/seminar essay and the presentation may be delivered in English or in German.		
prerequisites for the module: none		
Recommended prior knowledge: basic knowledge in computer science (e.g., acquired in a Bachelor's curriculum)		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** Semester

Module Units	
Masterseminar Smart Environments **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Diedrich Wolter **Language:** English/German **Frequency:** every summer semester **Learning outcome:** see description of module **Contents:** see description of module **Literature:** will be announced in first meeting	**2,00 Weekly Contact Hours**

Examination Internship report / Duration of Examination: 30 minutes	

Module SNA-ASN-M Social Network Analysis *Analyse sozialer Netzwerke*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Kai Fischbach		
Contents: Social network analysis focuses on relationships between or among social entities. This course presents an introduction to various concepts, methods, and applications of social network analysis. The primary focus of these methods is the analysis of relational data measured on populations of social actors.		
Learning outcomes: Erwerb vertiefter Kenntnisse der Methoden und Modelle der Netzwerkanalyse. Die Studierenden verstehen die Bedeutung der Struktur sozialer Netzwerke für die Effektivität und Effizienz betrieblicher Arbeitsprozesse. Sie erlernen methodische Grundlagen der Analyse sozialer Netzwerke und die Bewertung ihrer strukturellen Eigenschaften. Sie sind in der Lage, ihre Kenntnisse auf Forschungsfragen der Wirtschaftsinformatik anzuwenden.		
Remark: The language of instruction in this course is German. However, the exam is available in English.		
prerequisites for the module: none		
Recommended prior knowledge: keine		**Admission requirements:** keine
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Analyse sozialer Netzwerke **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Kai Fischbach **Language:** German **Frequency:** every winter semester **Contents:** Topics include an introduction to graph theory and the use of directed graphs and matrices to study actor interrelations; structural and locational properties of actors, such as centrality, prestige, and prominence; subgroups and cliques; equivalence of actors, including structural equivalence and, blockmodels;local analyses, including dyadic and triad analysis; and introduction to statistical global analyses, using models such as p* and their relatives. Methods are illustrated on a wide range of social network examples using both standard social network analysis software and special purpose computer programs. **Literature:** • Carrington PJ, Scott J, Wasserman S (2005) Models and Methods in Social Network Analysis. Cambridge University Press, New York. • Knoke D, Yang S (2007) Social Network Analysis, 2. Auflage. Sage Publications, Thousand Oaks	**2,00 Weekly Contact Hours**

• Newman MEJ (2010) Networks. An Introduction. Oxford University Press, Oxford. • Wasserman S, Faust K (1994) Social Network Analysis: Methods and Applications. Cambridge University Press, New York.	
2. Analyse sozialer Netzwerke **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Wirtschaftsinf, Soz Netzwerke **Language:** German **Frequency:** every winter semester **Contents:** Die Inhalte der Vorlesung werden anhand von Übungsaufgaben und Fallbeispielen vertieft. Praktische Übungen werden unter Verwendung gängiger Software zur Analyse sozialer Netzwerke durchgeführt. **Literature:** • Borgatti SP, Everett MG & Freeman LC (2002) Ucinet for Windows: Software for Social Network Analysis. Analytic Technologies, Harvard. • Nooy W, Mrvar A, Batagelj V (2011) Exploratory Social Network Analysis with Pajek. Revised and Expanded Second Edition. Cambridge University Press, New York.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** In der Klausur werden die in Vorlesung und Übung behandelten Inhalte geprüft. Es können 90 Punkte erzielt werden. Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.	

Module SNA-ITSM-B IT Service Management *IT Service Management*		6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Kai Fischbach		
Contents: This module is an introduction to the concepts, principles, problems, and practices of successful service operations management. Emphasis is focused on preparing students to identify and apply appropriate management processes to ensure efficient, effective, and quality oriented service operations, while achieving operational excellence.		
Learning outcomes: At the conclusion of the course, students should know how: • to apply a set of basic tools and skills used in solving problems traditionally associated with operating the service operations system. • to deploy technology in the improvement of service, customer relationships and globalization.		
Remark: The language of instruction in this course is German. However, all course materials (lecture slides and tutorial notes) as well as the exam are available in English.		
prerequisites for the module: none		
Recommended prior knowledge: keine		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. IT Service Management **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Kai Fischbach **Language:** German **Frequency:** every winter semester **Contents:** Topics covered include: the role of services in the economy, strategic positioning and internet strategies, environmental strategies, new service development process, managing service expectations, front-office & back-office interface, service quality, and service innovation. **Literature:** • Rai A, Sambamurthy V (2006) Editorial Notes. The Growth of Interest in Services Management: Opportunities for Information Systems Scholars. Information Systems Research 17(4): 327-331.	**2,00 Weekly Contact Hours**
2. IT Service Management **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Wirtschaftsinf, Soz Netzwerke **Language:** German	**2,00 Weekly Contact Hours**

Frequency: every winter semester

Contents:

Die Inhalte der Vorlesung werden anhand von Übungsaufgaben und Fallstudien vertieft.

Literature:

Siehe Vorlesung.

Examination

Written examination / Duration of Examination: 90 minutes

Description:

In der Klausur werden die in Vorlesung und Übung behandelten Inhalte geprüft. Es können 90 Punkte erzielt werden. Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.

Module SNA-NET-M Network Theory *Netzwerktheorie*	6 ECTS / 180 h

(since WS17/18)
Person responsible for module: Prof. Dr. Kai Fischbach

Contents:
Individuals and technology shape and are shaped by organizations. Individuals and organizations are also affected by sets of interlinked networks linking people, technology, organizations, knowledge and resources. In this world of networks and organizations, how do coordination, communication, power, tasks, goals, and information interact to affect group and organizational behavior and the impact of information technology on this behavior? How do we conceptualize, measure, and evaluate organizations and networks? How do we evaluate the impact of policies and technology on these organizations and networks especially given the fact that organizations and networks are dynamic?

Learning outcomes:
Die Studierenden kennen interdisziplinäre Theoriebeiträge zur Erklärung der Struktur und Dynamik sozialer Netzwerke und können das erworbene Wissen auf relevante Forschungsfragen der Wirtschaftsinformatik anwenden. Sie verstehen den Einfluss der Struktur eines Netzwerkes auf seine internen Prozesse und die Veränderung der Struktur eines Netzwerkes im Zeitverlauf.

Themenfelder:

- Theorien sozialer und komplexer Netzwerke
- Emergenz und Dynamik sozialer Netzwerke
- Agentenbasierte Modellierung und Spieltheorie
- Informationsverarbeitung in sozialen Netzwerken
- Netzwerkprozesse
- Wissensnetzwerke

Remark:
The language of instruction in this course is German. However, the exam is available in English.

prerequisites for the module:
none

Recommended prior knowledge: Kenntnisse aus dem Modul Analyse sozialer Netzwerke sind wünschenswert, jedoch nicht Voraussetzung		**Admission requirements:** keine
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Netzwerktheorie **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Kai Fischbach **Language:** German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: This course provides an overview of the dominant perspectives on organizations and networks from a macro perspective. Topics covered include knowledge	

management, organizational design, organizational learning, organizational evolution and population ecology, organizational culture, organizations as complex systems, social and organizational networks, and dynamic network analysis. **Literature:** • Easley D, Kleinberg J (2010) Networks, Crowds, and Markets. Reasoning about a Highly Connected World. Cambridge University Press, New York • Goyal S (2009) Connections: An Introduction to the Economics of Networks, Princeton University Press, Princeton und Oxford • Jackson MO (2008) Social and Economic Networks. Princeton University Press, Princeton und Oxford • Kilduff M, Tsai W (2003) Social Networks and Organizations. Sage Publications, Thousand Oaks • Monge PR, Contractor N (2003) Theories of Communication Networks. Oxford University Press, New York	
2. Netzwerktheorie **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Wirtschaftsinf, Soz Netzwerke **Language:** German **Frequency:** every summer semester **Contents:** Die Inhalte der Vorlesung werden anhand von Übungsaufgaben und Fallbeispielen vertieft. Praktische Übungen werden unter Verwendung gängiger Software zur Analyse sozialer Netzwerke durchgeführt. **Literature:** Siehe Vorlesung.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** In der Klausur werden die in Vorlesung und Übung behandelten Inhalte geprüft. Es können 90 Punkte erzielt werden. Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.	

Module SNA-OSN-M Project Online Social Networks *Projekt zu Online Social Networks*		6 ECTS / 180 h
(since WS13/14) Person responsible for module: Prof. Dr. Kai Fischbach further responsible : Zylka, Matthäus, Dipl.-Wirt.-Inf.		
Contents: This module is an introduction to the analysis of online social networks. The aim is twofold: to provide students with the tools necessary to undertake research into online networks, and to give an overview of the type of questions these data can answer.		
Learning outcomes: At the conclusion of the course, students should know not only how to calculate basic network metrics on pre-existing data sets, but also how to capture an online social network efficiently with the intent of answering a specific research question. Further goals: • Learn how the radical innovation process in small teams works • Learn how to collaborate in multidisciplinary intercultural virtual teams • Learn how to find trendsetter and trends on the Internet and social media • Learn how to predict trends using SNA und statistical forecasting techniques		
Remark: The main language of instruction in this course is English. The written reports/seminar essay and the presentation have to be delivered in English.		
prerequisites for the module: none		
Recommended prior knowledge: We recommend attending at least one of the following courses: • Social Network Analysis (SNA-ASN-M) • Theories of Social Networks (SNA-NET-M)		**Admission requirements:** keine
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Online Social Networks **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Kai Fischbach **Language:** English/German **Frequency:** every winter semester **Contents:** The course will define online networks, examine how they differ from offline social networks, and consider theoretical and methodological issues associated with their analysis. The sessions will explore different strategies to retrieve and analyze online network data, and present different empirical scenarios to which those tools have been applied. **Literature:**	**4,00 Weekly Contact Hours**

• Gloor, P. A. Swarm Creativity, Competitive Advantage Through Collaborative Innovation Networks. Oxford University Press, 2006 Further literature will be announced in the lecture.	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Die Gewichtung der Prüfungsleistungen Hausarbeit und Kolloquium wird zu Beginn der Lehrveranstaltung von der Dozentin bzw. dem Dozenten bekannt gegeben.	

Module SNA-Sem-B Social Networks (Bachelor) *Soziale Netzwerke*		3 ECTS / 90 h
(since SS12) Person responsible for module: Prof. Dr. Kai Fischbach		
Contents: Seminars are offered regularly on varying topics, both in the winter and summer semesters. The seminars are usually advertised at the beginning of each semester.		
Learning outcomes: Eigenständige Erarbeitung und Präsentation eines Themas aus dem Fachgebiet Soziale Netzwerke auf Basis relevanter Literatur. Kompetenzerwerb auf dem Gebiet der kritischen und systematischen Literaturanalyse sowie der Präsentation von Fachthemen.		
Remark: The written reports/seminar essay and the presentation may be delivered in English or in German.		
prerequisites for the module: none		
Recommended prior knowledge: keine		**Admission requirements:** Erfolgreiche Erstellung einer Hausarbeit sowie erfolgreich bewertetes Referat
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelor-Seminar Soziale Netzwerke **Mode of Delivery:** Introductory seminar **Lecturers:** Prof. Dr. Kai Fischbach **Language:** German **Frequency:** every semester **Contents:** Rahmenthema mit wechselnden Schwerpunkten **Literature:** Literatur zur Einführung in das Themenfeld wird in der Veranstaltung bekannt gegeben.	**2,00 Weekly Contact Hours**
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes **Description:** Im Rahmen des Seminars fertigen die Studierenden eine Hausarbeit an, die anschließend im Teilnehmerkreis vorgestellt wird. Vortrag und Diskussion der Arbeit haben i.d.R. einen Umfang von ca. 30 Minuten.	

Module SNA-Sem-M Social Networks (Master) *Soziale Netzwerke*		3 ECTS / 90 h
(since SS12) Person responsible for module: Prof. Dr. Kai Fischbach		
Contents: This seminar is offered regularly on varying topics in the summer semester. The seminar is usually advertised at the end of the winter semester.		
Learning outcomes: Eigenständige Erarbeitung und Präsentation eines Themas aus dem Fachgebiet Soziale Netzwerke mit wissenschaftlichen Methoden. Kompetenzerwerb in den Bereichen kritische und systematische Literaturanalyse, Strukturierung komplexer Sachverhalte, bewertender Vergleich konkurrierender Ansätze. Professionelle Präsentation von Fachthemen. Erlernen des Verfassens wissenschaftlicher Arbeiten.		
Remark: The written reports/seminar essay and the presentation may be delivered in English or in German.		
prerequisites for the module: none		
Recommended prior knowledge: We recommend attending at least one of the following courses: • Social Network Analysis (SNA-ASN-M) • Theories of Social Networks (SNA-NET-M)		**Admission requirements:** Erfolgreiche Erstellung einer Hausarbeit sowie erfolgreich bewertetes Referat.
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Master-Seminar Soziale Netzwerke **Mode of Delivery:** Introductory seminar **Lecturers:** Prof. Dr. Kai Fischbach **Language:** German **Frequency:** every semester **Contents:** Rahmenthema mit wechselnden Schwerpunkten **Literature:** Literatur zur Einführung in das Themenfeld wird in der Veranstaltung bekannt gegeben.	**2,00 Weekly Contact Hours**
Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes **Description:** Im Rahmen des Seminars fertigen die Studierenden eine Hausarbeit an, die anschließend im Teilnehmerkreis vorgestellt wird. Vortrag und Diskussion der Arbeit haben i.d.R. einen Umfang von ca. 30 Minuten.	

Module SNA-WIM-B Knowledge- and Informationmanagement *Wissens- und Informationsmanagement*		6 ECTS / 180 h
(since WS18/19) Person responsible for module: Prof. Dr. Kai Fischbach		
Contents: Die Veranstaltung bietet eine Einführung in das betriebliche Wissens- und Informationsmanagement.		
Learning outcomes: Ziel der Veranstaltung ist die Vermittlung folgender Kenntnisse und Fähigkeiten: • Studierende kennen und verstehen relevante Begriffe, Modelle und Theorien des Wissens- und Informationsmanagements. • Studierende können die Modelle und Theorien zur Analyse und Bewertung verschiedener Wissens- und Informationsmanagementaspekte anwenden. • Studierende kennen verschiedene Wissens- und Informationsmanagementsysteme, die im inner- und überbetrieblichen Bereich zum Einsatz kommen. • Studierende verstehen, wie Wissensmanagementsysteme geeignet gestaltet und genutzt werden können. • Studierende verstehen die Bedeutung sozialer Netzwerke für das Wissensmanagement.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Wissens- und Informationsmanagement **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Kai Fischbach **Language:** German **Frequency:** every summer semester **Contents:** Vor dem Hintergrund der Globalisierung und Digitalisierung sowie der damit einhergehenden Intensivierung und Diversifizierung der Vernetzung erlangt das effektive und effiziente Management der Ressourcen Information und Wissen in Unternehmen strategischen Rang. Die Lehrveranstaltung befasst sich in diesem Kontext mit Zielen, Aufgaben, Systemen, Theorien und Methoden des Wissens- und Informationsmanagements. Dazu werden unter anderem die Wissensentwicklung, -verteilung, -nutzung, -bewertung, -bewahrung sowie der Wissenserwerb innerhalb von Unternehmen betrachtet. **Literature:**	**2,00 Weekly Contact Hours**

Dalkir, K. (2017): Knowledge Management in Theory and Practice. (3. Auflage). Cambridge, Massachusetts: The MIT Press. Weitere Literatur wird in der Veranstaltung bekannt gegeben.	
2. Wissens- und Informationsmanagement **Mode of Delivery:** Practicals **Lecturers:** Diana Fischer-Preßler **Language:** German **Frequency:** every summer semester **Contents:** Die Übung Wissens- und Informationsmanagement dient der Vertiefung, Übung und Anwendung des in der Vorlesung vermittelten Stoffs. Dazu werden Aufgaben und Methoden des Wissens- und Informationsmanagements behandelt und Fallstudien in Gruppen bearbeitet. **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, werden zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung und in der Modulprüfung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.	

Module SWT-ASV-M Applied Software Verification *Applied Software Verification*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Gerald Lüttgen		
Contents: This module focuses on the increasingly important field of automated software verification, which aims at increasing the quality of today's complex computer systems. Students will be introduced to modern automated software verification and, in particular, to software model checking, and will be familiarised with a variety of important formal verification concepts, techniques and algorithms, as well as with state-of-the-art verification tools.		
Learning outcomes: On completion of this module, students will be able to thoroughly analyse software using modern software verification tools and understand the state-of-the-art techniques and algorithms that drive cutting-edge development environments offered by major software companies.		
Remark: The main language of instruction is English. The lectures and practicals may be delivered in German if all participating students are fluent in German. The total workload of 180 hrs. is split approximately as follows: • 30 hrs. attending lectures (Vorlesungen) • 30 hrs. attending practicals (Übungen) • 60 hrs. preparing and reviewing the lectures and practicals, including researching literature, studying material from additional sources and applying software tools • 30 hrs. working on the assignment (Hausarbeit) • 30 hrs. preparing for the colloquium (Kolloquium)		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge in algorithms and data structures, mathematical logic and theoretical computer science. Knowledge of the module "Foundations of Software Analysis" (SWT-FSA-B) - or equivalent - is desirable.		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Applied Software Verification **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Gerald Lüttgen **Language:** English/German **Frequency:** every summer semester **Contents:** The lectures (Vorlesungen) will address the following topics in automated software verification: (i) state machines, assertions and algorithms for state	**2,00 Weekly Contact Hours**

space exploration; (ii) temporal logics for specifying program properties; (iii) model checking using binary decision diagrams; (iv) SAT-based bounded model checking; (v) software model checking based on decision procedures; (vi) abstraction-based software model checking. In addition, several state-of-the-art software verification tools will be introduced. **Literature:** • Baier, C., Katoen, J.-P. Principles of Model Checking. MIT Press, 2008. • Clarke, E., Grumberg, O. and Peled, D. Model Checking. MIT Press, 1999. • Huth, M. and Ryan, M. Logic in Computer Science. 2nd ed. Cambridge University Press, 2004. • Kroening, D. and Strichman, O. Decision Procedures: An Algorithmic Point of View. Springer, 2008. • Loeckx, J. and Sieber, K. The Foundations of Program Verification. 2nd ed. Wiley, 1987.	
2. Applied Software Verification **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** English/German **Frequency:** every summer semester **Contents:** Students will practice the various theoretical and practical concepts taught in the lectures (Vorlesungen) by applying them to solve verification problems using several modern model-checking tools, and also by engaging in pen-and-paper exercises. Emphasis will be put on presenting and discussing the solutions to the exercises by and among the students, within the timetabled practicals (Übungen). **Literature:** - see the corresponding lectures -	**2,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 3 weeks **Description:** Assignment (Hausarbeit) consisting of questions that practice, review and deepen the knowledge transferred in the lectures and practicals (Vorlesungen und Übungen). The assignment is set in English language, while answers may be provided in either English or German. Colloquium (Kolloquium) consisting of questions testing the knowledge transferred in the lectures and practicals (Vorlesungen und Übungen), on the basis of the submitted solutions to the assignment (Hausarbeit). The colloquium can be held electively in English or German language.	

<table>
<tr><td colspan="2">Module SWT-FSA-B Foundations of Software Analysis
Foundations of Software Analysis</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS19/20)
Person responsible for module: Prof. Dr. Gerald Lüttgen</td></tr>
<tr><td colspan="3">Contents:
This module introduces students to the mathematical and practical foundations of software analysis, which are at the heart of modern techniques for software verification and compiler optimization and key for enhancing software quality.</td></tr>
<tr><td colspan="3">Learning outcomes:
On completion of this module, students will be able to understand key concepts, techniques and algorithms for software analysis and appreciate the workings of modern software analysis tools.</td></tr>
<tr><td colspan="3">Remark:
The main language of instruction is English. The lectures and practicals may be delivered in German if all participating students are fluent in German.

The total workload of 180 hrs. is split approximately as follows:
• 45 hrs. attending lectures (Vorlesungen)
• 45 hrs. attending practicals (Übungen)
• 50 hrs. preparing and reviewing the lectures and practicals, including researching literature, studying material from additional sources
• 40 hrs. working on the assignment (Hausarbeit) and preparing for the colloquium (Kolloquium)</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Basic knowledge in discrete mathematics and logics, such as acquired in the module "Mathematik für Informatik 1 (Aussagen- und Prädikatenlogik)" (GdI-MfI-1).</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>1. Foundations of Software Analysis
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Gerald Lüttgen
Language: English/German
Frequency: every winter semester

Contents:
Students will be introduced to the foundations of software analysis and their

applications to software verification and code analysis and optimization.
Particular emphasis will be put on semantics and abstraction, and their underlying mathematical theories based on lattices and order.
The following topics will be covered: (i) inductive definitions and proofs; (ii) semantics of programs; (iii) abstraction and abstract interpretation; (iv) elementary fixed point theory; (v) operational and denotational abstract semantics; (vi)</td><td>3,00 Weekly Contact Hours</td></tr>
</table>

<table>
<tr><td>software verification based on the methods of Floyd and Hoare; (vii) code analysis and optimization based on data flow analysis; (viii) outlook on advanced, modern aspects of software analysis.
Literature:
Berghammer, R. Semantik von Programmiersprachen, Berlin, Logos Verlag 2001.
Nielson, H. R. and Nielson, F., Semantics with Applications: An Appetizer, Springer, 2007.
Nielson, F., Nielson, H. R. and Hankin, C. Principles of Program Analysis, Springer, 1999.
Loeckx, J. and Sieber, K. The Foundations of Program Verification, 2nd ed. Wiley, 1987.
Davey, B. A. and Priestley, H. A. Introduction to Lattices and Order, 2nd ed. Cambridge University Press, 2002.
Steffen, B., Rüthing, O. and Isberner, M. Grundlagen der höheren Informatik: Induktives Vorgehen. Springer, 2013.</td><td></td></tr>
<tr><td>2. Foundations of Software Analysis
Mode of Delivery: Practicals
Lecturers: Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen
Language: English/German
Frequency: every winter semester
Contents:
The practicals (Übungen) will deepen the concepts and techniques taught in the lectures (Vorlesungen), and apply them to the analysis of small examples of software. They will mainly cover pen-and-paper exercises, but will also introduce students to modern software analysis tools. Emphasis will be put on presenting and discussing the solutions to the exercises by and among the students.
Literature:
- see the corresponding lectures -</td><td>3,00 Weekly Contact Hours</td></tr>
<tr><td>Examination
Coursework Assignment and Colloquium / Duration of Examination: 20 minutes
Duration of Coursework: 3 weeks
Description:
Assignment (Hausarbeit) consisting of questions practicing, reviewing and deepening the knowledge transferred in the lectures and practicals (Vorlesungen und Übungen).

Colloquium (Kolloquium) consisting of questions testing the knowledge transferred in the lectures and practicals (Vorlesungen und Übungen), on the basis of the submitted solutions to the assignment (Hausarbeit).</td><td></td></tr>
</table>

Module SWT-FSE-B Foundations of Software Engineering *Foundations of Software Engineering*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Gerald Lüttgen		
Contents: This module teaches the foundations of software engineering that are applicable to various kinds of software systems – from information systems to embedded systems. It focusses on technologies, notations and processes for system specification, design, implementation, and verification and validation.		
Learning outcomes: Students will receive an introduction to the common problems and paradigms in, and foundations of, software development. They will also gather conceptional and practical knowledge in the analysis, design and testing of software, with an emphasis on technical aspects of specifying, designing, implementing, verifying and validating software.		
Remark: The main language of instruction is English. The lectures and practicals may be delivered in German if all participating students are fluent in German. The total workload of 180 hrs. is split approximately as follows: • 45 hrs. attending lectures (Vorlesungen) • 30 hrs. reviewing the lectures, including researching and studying material from additional sources • 45 hrs. attending practicals (Übungen) • 30 hrs. preparing and reviewing the practicals, including researching and studying material from additional sources • 30 hrs. preparing for the written exam (Klausur)		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge in Computer Science, as well as knowledge in programming in Java and in algorithms and data structures.		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Foundations of Software Engineering **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Gerald Lüttgen **Language:** English/German **Frequency:** every summer semester	**3,00 Weekly Contact Hours**
Contents: The lectures (Vorlesungen) provide an introduction to the foundations of software engineering, including commonly used technologies, notations and processes for all software engineering phases. In particular, conceptual and technical aspects of software specification, architecture and design, and verification and validation	

<table>
<tr><td>are discussed, such as the Unified Modeling Language (UML) and its semantics, model-driven and pattern-based development, and software testing. Students are also introduced to specific aspects of agile software development.

Literature:
• Sommerville, I. Software Engineering, 10th ed. Pearson, 2016.
• Robertson, S. and Robertson, J. Mastering the Requirements Process, 3rd ed. Addison-Wesley, 2012.
• Cohn, M. User Stories Applied. Addison-Wesley, 2004.
• Stevens, P. and Pooley, R. Using UML - Software Engineering with Objects and Components, 2nd. ed. Addison-Wesley, 2006.
• Freeman, E., Robson, E., Sierra, K. and Bates, B. Head First Design Patterns. O'Reilly, 2004.
• Gamma, E., Helm, R., Johnson, R. and Vlissides, J. Design Patterns: Elements of Reusable Object-Oriented Design. Prentice Hall, 1994.
Further literature will be announced in the lectures.</td><td></td></tr>
<tr><td>2. Foundations of Software Engineering
Mode of Delivery: Practicals
Lecturers: Prof. Dr. Gerald Lüttgen, Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen
Language: English/German
Frequency: every summer semester

Contents:
The practicals (Übungen) exercise and deepen the conceptual knowledge transferred via the lectures (Vorlesungen), and relay practical knowledge in software engineering.

Literature:
- see the corresponding lectures -</td><td>3,00 Weekly Contact Hours</td></tr>
</table>

<table>
<tr><td>Examination
Written examination / Duration of Examination: 120 minutes
Description:
Written exam (Klausur) consisting of questions that relate to the contents of the lectures (Vorlesungen) and practicals (Übungen) of this module.

The written exam is set in English, while answers may be provided in either English or German. The exam is passed if at least 50% of the available points are reached.</td><td></td></tr>
</table>

Module SWT-MBT-B Model-based Testing *Modellbasiertes Testen*	3 ECTS / 90 h 30 h Präsenzzeit 60 h Selbststudium
(since WS19/20) Person responsible for module: Prof. Dr. Gerald Lüttgen	

Contents:

Heutige Softwaresysteme zeichnen sich durch einen steigenden Grad an Komplexität und Vernetzung aus. Dies erfordert eine stetig wachsende Anzahl an Testfällen, um eine hohe Testabdeckung für das zu testende System zu gewährleisten. Darüber hinaus werden klassische Vorgehensmodelle bei der Softwareentwicklung zunehmend durch agile Ansätze abgelöst, wodurch die für die Testfallerstellung und -durchführung zur Verfügung stehende Zeit im Vergleich zu klassischen Vorgehensmodellen stark verkürzt wird. Um nun eine hohe Anzahl an Testfällen auch in kurzer Zeit durchführen zu können, ist Testautomatisierung unerlässlich, was allerdings die manuelle Erstellung von Testskripten für das gewünschte Testautomatisierungswerkzeug erfordert. Diese zumeist zeit- und kostenintensive Tätigkeit kann mithilfe des modellbasierten Testens (MBT) automatisiert werden. Im Fokus von MBT steht die Erstellung von sog. Testmodellen, welche die zu testenden Aspekte eines Systems repräsentieren und als Input für die Testfallgenerierung mittels eines MBT-Werkzeugs dienen. Somit lassen sich Testfallbeschreibungen oder ausführbare Testskripte für Testautomatisierungswerkzeuge erzeugen.

Ziel des Moduls ist es, einführende theoretische und praktische Kenntnisse des modellbasierten Testens zu vermitteln. Zum Erwerb der praktischen Kenntnisse erstellen Studierenden eigenständig kleine Testmodelle und generieren hieraus ausführbare Testfälle mit einem MBT-Werkzeug.

Learning outcomes:

Nach erfolgreicher Teilnahme an diesem Modul können Studierende insbesondere:

- MBT in klassischen und agilen/iterativen Vorgehensmodellen anwenden;
- Eigenständig Testmodelle erstellen;
- Testselektionskriterien zur Testfallgenerierung definieren und anwenden;
- Aus Testmodellen Testfallbeschreibungen und ausführbare Testskripte generieren.

Remark:

Der Arbeitsaufwand beträgt 90 Std., welche sich grob wie folgt gliedern:

- 30 Std. Teilnahme an der Vorlesung und Übung
- 45 Std. Vor- und Nachbereitung der Vorlesung und Übung
- 15 Std. Vorbereitung auf die Klausur

prerequisites for the module:

keine

Recommended prior knowledge: Grundlegende Kenntnisse in Softwareentwicklung und Modellierung mittels UML, wie sie beispielsweise in dem Modul "Foundations of Software Engineering" (SWT-FSE-B) vermittelt werden.		**Admission requirements:** Keine
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

<table>
<tr><th colspan="2">Module Units</th></tr>
<tr><td>Modellbasiertes Testen
Mode of Delivery: Lectures and Practicals
Lecturers: N.N.
Language: German
Frequency: every winter semester
<hr>Learning outcome:
Siehe Modul-Lernziele/-Kompetenzen
<hr>Contents:
Im theoretischen Teil dieses Moduls werden folgende Kenntnisse vermittelt:
1. Einführung in MBT: Motivation und Konzept
2. Gängige Arten von Testmodellen
3. Testauswahlkriterien und Generierung von Testfällen
4. Übersicht aktueller MBT-Werkzeuge
5. Einsatz von MBT in klassischen und agilen Entwicklungsprojekten
Im praktischen Teil dieses Moduls werden die im theoretischen Teil vermittelten
Aspekte mittels eines MBT-Werkzeugs vertieft.
<hr>Literature:
• Kramer, A. and Legeard, B. Model-Based Testing Essentials – Guide to the ISTQB(R) Certified Model-Based Tester – Foundation Level. John Wiley & Sons, 2016.
• Roßner, T., Brandes, C., Götz, H. and Winter, M. Basiswissen Modellbasierter Test. dpunkt-Verlag, 2010.
• Utting, M. and Legeard, B. Practical Model-Based Testing – A Tools Approach. Morgan Kaufmann, 2007.
Weitere Literatur wird zu Modulbeginn bekannt gegeben.</td><td>2,00 Weekly Contact Hours</td></tr>
<tr><td>Examination
Written examination / Duration of Examination: 90 minutes
Description:
Die Klausur prüft Wissen und Verständnis der in der Vorlesung und Übung vermittelten Lehrinhalte.</td><td></td></tr>
</table>

<table>
<tr><td colspan="2">Module SWT-PCC-M Principles of Compiler Construction
Principles of Compiler Construction</td><td>6 ECTS / 180 h</td></tr>
<tr><td colspan="3">(since WS19/20)
Person responsible for module: Prof. Dr. Gerald Lüttgen</td></tr>
<tr><td colspan="3">Contents:
The module teaches the theoretical and practical principles of compiler construction, from lexical analysis and parsing, to semantic analysis, to code generation and optimisation.</td></tr>
<tr><td colspan="3">Learning outcomes:
On completion of this module, students will be familiar with all phases of a modern compiler – from lexical analysis and parsing, to semantic analysis and finally code generation and code optimisation – and will have a deep understanding of the workings of compilers. As a result, students will be able to use compilers more effectively and learn better debugging practices. Students will also be able to start building compilers on their own.</td></tr>
<tr><td colspan="3">Remark:
The main language of instruction is English. The lectures and practicals may be delivered in German if all participating students are fluent in German.

The total workload of 180 hrs. is split approximately as follows:
• 30 hrs. attending lectures (Vorlesungen)
• 30 hrs. reviewing the lectures, including researching and studying material from additional sources
• 30 hrs. attending practicals (Übungen)
• 30 hrs. preparing and reviewing the practicals, including researching and studying material from additional sources
• 60 hrs. working on the assignment (Hausarbeit) and preparing for the colloquium (Kolloquium)</td></tr>
<tr><td colspan="3">prerequisites for the module:
none</td></tr>
<tr><td colspan="2">Recommended prior knowledge:
Basic knowledge in programming languages, in the theoretical foundations of Computer Science (especially in language theory and automata theory) and in algorithms and data structures.</td><td>Admission requirements:
none</td></tr>
<tr><td>Frequency: every winter semester</td><td>Recommended semester:</td><td>Minimal Duration of the Module:
1 Semester</td></tr>
</table>

<table>
<tr><td colspan="2">Module Units</td></tr>
<tr><td>1. Principles of Compiler Construction
Mode of Delivery: Lectures
Lecturers: Prof. Dr. Gerald Lüttgen
Language: English/German
Frequency: every winter semester
Contents:
Students will be familiarised with a variety of theoretical and practical concepts, techniques and algorithms employed in compiler construction, which reach from language theory, to automata theory, and to data flow analysis. The lectures will</td><td>2,00 Weekly Contact Hours</td></tr>
</table>

focus on the following aspects of compiler construction: lexical analysis, parsing, abstract syntax, semantic analysis, code generation and code optimisation. **Literature:** • Louden, K. C. Compiler Construction: Principles and Practice. Course Technology, 1997. • Aho, A. V., Lam, M. S., Sethi, R. and Ullman, J. D. Compilers: Principles, Techniques, and Tools, 2nd ed. Pearson, 2007. • Fischer, C. N., Cytron, R. K. and LeBlanc Jr., R. J. Crafting a Compiler. Pearson, 2010. • Muchnick, S. S. Advanced Compiler Design and Implementation, Morgan Kaufmann, 1997.	
2. Principles of Compiler Construction **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Gerald Lüttgen, Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** English/German **Frequency:** every winter semester **Contents:** Students will practice the theoretical concepts taught in the lectures by applying them to a variety of exercises, so that they can appreciate the diverse range of foundations that make modern programming languages possible. The exercises will largely be pen-and-paper exercises but may also involve some work using computers. Emphasis will be put on presenting and discussing the solutions to the exercises by and among the students, within the timetabled practicals (Übungen). Students can gain further practical experience in compiler construction by attending one of the modules "Masterprojekt Softwaretechnik und Programmiersprachen" (SWT-PR1-M) or "Masters Project in Software Systems Science" (SWT-PR2-M). **Literature:** - see the corresponding lectures -	**2,00 Weekly Contact Hours**
Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 3 weeks **Description:** Assignment (Hausarbeit) consisting of questions practicing, reviewing and deepening the knowledge transferred in the lectures (Vorlesungen) and practicals (Übungen). The examination is set in English language, while answers may be provided in either English or German. Colloquium (Kolloquium) consisting of questions testing the knowledge transferred in the lectures (Vorlesungen) and practicals (Übungen), on the basis of the submitted solutions to the assignment (Hausarbeit). The colloquium can be held electively in English or German language.	

Module SWT-PR1-B Bachelors Project in Software Engineering and Programming Languages *Bachelorprojekt Softwaretechnik und Programmiersprachen*	6 ECTS / 180 h

(since WS19/20)
Person responsible for module: Prof. Dr. Gerald Lüttgen

Contents:
Manageable current topics in software engineering and programming languages are carried out in small teams of students or, if necessary, individually, from conception, via realization, to evaluation, to presentation. The project not only concerns software implementation, but also the development of sound concepts pertaining to the task to be addressed. Typically, this requires studying the current literature and implementing and/or adapting approaches on the project's topic that have been proposed therein. An example of a possible project task would be the development of a modern application software using sound software engineering principles.

Learning outcomes:
Students will gain knowledge regarding the conceptual and practical problems that arise when carrying out software projects, and regarding approaches to possible solutions. Since this will be done by means of the intensive conduct of a topic in software engineering and programming languages, students will gain important experience in carrying out small, academic-oriented projects, from project planning, to the abstract and concrete design, to the realization, to the documentation of results in a scientific project report.

Remark:
The main language of instruction is English. The module may be delivered in German if all participating students are fluent in German. A regular participation in the project meetings is necessary.

The total workload of 180 hrs. is split approximately as follows:

- 40 hrs. participating in project meetings
- 110 hrs. conducting the project work
- 30 hrs. compiling a project report (Assignment/Hausarbeit) and preparing the Colloquium (Kolloquium).

The project report can be written in either English or German.

prerequisites for the module:
none

Recommended prior knowledge: Basic knowledge in software engineering and programming languages, as well as knowledge in the subject matter of the project topic.		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelors Project in Software Engineering and Programming Languages **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Gerald Lüttgen, Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen	**4,00 Weekly Contact Hours**

Language: English/German
Frequency: every semester

Learning outcome:
To be announced at the beginning of the project.

Contents:
Conduct of the project, accompanied by regular meetings between students and lecturer.

Literature:
To be announced at the beginning of the project.

Examination
Coursework Assignment and Colloquium / Duration of Examination: 20 minutes
Duration of Coursework: 12 weeks
prerequisites for module examination:
Regelmäßige Teilnahme an der Lehrveranstaltung.
Description:
Production of a written report in English or German language on the software project carried out (Assignment/Hausarbeit). Discussion of this project report and of the developed artefacts in the context of the wider project topic (Colloquium/ Kolloquium). The Colloquium can be held electively in English or German language.

Module SWT-PR1-M Masters Project in Software Engineering and Programming Languages

Masterprojekt Softwaretechnik und Programmiersprachen

6 ECTS / 180 h

(since WS19/20)

Person responsible for module: Prof. Dr. Gerald Lüttgen

Contents:

Topics in Software Engineering and Programming Languages are carried out individually or in teams of students, from conception, via theoretical and/or practical realization, to evaluation. In particular, the project concerns the development of sound concepts pertaining to the task to be addressed under the given project constraints. This requires studying academic literature and relevant technologies and approaches on the project's topic.

An example of a project task would be the conceptual development, the prototypic implementation, and the case-study-driven evaluation of tools for software verification, which requires the prior attendance of the module "Applied Software Verification" (SWT-ASV-M), or equivalent knowledge. Another example would be designing and implementing a compiler of a small programming language in either an imperative, object-oriented or functional language, which requires the prior attendance of the module "Principles of Compiler Construction" (SWT-PCC-M), or equivalent knowledge.

Learning outcomes:

Students will deepen their knowledge regarding the conceptual problems that arise when carrying out scientific projects related to Software Systems Science, and regarding approaches to possible solutions. Students will also gain important experience in carrying out such projects, from project planning, to the abstract and concrete design, to the realization, to the documentation of results in a scientific project report.

Remark:

The main language of instruction is English. The module may be delivered in German if all participating students are fluent in German. A regular participation in the project meetings is necessary.

The total workload of 180 hrs. is split approximately as follows:

- 10 hrs. participating in introductions to and tutorials on methods, software tools, and giving presentations on the project status
- 20 hrs. completing the exercises for bonus points
- 115 hrs. researching and familiarization with the project topic and conducting the project work
- 35 hrs. compilating a project report (Assignment/Hausarbeit) and preparation of the Colloquium (Kolloquium).

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**
Basic knowledge in software engineering and programming languages, knowledge in the subject matter of the project topic.	none

Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Masters Project in Software Engineering and Programming Languages **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Gerald Lüttgen, Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** English/German **Frequency:** every semester **Learning outcome:** To be announced at the beginning of the project. **Contents:** Conduct of the project, accompanied by tutorials and regular project meetings. **Literature:** To be announced at the beginning of the project.	**4,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 12 weeks **prerequisites for module examination:** Regelmäßige Teilnahme an den zugehörigen Lehrveranstaltungen **Description:** Production of a written report on the software project carried out (Assignment/ Hausarbeit). The student may choose whether to write/compose the project report in English or German. Discussion of this project report and of the developed artefacts in the context of the wider project topic (Colloquium/Kolloquium). The examination language is either English or German and may be chosen by the student at the colloquium.	

Module SWT-PR2-B SWT Bachelors Project in Software Systems Science *SWT Bachelorprojekt Software Systems Science*		12 ECTS / 360 h
(since WS19/20) Person responsible for module: Prof. Dr. Gerald Lüttgen		
Contents: Manageable topics, which are taken from current topics in the modelling, programming, development, analysis and verification of software systems, are carried out in small teams of students or, if necessary, individually, from conception, to realization, to evaluation, to presentation. In particular, the project addresses the development of sound concepts pertaining to the task to be solved, within the given constraints. This requires detailed planning and studying of the current literature and proposed approaches on the project's topic. One example of a possible project topic is the development of a multi-user web-application consisting of front-end and back-end with modern technologies.		
Learning outcomes: Students will deepen their knowledge regarding the conceptual and practical problems that arise when carrying out software systems projects, and regarding approaches to possible solutions. Since this will be done in small teams (or, if necessary, individually) and by means of the intensive conduct of a current topic in software engineering and programming languages, students will gain important experience in carrying out small, academic-oriented projects, from project planning, to the abstract and concrete design, to the realization, to the documentation of results in a scientific project report and their presentation.		
Remark: This module spans two semesters: 2x6=12 ECTS, 2x4=8 SWS. A regular participation in the project meetings is necessary. The main language of instruction is English. The module may be delivered in German if all participating students are fluent in German. The total workload of 360 hrs. is split approximately as follows: • 90 hrs. attending project meetings, including tutorials • 180 hrs. conducting the project (project work) • 30 hrs. compilation of the interim report (Assignment/Hausarbeit) • 60 hrs. compilation of the final report, as well as preparing and presenting the project poster (Assignment with Colloquium / Hausarbeit mit Kolloquium) Reports and poster presentation can be written/composed in either English or German.		
prerequisites for the module: none		
Recommended prior knowledge: Basic methodological and practical knowledge in the planning and conduct of software projects, e.g., as acquired in the modules "Foundations of Software Engineering" (SWT-FSE-B) and "Software Engineering Lab" (SWT-SWL-B).		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 2 Semester

Module Units	
SWT Bachelors Project in Software Systems Science **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Gerald Lüttgen, Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** English/German **Frequency:** every semester **Learning outcome:** To be announced at the beginning of the project. **Contents:** Conduct of the project. The project will be accompanied by tutorials where needed, in which students will be familiarized with methods, techniques and software tools that are relevant for the project's topic. There will also be regular meetings between students and lecturer, whose purpose is to control progress and to engage in professional discussions on the project's subject. The progress and the results of the project will be documented by students in an interim report and a final report. In addition, every team (or, in case of an individual project, the student) will prepare a project poster, which will be presented, explained and discussed in the context of a closing workshop. **Literature:** To be announced at the beginning of the project.	**8,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 12 weeks **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung. **Description:** Colloquium (Kolloquium): Professional discussion of the topic addressed in the project at which the produced poster will be explained; in addition, practical project results such as executable software can be demonstrated. The colloquium can be held electively in English or German language. Assignment (Hausarbeit): Compilation of a written report in English or German language after completion of the project work.	

Examination Coursework Assignment / Duration of Coursework: 12 weeks **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung. **Description:** Compiling a written interim report in English or German language, at the latest at the end of the semester in which the project has been started.	

Module SWT-PR2-M SWT Masters Project in Software Systems Science *SWT Masters Project in Software Systems Science*	9 ECTS / 270 h

(since WS19/20)
Person responsible for module: Prof. Dr. Gerald Lüttgen

Contents:

Topics in Software Systems Science are carried out individually or in teams of students, from conception, via theoretical and/or practical realization, to evaluation. In particular, the project concerns the development of sound concepts pertaining to the task to be addressed under the given project constraints. This requires studying academic literature and relevant technologies and approaches on the project's topic.

An example of a project task would be the conceptual development, the prototypic implementation, and the case-study-driven evaluation of tools for software verification, which requires the prior attendance of the module "Applied Software Verification" (SWT-ASV-M), or equivalent knowledge. Another example would be designing and implementing a compiler of a small programming language in either an imperative, object-oriented or functional language, which requires the prior attendance of the module "Principles of Compiler Construction" (SWT-PCC-M), or equivalent knowledge.

Learning outcomes:

Students will deepen their knowledge regarding the conceptual problems that arise when carrying out scientific projects related to Software Systems Science, and regarding approaches to possible solutions. Students will also gain important experience in carrying out such projects, from project planning, to the abstract and concrete design, to the realization, to the documentation of results in a scientific project report.

Remark:

The main language of instruction is English. The module may be delivered in German if all participating students are fluent in German. A regular participation in the project meetings is necessary.

The total workload of 270 hrs. is split approximately as follows:

- 10 hrs. participating in introductions to and tutorials on methods, software tools, and giving presentations on the project status
- 20 hrs. completing the exercises for bonus points
- 195 hrs. researching and familiarization with the project topic and conducting the project work
- 45 hrs. compiling a project report (Assignment/Hausarbeit) and preparation of the Colloquium (Kolloquium).

The project report can be written/composed in either English or German.

prerequisites for the module:

none

Recommended prior knowledge: Basic knowledge in software engineering and programming languages, knowledge in the subject matter of the project topic.		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
SWT Masters Project in Software Systems Science **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Gerald Lüttgen **Language:** English/German **Frequency:** every semester **Learning outcome:** To be announced at the beginning of the project. **Contents:** Conduct of the project, accompanied by tutorials and regular project meetings. **Literature:** To be announced at the beginning of the project.	**6,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 12 weeks **prerequisites for module examination:** Regular participation in the practicals. **Description:** Production of a written report on the software project carried out (Assignment/ Hausarbeit). Discussion of this project report and of the developed artefacts in the context of the wider project topic (Colloquium/Kolloquium).	

Module SWT-RSD-B Reactive Systems Design

Reactive Systems Design

6 ECTS / 180 h

(since WS19/20)
Person responsible for module: Prof. Dr. Gerald Lüttgen

Contents:

Reactive systems are digital systems that continuously react to their environment by reading sensor values, computing output values and emitting those values to actuators. Such systems are embedded in many parts of our daily lives and some must even satisfy stringent real-time requirements. Whether it is a home automation system, a driver's assistance system in a modern car, or sophisticated medical equipment at the hospital, we depend on the reliability, correctness, and quality of these systems' software.

This module discusses the theoretical concepts and the engineering practice of the model-driven development of reactive systems software. The module's foci are on the synchronous programming paradigm, on automatic code generation from system models, on techniques for verifying and testing reactive systems, and on deploying and integrating reactive software components on a specific operating system and execution platform.

Learning outcomes:

On completion of this module, students will be able to understand the context and concepts of reactive systems design. They will be able to employ state-of-the-art techniques for the model-driven engineering of reactive software and to apply methods for testing and verifying reactive systems. Moreover, they will have the competence to deploy and integrate reactive software components on a physical execution platform, taking timing requirements into account.

Remark:

The main language of instruction is English.

The total workload of 180 hrs. is split approximately as follows:

- 30 hrs. attending lectures (Vorlesungen)
- 30 hrs. attending practicals (Übungen)
- 60 hrs. preparing and reviewing the lectures and practicals, including researching literature, studying material from additional sources
- 60 hrs. working on the assignment (Hausarbeit) and preparing for the colloquium (Kolloquium)

prerequisites for the module:

none

Recommended prior knowledge:	Admission requirements:
Basic knowledge in discrete mathematics and programming, e.g., acquired in the modules "*Mathematik für Informatik 1 (Aussagen- und Prädikatenlogik)*" (GdI-MfI-1) and "*Einführung in Algorithmen, Programmierung und Software*" (DSG-EiAPS-B). Knowledge gained in program semantics and verification, e.g., in the module "*Foundations of Software Analysis*" (SWT-FSA-B), is beneficial but not necessary for following the module's content.	none

Frequency:	Recommended semester:	Minimal Duration of the Module:
every summer semester	4.	1 Semester

Module Units	
1. Reactive Systems Design **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Gerald Lüttgen, Eugene Yip **Language:** English/German **Frequency:** every summer semester **Learning outcome:** – see the module's learning outcomes/competences (Lernziele/Kompetenzen) listed above – **Contents:** Students are introduced to modern model-driven techniques, languages and tools for designing and programming reactive systems. The lectures first motivate reactive systems, present their basic design principles, and examine the synchronous programming paradigm. Then, techniques for verifying design properties via model checking, for automatically transforming design models into running code, and for automated testing are studied. The synchronous language and model-based development environment *KIELER SCCharts* is used for illustrating key semantic and engineering concepts. Several topics on the deployment and integration of reactive software components on a physical execution platform are also addressed: the timing analysis problem, real-time operating systems and scheduling disciplines. In particular, the logical execution time (LET) programming model is discussed as a means to execute reactive software components together in a semantics-preserving manner, and is exemplified by the synchronous programming language ForeC that supports the LET semantics. **Literature:** • Lee, E. A., and Seshia, S. A. Introduction to Embedded Systems: A Cyber-Physical Systems Approach, 2nd ed. MIT Press, 2017. • Halbwachs, N. Synchronous Programming of Reactive Systems. Springer, 1993. • Harel, D. and Politi, M. Modeling Reactive Systems with Statecharts. McGraw-Hill, 1998. Further literature will be announced at the beginning of the module.	**2,00 Weekly Contact Hours**
2. Reactive Systems Design **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** English/German **Frequency:** every summer semester **Learning outcome:** – see the module's learning outcomes/competences (Lernziele/Kompetenzen) listed above – **Contents:**	**2,00 Weekly Contact Hours**

The practicals (Übungen) deepen the concepts and techniques taught in the lectures (Vorlesungen) and apply them to the development of reactive software. The latter involves a small programming project of a real reactive system with a modern development tool such as *KIELER SSCharts*. **Literature:** – see the corresponding lectures –	
Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 3 weeks **Description:** The Assignment (Hausarbeit) consists of questions practicing, reviewing and deepening the knowledge transferred in the lectures and practicals (Vorlesungen und Übungen); questions may also involve the practical use of the development tool introduced in the practicals. The assignment is set in English; students may answer in either English or German. The Colloquium (Kolloquium) consists of questions testing the knowledge transferred in the lectures and practicals (Vorlesungen und Übungen), on the basis of the submitted solutions to the assignment (Hausarbeit). The examination language is either English or German and may be chosen by the student at the colloquium.	

Module SWT-SEM-B Seminar in Software Engineering and Programming Languages (Bachelor) *Seminar Software Engineering and Programming Languages (Bachelor)*	3 ECTS / 90 h	
(since WS17/18) Person responsible for module: Prof. Dr. Gerald Lüttgen		
Contents: Current topics in software engineering and programming languages.		
Learning outcomes: Students will compile and acquire current topics in software engineering and programming languages by carrying out and documenting a guided literature survey, and by preparing and delivering a coherent, comprehensible presentation to their peers.		
Remark: The main language of instruction is English. The seminar may be delivered in German if all participating students are fluent in German. Regular participation in the presentations is required. The total workload of 90 hrs. is split approximately as follows: • 20 hrs. consultations and presentations (Referate), including discussions • 25 hrs. literature research and familiarization and evaluation of literature • 45 hrs. working on the assignment (Hausarbeit) and preparation for the presentation (Referat)		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge in software engineering, in programming languages and in the subject matter of the seminar. In addition, elementary knowledge in scientific methods is desirable.		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Software Engineering and Programming Languages (Bachelor) **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Gerald Lüttgen, Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** English/German **Frequency:** every summer semester **Contents:** Various current topics in software engineering and programming languages, which complement and/or extend the technical and methodological aspects of the degree programme's modules related to these fields. **Literature:** Will be allocated according to the topics to be discussed.	**2,00 Weekly Contact Hours**

Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 3 weeks **prerequisites for module examination:** Regular participation in the seminar. **Description:** Assignment (Hausarbeit) consisting of a written report on the topic assigned to the student. Presentation (Referat) on the topic assigned to the student, including a discussion.	

Module SWT-SEM-M Seminar in Software Engineering and Programming Languages (Master) *Seminar Software Engineering and Programming Languages (Master)*		3 ECTS / 90 h
(since WS17/18) Person responsible for module: Prof. Dr. Gerald Lüttgen		
Contents: Current topics in software engineering and programming languages. This may comprise the full spectrum of research topics in these fields, from the analysis, comparison and evaluation of current software technologies and tools, to the discussion and evaluation of novel research proposals.		
Learning outcomes: Students will compile and acquire current topics in software engineering and programming languages by independently carrying out and documenting a literature survey, and by preparing and delivering a coherent, comprehensible presentation to their peers. Students will also be able to scientifically discuss topics in software engineering and programming languages with their peers.		
Remark: The main language of instruction is English. The seminar may be delivered in German if all participating students are fluent in German. Regular participation in the presentations is required. The total workload of 90 hrs. is split approximately as follows: • 20 hrs. consultations and presentations (Referate), including discussions • 25 hrs. literature research and familiarization and evaluation of literature • 45 hrs. working on the assignment (Hausarbeit) and preparation for the presentation (Referat)		
prerequisites for the module: none		
Recommended prior knowledge: Basic knowledge in software engineering, in programming languages and in the subject matter of the seminar. In addition, elementary knowledge in scientific methods is desirable.		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Software Engineering and Programming Languages (Master) **Mode of Delivery:** Seminar **Lecturers:** Prof. Dr. Gerald Lüttgen, Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** English/German **Frequency:** every semester **Contents:** Various current topics in software engineering and programming languages, which complement and/or extend the technical and methodological aspects of the degree programme's modules related to these fields. **Literature:** Will be allocated according to the topics to be discussed.	**2,00 Weekly Contact Hours**

Examination Coursework Assignment with presentation / Duration of Examination: 30 minutes Duration of Coursework: 3 weeks **prerequisites for module examination:** Regular participation in the seminar. **Description:** Assignment (Hausarbeit) consisting of a written report on the topic assigned to the student. Presentation (Referat) on the topic assigned to the student, including a discussion.	

Module SWT-SSP-B Soft Skills for IT Projects *Soft Skills in IT-Projekten*		3 ECTS / 90 h 30 h Präsenzzeit 60 h Selbststudium
(since SS14) Person responsible for module: Prof. Dr. Gerald Lüttgen		
Contents: Ziel des Moduls ist es, die in der Praxis der IT-Projekte immer wichtiger werdenden Soft Skills wissenschaftlich und methodisch fundiert zu vermitteln. Die Studierenden lernen, dieses Wissen in der Praxis ziel- und lösungsorientiert anwenden zu können.		
Learning outcomes: Nach erfolgreicher Teilnahme an diesem Modul können Studierende insbesondere: • Sich die Bedeutung menschlicher Faktoren in großen IT-Projekten bewusst machen; • Erfolgsfaktoren der Teamarbeit kennen und einschätzen; • Eigenkompetenzen und Kompetenzen anderer wahrnehmen, beurteilen und für die Teamorganisation nutzen; • Muster der Gruppendynamik - insbes. Kommunikationsmuster, Konfliktsituationen und Verantwortungsdiffusion - erkennen und managen.		
Remark: Der Arbeitsaufwand beträgt 90 Std., welche sich grob wie folgt gliedern: • 30 Std. Teilnahme an der Vorlesung und Übung • 45 Std. Vor- und Nachbereitung der Vorlesung und Übung • 15 Std. Vorbereitung auf die Klausur (Studies in German only.)		
prerequisites for the module: none		
Recommended prior knowledge: Keine.		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Soft Skills in IT-Projekten **Mode of Delivery:** Lectures and Practicals **Lecturers:** Norbert Seifert **Language:** German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: Der Inhalt orientiert sich an der in der Praxis großer IT-Projekte erforderlicher Soft Skills: 1. Vorsprung durch Menschenkenntnis; 2. Teamorganisation und -aufstellung; 3. Kommunikation und Konfliktmanagement; 4. Motivationsfaktoren und Selbstverantwortung;	

5. Menschliche Spielregeln großer IT-Projekte. **Literature:** Literatur wird zu Beginn der Lehrveranstaltung angegeben.	
Examination Written examination / Duration of Examination: 90 minutes **Description:** Die Klausur prüft Wissen und Verständnis der in der Vorlesung und Übung vermittelten Lehrinhalte.	

Module SWT-SWL-B Software Engineering Lab *Software Engineering Lab*		6 ECTS / 180 h

(since WS19/20)
Person responsible for module: Prof. Dr. Gerald Lüttgen

Contents:
Small teams of students will conduct a software project, starting from a brief problem description.
This involves the application of modern software engineering tools, skills in collaboration and team organisation, and knowledge of processes and techniques for producing software artefacts and associated documents.

Learning outcomes:
Students will develop a piece of medium-sized software in small teams, thereby acquiring practical expertise in software engineering and skills in working in a software development team. In addition, this module deepens the students' programming proficiency and their understanding of flexible software engineering processes and of software and process quality, and familiarises them with the deployment and use of modern software engineering tools.

Remark:
The main language of instruction is English. The practicals may be delivered in German if all participating students are fluent in German. A regular attendance of team meetings and active participation is required throughout.

The total workload of 180 hrs. is split approximately as follows:

- 20 hrs. attending meetings of the student's team with the lecturer (Dozent) on planning, coordination and feedback
- 10 hrs. attending the accompanying practicals/tutorials (Übungen/Tutorials) on software tools
- 130 hrs. conducting the team project
- 20 hrs. working on the assignment (Hausarbeit) and preparing for the colloquium (Kolloquium)

prerequisites for the module:
none

Recommended prior knowledge: Basic knowledge in Computer Science and Software Engineering, as well as knowledge in Java programming and in programming in the small.		**Admission requirements:**
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

Software Engineering Lab **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Gerald Lüttgen, Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** German/English **Frequency:** every winter semester	**4,00 Weekly Contact Hours**

Contents:

Each team will carry out a software project, regularly meet with their tutor

(Dozent) in order to critically reflect on the team's work, and participate in tutorials that introduce the software engineering tools and some software engineering techniques to be used in this project.

Literature:

- Tahchiev, P., Leme, F., Massol, V. and Gregory, G. JUnit in Action, 2nd ed. Manning Publications, 2010.
- Loeliger, J. and McCullough, M. Version Control with Git: Powerful Tools and Techniques for Collaborative Software Development, 2nd ed. O'Reilly, 2012.
- Vogel, L. Eclipse IDE. Lars Vogel, 2013. ISBN 3943747042.
- Schwaber, K. and Beedle, M. Agile Software Development with Scrum, Pearson, 2001.
- Cohn, M. User Stories Applied. Addison-Wesley, 2004.

See the description of the module "Foundations of Software Engineering (SWT-FSE-B)" for further literature.

Examination

Coursework Assignment and Colloquium / Duration of Examination: 45 minutes
Duration of Coursework: 2 weeks

prerequisites for module examination:

Regular participation in the associated practicals

Description:

Assignment (Hausarbeit) involving the compilation of a written project report in English or German language by each team, which shall cover the following topics:

- A description of the team’s produced artefacts, including the electronic submission of the artefacts themselves;
- A description, justification and critical reflection of the employed software engineering processes, methods and techniques in general and in each development phase;
- A description of the team’s organisation, the distribution of work and the contributions of each team member.

The submission deadline and the details of the required content and format of this report will be announced at the beginning of the semester.

Colloquium (Kolloquium) consisting of a critical discussion of the team's produced software and project report with respect to the taken design decisions and possible alternatives, the quality of the produced artefacts and documentation, the project's status and completeness, the conduct of testing, and the appropriateness of the employed techniques and processes. The colloquium takes place in the presence of the team as a whole, but each question will be addressed to a specific student so that marks can be individualised. The colloquium can be held electively in English or German language.

Because this module involves a team effort, the examination can only be resit in a winter semester. In addition, this module calls for active participation throughout.