# M.Sc. Information System Technology, Mandatory areas (PO 2023)

**Module handbook**
FB 18
Date: 01.09.2023

TECHNISCHE UNIVERSITÄT DARMSTADT

FB 18

Module handbook: M.Sc. Information System Technology, Mandatory areas (PO 2023)

Date: 01.09.2023

FB 18
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# Contents

# 1 Options - Fundamentals

## 1.1 Optional Subjects CTS: Communication Technology and Communication Systems

| **Module name**<br>Communication Networks II | | | | | |
|---|---|---|---|---|---|
| **Module nr.**<br>18-sm-2010 | **Credit points**<br>6 CP | **Workload**<br>180 h | **Self-study**<br>120 h | **Module duration**<br>1 Term | **Module cycle**<br>Winter term |
| **Language**<br>English | | | **Module owner**<br>Prof. Dr.-Ing. Ralf Steinmetz | | |

**1 Teaching content**

The course Communication Networks II covers the principles and practice of computer networking and telecommunications with emphasis on the Internet. Starting with the history, the course discusses past, current and future aspects of communication networks. In addition to the basics including well known protocols and technologies, recent developments in the area of multimedia communication (e.g., Video Streaming, P2P, IP-Telephony, Cloud Computing and Service-oriented Architectures) will be examined thoroughly. The course is designed as follow-up to Communication Networks I.

Topics are:

- Basics and History of Communication Networks (Telegraphy vs. Telephony, Reference Models, ...)
- Transport Layer (Addressing, Flow Control, Connection Management, Error Detection, Congestion Control, ...)
- Transport Protocols (TCP, SCTP)
- Interactive Protocols (Telnet, SSH, FTP, ...)
- Electronic Mail (SMTP, POP3, IMAP, MIME, ...)
- World Wide Web (HTML, URL, HTTP, DNS, ...)
- Distributed Programming (RPC, Web Services, Event-based Communication)
- SOA (WSDL, SOAP, REST, UDDI, ...)
- Cloud Computing (SaaS, PaaS, IaaS, Virtualization, ...)
- Overlay Networks (Unstructured P2P, DHT Systems, Application Layer Multicast, ...)
- Video Streaming (HTTP Streaming, Flash Streaming, RTP/RTSP, P2P Streaming, ...)
- VoIP and Instant Messaging (SIP, H.323)

**2 Learning objectives**

Upon successful completion, the module provides students with an understanding of the principles and practice of computer networking and telecommunications with emphasis on the Internet. Starting with the history, the course discusses past, current and future aspects of communication networks. In addition to the basics including well known protocols and technologies, recent developments in the area of multimedia communication (e.g., Video Streaming, P2P, IP-Telephony, Cloud Computing and Service-oriented Architectures) will be examined thoroughly. The course is designed as follow-up to Communication Networks I.

**3 Recommended prerequisites for participation**

Basic courses of first 4 semesters are required. Knowledge in the topics covered by the course Communication Networks I is recommended. Theoretical knowledge obtained in the course Communication Networks II will be strengthened in practical programming exercises. So, basic programming skills are beneficial.

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| 4 | **Form of examination**<br>Module exam:<br>• Module exam (Technical examination, Examination, Duration: 120 Min., Default RS) |
| 5 | **Prerequisite for the award of credit points**<br>Passing the final module examination |
| 6 | **Grading**<br>Module exam:<br>• Module exam (Technical examination, Examination, Weighting: 100 %) |
| 7 | **Usability of the module**<br>MSc ETiT, MSc iST, Wi-ETiT, CS, Wi-CS |
| 8 | **Grade bonus compliant to §25 (2)**<br>The maximum grade improvement is 1.0. For a grade improvement to be awarded, a minimum number of points (50% of the maximum achievable points) must be reached. From this minimum number, the grade improvemnet increases proportionally (from 0.0 grade improvement at the minimum number to a maximum of 1.0 grade improvement from 95% of the maximum achievable points). Above 95% of the maximum achievable points, the bonus is 1.0. |
| 9 | **References**<br>Selected chapters from following books:<br>• Andrew S. Tanenbaum: Computer Networks, Fourth 5th Edition, Prentice Hall, 2010<br>• James F. Kurose, Keith Ross: Computer Networking: A Top-Down Approach, 6th Edition, Addison-Wesley, 2009<br>• Larry Peterson, Bruce Davie: Computer Networks, 5th Edition, Elsevier Science, 2011 |

**Courses**

| | | | |
|---|---|---|---|
| **Course nr.**<br>18-sm-2010-vl | **Course name**<br>Communication Networks II | | |
| **Instructor**<br>Prof. Dr.-Ing. Ralf Steinmetz, M.Sc. Pratyush Agnihotri, Dr.-Ing. Tobias Meuser, M.Sc. Christoph Gärtner | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course nr.**<br>18-sm-2010-ue | **Course name**<br>Communication Networks II | | |
| **Instructor**<br>Prof. Dr.-Ing. Ralf Steinmetz, M.Sc. Pratyush Agnihotri, Dr.-Ing. Tobias Meuser, M.Sc. Christoph Gärtner | | **Type**<br>Practice | **SWS**<br>1 |

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|---|---|---|---|---|---|
| **Module name**<br>Communication Technology I | | | | | |
| **Module nr.**<br>18-kl-1020 | **Credit points**<br>6 CP | **Workload**<br>180 h | **Self-study**<br>120 h | **Module duration**<br>1 Term | **Module cycle**<br>Winter term |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Anja Klein | | |

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| **1** | **Teaching content**<br>Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access |
| **2** | **Learning objectives**<br>After completion of the module, students possess the ability to:<br>• classify signals and communication systems,<br>• understand, model and analyse basic components of communication systems,<br>• understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,<br>• model and analyse base-band commnication systems,<br>• describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,<br>• understand, model, evaluate, compare and apply linear modulation schemes,<br>• design receiver structures for different modulation schemes,<br>• detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,<br>• understand and model OFDM,<br>• understand and model CDMA,<br>• understand and compare the basic properties of multiple access schemes. |
| **3** | **Recommended prerequisites for participation**<br>Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to III, Statistics/Probability Theory, Scientific Computing |
| **4** | **Form of examination**<br>Module exam:<br>• Module exam (Technical examination, Examination, Duration: 90 Min., Default RS) |
| **5** | **Prerequisite for the award of credit points**<br>Passing the final module examination |
| **6** | **Grading**<br>Module exam:<br>• Module exam (Technical examination, Examination, Weighting: 100 %) |
| **7** | **Usability of the module**<br>BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC |
| **8** | **Grade bonus compliant to §25 (2)** |
| **9** | **References**<br>Will be announced in the lecture |
| **Courses** | |

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|---|---|---|---|---|
| | **Course nr.**<br>18-kl-1020-vl | **Course name**<br>Communication Technology I | | |
| | **Instructor**<br>Prof. Dr.-Ing. Anja Klein | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course nr.**<br>18-kl-1020-ue | **Course name**<br>Communication Technology I | | |
| | **Instructor**<br>Dr. rer. nat. Sabrina Klos, Prof. Dr.-Ing. Anja Klein | | **Type**<br>Practice | **SWS**<br>1 |

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|---|---|---|---|---|---|
| **Module name**<br>TK3: Ubiquitous / Mobile Computing | | | | | |
| **Module nr.**<br>20-00-0120 | **Credit points**<br>6 CP | **Workload**<br>180 h | **Self-study**<br>120 h | **Module duration**<br>1 Term | **Module cycle**<br>Summer term |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Eberhard Mühlhäuser | | |

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| **1** | **Teaching content**<br>Objectives:<br><br>- Knowledge of technical basics of the mobile communication<br>- Knowledge of important challenges of the Ubiquitous Computing<br>- Methodic knowledge about current approaches to these challenges<br><br>Course Content:<br><br>- Introduction to Ubiquitous Computing<br>- Mobile Communication<br>- Internet of Things: RFID and Smart Items<br>- Service Discovery & Cloudlets<br>- Context- and Location-aware Computing<br>- Human Computer Interaction<br>- Privacy and Trust in Ubiquitous Computing |
| **2** | **Learning objectives**<br>After successfully attending the course, students are familiar with the technical basis of mobile communication. They understand the fundamental challenge of ubiquitous computing. They know current approaches to solve these challenges. They are able to apply their knowledge to build ubiquitous computing systems. |
| **3** | **Recommended prerequisites for participation**<br>Computer Netzwerke and Distributed Systems |
| **4** | **Form of examination**<br>Course related exam:<br>• [20-00-0120-iv] (Technical examination, Oral/written examination, Default RS) |
| **5** | **Prerequisite for the award of credit points**<br>Pass exam (100%) |
| **6** | **Grading**<br>Course related exam:<br>• [20-00-0120-iv] (Technical examination, Oral/written examination, Weighting: 100 %) |
| **7** | **Usability of the module**<br>B.Sc. Informatik<br>M.Sc. Informatik<br>M.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br><br>May be used in other degree programs. |
| **8** | **Grade bonus compliant to §25 (2)** |

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| | In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. 25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann. |
| **9** | **References**<br>Literature recommendations will be updated regularly, an example might be:<br>A Primary Literature:<br><br>Handbook of Research: Ubiquitous Computing Technology for Real Time Enterprises edited by Prof. Dr. Max Mühlhäuser, Dr. Iryna Gurevych, 2008, Information Science Reference, ISBN-10: 1599048329<br><br>B Secondary Literature:<br><br>1. F. Adelstein, S. Gupta et al.: Fundamentals of Mobile & Pervasive Computing McGraw Hill 2004,<br>2. Stefan Poslad: Ubiquitous Computing, Wiley 2009, ISBN 978-0-470-03560-3<br>3. Kapitel Mobilkommunikation: M. Sauter: Grundkurs Mobile Kommunikationssysteme: UMTS, HSDPA und LTE, GSM, GPRS und Wireless LAN; Vieweg-Teubner Studium 2010<br>4. J. Krumm (Ed.): Ubiquitous Computing Fundamentals, CRC Press 2010<br>D. Cook, S. Das (Ed.): Smart Environments, Wiley 2005 |

**Courses**

| | **Course nr.** | **Course name** | | |
|---|---|---|---|---|
| | 20-00-0120-iv | TK3: Ubiquitous / Mobile Computing | | |
| | **Instructor** | | **Type**<br>Integrated course | **SWS**<br>4 |

## 1.2 Optional Subjects SES: System on Chip and Embedded Systems

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|---|---|---|---|---|---|
| **Module name**<br>Algorithms for Electronic Design Automation Tools | | | | | |
| **Module nr.**<br>20-00-0183 | **Credit points**<br>3 CP | **Workload**<br>90 h | **Self-study**<br>60 h | **Module duration**<br>1 Term | **Module cycle**<br>Winter term |
| **Language**<br>German/English | | | **Module owner**<br>Prof. Dr.-Ing. Andreas Koch | | |

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|---|---|
| 1 | **Teaching content**<br>- The VLSI design problem<br>- Fundamental graph representations and algorithms<br>- Representations for hierarchical circuits<br>- Fabrication technologies for integrated circuits<br>- Layout compaction<br>- Timing analysis<br>- Heuristical optimization techniques<br>- Placement problems, algorithms, and cost functions<br>- Exact optimization techniques<br>- Partitioning and its use in placement<br>- Floorplanning problems, representations, and techniques<br>- Routing problems, algorithms, and cost functions |
| 2 | **Learning objectives**<br>After successfully attending the course, the students know a number of fabrication technologies for integrated circuits. They are able to deduce from the technologies the requirements on automation tools for the different tasks in the design and realization process. They are familiar with modeling technological problems by formal concepts such as graphs and equation systems. They understand fundamental techniques for solving even hard computational problems and are able to apply these, together with knowledge of representative EDA algorithms, to develop new or refined implementations of design tools. |
| 3 | **Recommended prerequisites for participation**<br>Recommended:<br>Participation of lecture “Digitaltechnik", “Algorithmen und Datenstrukturen” and “Funktionale und objektorientierte Programmierung”. |
| 4 | **Form of examination**<br>Course related exam:<br>• [20-00-0183-vl] (Technical examination, Oral/written examination, Default RS) |
| 5 | **Prerequisite for the award of credit points**<br>Pass exam (100%) |
| 6 | **Grading**<br>Course related exam:<br>• [20-00-0183-vl] (Technical examination, Oral/written examination, Weighting: 100 %) |
| 7 | **Usability of the module** |

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| | B.Sc. Informatik<br>M.Sc. Informatik<br>B.Sc. Computational Engineering<br>M.Sc. Computational Engineering<br>M.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br><br>May be used in other degree programs. |
| **8** | **Grade bonus compliant to §25 (2)** |
| **9** | **References**<br>Literature reommendations will be updated regularly, an example might be:<br>Gerez: Algorithms for VLSI Design Automation<br>Wang/Chang/Cheng: Electronic Design Automation |

**Courses**

| | **Course nr.** | **Course name** | | |
|---|---|---|---|---|
| | 20-00-0183-vl | Algorithms for Chip Design Tools | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |

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|---|---|---|---|---|---|
| **Module name**<br>Labs on Algorithms for Electronic Design Automation Tools | | | | | |
| **Module nr.**<br>20-00-0571 | **Credit points**<br>6 CP | **Workload**<br>180 h | **Self-study**<br>120 h | **Module duration**<br>1 Term | **Module cycle**<br>Winter term |
| **Language**<br>German/English | | | **Module owner**<br>Prof. Dr.-Ing. Andreas Koch | | |

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| **1** | **Teaching content**<br>- Realizing Electronic Design Automation tools for layout synthesis, specifically for topics such as timing analysis, placement, and routing<br>- Evaluation of the quality-of-results and compute/memory requirements of developed tools in comparison to existing implementations |
| **2** | **Learning objectives**<br>After successfully attending the course, the students can independently implement Electronic Design Automation tools for the specified fabrication technology. They can evaluate their tools according to a number of quality metrics and perform a comparison with existing implementations. |
| **3** | **Recommended prerequisites for participation**<br>Recommended:<br>Participation of lecture “Algorithmen für Hardware-Entwurfswerkzeuge”. |
| **4** | **Form of examination**<br>Course related exam:<br>• [20-00-0571-pr] (Study achievement, Oral/written examination, Default RS) |
| **5** | **Prerequisite for the award of credit points**<br>Pass exam (100%) |
| **6** | **Grading**<br>Course related exam:<br>• [20-00-0571-pr] (Study achievement, Oral/written examination, Weighting: 100 %) |
| **7** | **Usability of the module**<br>B.Sc. Informatik<br>M.Sc. Informatik<br>B.Sc. Computational Engineering<br>M.Sc. Computational Engineering<br>M.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br><br>May be used in other degree programs. |
| **8** | **Grade bonus compliant to §25 (2)** |
| **9** | **References**<br>Given scientific Papers to recommeded base-methods. |
| **Courses** | |

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|---|---|---|---|---|
| | **Course nr.**<br>20-00-0571-pr | **Course name**<br>Labs on Algorithms for Electronic Design Automation Tools | | |
| | **Instructor**<br>Prof. Dr.-Ing. Andreas Koch | | **Type**<br>Internship | **SWS**<br>4 |

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|---|---|---|---|---|---|
| **Module name**<br>Advanced Digital Integrated Circuit Design | | | | | |
| **Module nr.**<br>18-ho-2010 | **Credit points**<br>6 CP | **Workload**<br>180 h | **Self-study**<br>120 h | **Module duration**<br>1 Term | **Module cycle**<br>Winter term |
| **Language**<br>English | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

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| 1 | **Teaching content**<br>MOS Transistor Models, CMOS Logic Gates, Chip Layout and Design Rules, Static and Dynamic Behavior of CMOS Circuits, Synchonous CMOS Circuits, Performance and Power Characterisation, Design Techniques and CAD Tools, FPGA and Gate Array Technologies, Memory Technologies, Data-Converters (A/D, D/A), Chip Test. |
| 2 | **Learning objectives**<br>A student is, after successful completion of this module, able to<br>• understand the short-channel effects of modern CMOS transistors,<br>• derive and analyse the most important circuit concepts for digital logic gates,<br>• understand the design flow of digital ASICs based on standard cells (design, layout, simulation/verification),<br>• know the pros and cons of synchronous vs. asynchronous logic, multiclockphase systems,<br>• understand the differential design methods of integrated circuits (ASIC, ASIP, Full-custom/Semicustom, PLA, PLD, FPGA),<br>• understand basic circuitry of logic and arithmetic units (adders, multipliers, PLL/DLL),<br>• understand the concepts of A/D and D/A-converters, and their fundamental technical properties and architectures,<br>• know the design principles and properties of integrated semiconductor memory (DRAM, SRAM, Flash. MRAM, FeRAM) |
| 3 | **Recommended prerequisites for participation**<br>Lecture "Electronics" |
| 4 | **Form of examination**<br>Module exam:<br>• Module exam (Technical examination, Examination, Duration: 90 Min., Default RS) |
| 5 | **Prerequisite for the award of credit points**<br>Passing the final module examination |
| 6 | **Grading**<br>Module exam:<br>• Module exam (Technical examination, Examination, Weighting: 100 %) |
| 7 | **Usability of the module**<br>MSc ETiT, MSc Wi-ETiT, MSc iCE, MSc iST, MSc MEC, MSc EPE |
| 8 | **Grade bonus compliant to §25 (2)**<br>A grade improvement of up to 1,0 due to a bonus is possible, which can be earned with tests. |
| 9 | **References**<br>Lecture Slide Copies<br>• John P. Uyemura: Fundamentals of MOS Digital Integrated Circuits<br>• Neil Weste et al.: Principles of CMOS VLSI Design |
| **Courses** | |

| | | | | |
|---|---|---|---|---|
| | **Course nr.**<br>18-ho-2010-vl | **Course name**<br>Advanced Digital Integrated Circuit Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course nr.**<br>18-ho-2010-ue | **Course name**<br>Advanced Digital Integrated Circuit Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Practice | **SWS**<br>1 |

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|---|---|---|---|---|---|
| **Module name**<br>Computer Systems II | | | | | |
| **Module nr.**<br>18-hb-2030 | **Credit points**<br>6 CP | **Workload**<br>180 h | **Self-study**<br>120 h | **Module duration**<br>1 Term | **Module cycle**<br>Summer term |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Christian Hochberger | | |

**1 Teaching content**

- Configurable Technologies
- FPGA architectures and properties
- System-On-Chip, HW components, SW toolchain, support SW
- Coarse grained reconfigurable architectures, PE architecture, Modulo schedu-ling

**2 Learning objectives**

After completion of the module, students know reconfigurable technologies as well as chip architecture that employ them (e.g. FPGAs and CGRAs). They can select an ap-propriate technology for a given specific application. They know the components a system-on-chip (SoC) consists of. Students can configure and program an application specific SoC. They can map simple applications to a CGRA and know the limitations and pitfalls of this mapping.

**3 Recommended prerequisites for participation**

Thorough basic knowledge of digital circuits and computer achitecture. as can be ob-tained in the lectures “Logischer Entwurf” and “Rechnersysteme I”. Additionally, stu-dents should be able to write simple programs in the programming language C.

**4 Form of examination**

Module exam:

- Module exam (Technical examination, Oral examination, Duration: 30 Min., Default RS)

**5 Prerequisite for the award of credit points**

Passing the final module examination

**6 Grading**

Module exam:

- Module exam (Technical examination, Oral examination, Weighting: 100 %)

**7 Usability of the module**

MSc ETiT, MSc iST, MSc iCE, MSc Wi-ETiT

**8 Grade bonus compliant to §25 (2)**

**9 References**

The slides (in German) of the lecture can be obtained through moodle.

**Courses**

| | | | |
|---|---|---|---|
| **Course nr.**<br>18-hb-2030-vl | **Course name**<br>Computer Systems II | | |
| **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Ramon Wirsch | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course nr.**<br>18-hb-2030-ue | **Course name**<br>Computer Systems II | | |
| **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Ramon Wirsch | | **Type**<br>Practice | **SWS**<br>1 |

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|---|---|---|---|---|---|
| **Module name**<br>Architecture and Design of Computer Systems | | | | | |
| **Module nr.**<br>20-00-0012 | **Credit points**<br>5 CP | **Workload**<br>150 h | **Self-study**<br>105 h | **Module duration**<br>1 Term | **Module cycle**<br>Winter term |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. phil. nat. Marc Fischlin | | |

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|---|---|
| **1** | **Teaching content**<br>- Technological foundations and trends in micro electronics<br>- Design flows for microelectronic systems<br>- Description of hardware systems<br>- Characteristics of computing systems<br>- Architectural support for parallel execution<br>- Memory systems<br>- Heterogeneous systems-on-chip<br>- On-chip and off-chip communication structures<br>- Embedded systems, including in context of cyber-physical systems |
| **2** | **Learning objectives**<br>After successfully attending the course, students are familiar with functional and non-functional requirements for heterogeneous discrete and integrated computing systems. They understand the techniques for realizing such systems and can use design methods and tools to apply the techniques to independently implement computing systems (or components thereof) that fulfill the given requirements. They are able to evaluate computing systems in a number of quality metrics. |
| **3** | **Recommended prerequisites for participation**<br>Recommended:<br>Pass of lecture „Digitaltechnik“ and „Rechnerorganisation“, respectively according knowledge. |
| **4** | **Form of examination**<br>Course related exam:<br>• [20-00-0012-iv] (Technical examination, Oral/written examination, Default RS) |
| **5** | **Prerequisite for the award of credit points**<br>Pass exam (100%) |
| **6** | **Grading**<br>Course related exam:<br>• [20-00-0012-iv] (Technical examination, Oral/written examination, Weighting: 100 %) |
| **7** | **Usability of the module**<br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs. |
| **8** | **Grade bonus compliant to §25 (2)** |
| **9** | **References** |

Literature recommendations will be updated regularly, an example might be:
Nikhil/Czeck: Bluespec by Example
Arvind/Nikhil/Emer/Vijayaraghavan: Computer Architecture: A Constructive Approach
Hennessy/Patterson: Computer Architecture - A Quantitative Approach
Crockett/Elliott/Enderwitz/Stewart: The Zynq Book
Flynn/Luk: Computer System Design
Sass/Schmidt: Embedded Systems Design

**Courses**

| **Course nr.** | **Course name** | | |
|---|---|---|---|
| 20-00-0012-iv | Architecture and Design of Computer Systems | | |
| **Instructor** | | **Type** | **SWS** |
| | | Integrated course | 3 |

## 1.3 Optional Subjects SWE: Software-Engineering

| | | | | | |
|---|---|---|---|---|---|
| **Module name**<br>Software-Engineering - Maintenance and Quality Assurance | | | | | |
| **Module nr.**<br>18-su-2010 | **Credit points**<br>6 CP | **Workload**<br>180 h | **Self-study**<br>120 h | **Module duration**<br>1 Term | **Module cycle**<br>Summer term |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Andreas Schürr | | |

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|---|---|
| 1 | **Teaching content**<br>The lecture covers advanced topics in the software engineering field that deal with maintenance and quality assurance of software. Therefore, those areas of the software engineering body of knowledge which are not addressed by the preceding introductory lecture, are in focus. The main topics of interest are: software maintenance and reengineering, configuration management, static programme analysis and metrics, dynamic programme analysis and runtime testing as well as programme transformations (refactoring). During the exercises, the participants analyze, test and restructure different examples. |
| 2 | **Learning objectives**<br>The lecture uses a single running example to teach basic software maintenance and quality assuring techniques in a practice-oriented style. Upon successful completion of the module, students should be familiar with all activities needed to maintain and evolve a software system of considerable size. Main emphasis is laid on software configuration management and testing activities. Selection and usage of CASE tool play a major role. |
| 3 | **Recommended prerequisites for participation**<br>Introduction to Computer Science for Engineers as well as basic knowledge of Java |
| 4 | **Form of examination**<br>Module exam:<br>• Module exam (Technical examination, Examination, Duration: 90 Min., Default RS) |
| 5 | **Prerequisite for the award of credit points**<br>Passing the final module examination |
| 6 | **Grading**<br>Module exam:<br>• Module exam (Technical examination, Examination, Weighting: 100 %) |
| 7 | **Usability of the module**<br>MSc ETiT, MSc iST, MSc Wi-ETiT, Informatik |
| 8 | **Grade bonus compliant to §25 (2)** |
| 9 | **References**<br>https://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/se-ii-v and Moodle |

**Courses**

| | | | |
|---|---|---|---|
| **Course nr.**<br>18-su-2010-vl | **Course name**<br>Software-Engineering - Maintenance and Quality Assurance | | |
| **Instructor**<br>M.Sc. Isabelle Bacher, Prof. Dr. rer. nat. Andreas Schürr | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course nr.**<br>18-su-2010-ue | **Course name**<br>Software-Engineering - Maintenance and Quality Assurance | | |
| **Instructor**<br>M.Sc. Isabelle Bacher, Prof. Dr. rer. nat. Andreas Schürr | | **Type**<br>Practice | **SWS**<br>1 |

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|---|---|---|---|---|---|
| **Module name**<br>Introduction to Compiler Construction | | | | | |
| **Module nr.**<br>20-00-0904 | **Credit points**<br>5 CP | **Workload**<br>150 h | **Self-study**<br>105 h | **Module duration**<br>1 Term | **Module cycle**<br>Winter term |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. phil. nat. Marc Fischlin | | |

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| **1** | **Teaching content**<br>- Structure of compilers<br>- Context-free grammars for the description of language syntax<br>- Lexing and parsing techniques<br>- Intermediate representations<br>- Semantic analysis<br>- Run-time organisation<br>- Code generation<br>- Software tools for compiler constructions<br>- Implementation techniques for compilers |
| **2** | **Learning objectives**<br>After successfully attending the course, students are familiar with the structure of compilers. They understand formal concepts for the description of syntax and semantics of programming languages. They can combine these concepts with algorithmic techniques to independently construct a compiler that maps a specified programming language to a given target machine. They know software tools supporting the construction of compilers and can apply these together with manual techniques to implement the compilers. |
| **3** | **Recommended prerequisites for participation**<br>Recommended:<br>Participation of lecture “Algorithmen und Datenstrukturen”, “Funktionale und objektorientierte Programmierung” and “Rechnerorganisation”, respectively according knowledge. |
| **4** | **Form of examination**<br>Course related exam:<br>• [20-00-0904-iv] (Study achievement, Oral/written examination, Default RS) |
| **5** | **Prerequisite for the award of credit points**<br>Pass exam (100%)<br>Course achievement may be acquired through exercises, hands-on training, programming and successfull discussion on colloquiums. Each area must be passed. |
| **6** | **Grading**<br>Course related exam:<br>• [20-00-0904-iv] (Study achievement, Oral/written examination, Weighting: 100 %) |
| **7** | **Usability of the module**<br>B.Sc. Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs. |
| **8** | **Grade bonus compliant to §25 (2)** |
| **9** | **References**<br>Literature recommendations will be updated regularly, an example might be:<br>Watt/Brown: Programming Language Processors in Java |
| **Courses** | |

| | Course nr. | Course name | | |
|---|---|---|---|---|
| | 20-00-0904-iv | Introduction to Compiler Construction | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Andreas Koch | | Integrated course | 3 |

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|---|---|---|---|---|---|
| **Module name**<br>Real-Time Systems | | | | | |
| **Module nr.**<br>18-su-2020 | **Credit points**<br>6 CP | **Workload**<br>180 h | **Self-study**<br>120 h | **Module duration**<br>1 Term | **Module cycle**<br>Summer term |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Andreas Schürr | | |

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| **1** | **Teaching content**<br>The lecture basically covers a model-driven software engineering process which is specially customized for real-time systems. This process is more deeply explored in the exercise using an automotive example. A focus is laid on object-oriented techniques. In this context, a real-time specific state-of-the-art CASE tool is introduced and used. Furthermore, fundamental characteristics of real-time systems and system architectures are introduced. Scheduling algorithms are discussed to get insights into real-time operating systems. Finally, a comparison between the Java programming language and its expansion for real-time operating systems (RT Java) will conclude the lecture. |
| **2** | **Learning objectives**<br>After successful completion of the module, students are able to use and evaluate model-based (object-oriented) techniques for the development of embedded real-time systems. This includes a deeper understanding of the following topics:<br>• classification of real-time systems<br>• create and analyze executable models<br>• application of real-time scheduling algorithms<br>• evaluation and comparison of pros/cons of real-time programming languages as well as real-time operating systems |
| **3** | **Recommended prerequisites for participation**<br>Basic knowledge of software engineering techniques and excellent knowledge of at least one object-oriented programming language (preferably Java) |
| **4** | **Form of examination**<br>Module exam:<br>• Module exam (Technical examination, Oral/written examination, Duration: 90 Min., Default RS)<br>The examination takes place in form of a written exam (duration: 90 minutes). If one can estimate that less than 15 students register, the examination will be an oral examination (duration: 30 min.). The type of examination will be announced in the beginning of the lecture. |
| **5** | **Prerequisite for the award of credit points**<br>Passing the final module examination |
| **6** | **Grading**<br>Module exam:<br>• Module exam (Technical examination, Oral/written examination, Weighting: 100 %) |
| **7** | **Usability of the module**<br>MSc ETiT, BSc iST, MSc Wi-ETiT, BSc Informatik |
| **8** | **Grade bonus compliant to §25 (2)**<br>Grade improvements up to 0.4 per APB 25 (2) due to bonus for regularly submitted homework tasks |
| **9** | **References**<br>https://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/es-v and Moodle |
| **Courses** | |

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|---|---|---|---|---|
| | **Course nr.**<br>18-su-2020-vl | **Course name**<br>Real-Time Systems | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Andreas Schürr | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course nr.**<br>18-su-2020-ue | **Course name**<br>Real-Time Systems | | |
| | **Instructor**<br>M.Sc. Hendrik Göttmann, Prof. Dr. rer. nat. Andreas Schürr | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Compiler Tooling | | | | | |
|---|---|---|---|---|---|
| **Module nr.**<br>20-00-1013 | **Credit points**<br>6 CP | **Workload**<br>180 h | **Self-study**<br>120 h | **Module duration**<br>1 Term | **Module cycle**<br>Winter term |
| **Language**<br>German/English | | | **Module owner**<br>Prof. Dr.-Ing. Andreas Koch | | |

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| **1** | **Teaching content**<br>Modern compilers are primarily designed to produce efficient code for a particular platform and in doing so they employ sophisticated analysis and transformation tools. Such an infrastructure is useful also for source code transformation, e.g. for tools to annotate, instrument, or canonicalize codes. The complexity of C++ makes the development of such tools a challenging task.<br>An open compiler infrastructure used in a variety of research and production compilers is the LLVM infrastructure (www.llvm.org). A well-established front-end for C, C++ and objective C is Clang, which provides powerful mechanisms for extracting information from an abstract syntax tree representation of the underlying code, and thus enables source code modifications as well as the generation of the LLVM intermediate representation.<br><br>The students will work with different components and techniques of the Clang/LLVM framework and implement practical exercises for source transformation. The Clang/LLVM techniques include, in particular, handling and matching of the Clang abstract syntax tree. Examples for source transformation will highlight various facets of code augmentation or refactoring, e.g. for instrumenting parallel codes, for passing information between the static analysis and runtime environment of (parallel) codes, or for code refactoring to conform to coding standards. |
| **2** | **Learning objectives**<br>After attending this course, the students know basic and advanced concepts of syntactic and semantic code analysis and source transformation for C++, based on the Clang/LLVM technology. In particular, they can design and implement custom static analysis and code transformation tools using the Clang/LLVM framework, reflect and decide on the appropriate level of abstraction of the code representation for the task at hand, and synthesize additional usage scenarios for compiler technology. |
| **3** | **Recommended prerequisites for participation**<br>Lecture Introduction to Compiler Construction (EiCB), Lecture System- and Parallel Programming (SPP), Knowledge of C++ |
| **4** | **Form of examination**<br>Course related exam:<br>• [20-00-1013-pr] (Study achievement, Oral/written examination, Default RS) |
| **5** | **Prerequisite for the award of credit points**<br>Pass exam (100%) |
| **6** | **Grading**<br>Course related exam:<br>• [20-00-1013-pr] (Study achievement, Oral/written examination, Weighting: 100 %) |
| **7** | **Usability of the module**<br>B.Sc. Informatik<br>M.Sc. Informatik<br>May be used in other degree programs. |
| **8** | **Grade bonus compliant to §25 (2)** |
| **9** | **References** |

| Courses | | | | |
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| | **Course nr.**<br>20-00-1013-pr | **Course name**<br>Compiler Tooling | | |
| | **Instructor**<br>Prof. Dr.-Ing. Andreas Koch | | **Type**<br>Internship | **SWS**<br>4 |

# 2 Studium Generale (usually no FB18 modules)

Please find a detailed module handbook about the Studium Generale online

# 3 Master Thesis

Master Thesis either at FB18 or at FB20

| **Module name**<br>Masterthesis | | | | | |
|---|---|---|---|---|---|
| **Module nr.**<br>18-dy-5000 | **Credit points**<br>30 CP | **Workload**<br>900 h | **Self-study**<br>900 h | **Module duration**<br>1 Term | **Module cycle**<br>Every Semester |
| **Language**<br>German/English | | | **Module owner** | | |

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| 1 | **Teaching content**<br>Students independently prepare a written paper on a scientific question, taking into account relevant scientific articles and specialist literature. The Bachelor thesis is written in a limited amount of time and takes into account the principles of scientific work. Further general conditions are specified by the offering department when the task is assigned. |
| 2 | **Learning objectives**<br>After completion of the module, students are able to,<br>• work independently on a scientific problem according to scientific principles.<br>• apply the knowledge, methods and competences acquired in the Master's program.<br>• to research, narrow down and evaluate the relevant literature.<br>• to systematize the topic in a meaningful way and to build up a line of argument.<br>• weigh the validity of pro and contra arguments in a comprehensible way.<br>• to set down the results in writing according to scientific criteria.<br>• represent the results in an argumentative manner. |
| 3 | **Recommended prerequisites for participation** |
| 4 | **Form of examination**<br>Module exam:<br>• Module exam (Technical examination, Written examination, Default RS)<br>Final examination consisting of the preparation of a thesis |
| 5 | **Prerequisite for the award of credit points**<br>Passing the final module examination |
| 6 | **Grading**<br>Module exam:<br>• Module exam (Technical examination, Written examination, Weighting: 100 %) |
| 7 | **Usability of the module** |
| 8 | **Grade bonus compliant to §25 (2)** |
| 9 | **References**<br>Topic-dependent research literature as introductory reading in German and English, which can be supplemented independently in a meaningful way. |

**Courses**

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| **Module name**<br>Masterthesis (FB20) | | | | | |
| **Module nr.**<br>18-dy-5002 | **Credit points**<br>30 CP | **Workload**<br>900 h | **Self-study**<br>900 h | **Module duration**<br>1 Term | **Module cycle**<br>Every Semester |
| **Language**<br>German/English | | | **Module owner** | | |
| **1** | **Teaching content**<br>Students independently prepare a written paper on a scientific question, taking into account relevant scientific articles and specialist literature. The Bachelor thesis is written in a limited amount of time and takes into account the principles of scientific work. Further general conditions are specified by the offering department when the task is assigned. | | | | |
| **2** | **Learning objectives**<br>After completion of the module, students are able to,<br>• work independently on a scientific problem according to scientific principles.<br>• apply the knowledge, methods and competences acquired in the Bachelor's program.<br>• to research, narrow down and evaluate the relevant literature.<br>• to systematize the topic in a meaningful way and to build up a line of argument.<br>• weigh the validity of pro and contra arguments in a comprehensible way.<br>• to set down the results in writing according to scientific criteria.<br>• represent the results in an argumentative manner. | | | | |
| **3** | **Recommended prerequisites for participation** | | | | |
| **4** | **Form of examination**<br>Module exam:<br>• Module exam (Technical examination, Written examination, Default RS)<br>Final examination consisting of the preparation of a thesis | | | | |
| **5** | **Prerequisite for the award of credit points**<br>Passing the final module examination | | | | |
| **6** | **Grading**<br>Module exam:<br>• Module exam (Technical examination, Written examination, Weighting: 100 %) | | | | |
| **7** | **Usability of the module** | | | | |
| **8** | **Grade bonus compliant to §25 (2)** | | | | |
| **9** | **References**<br>Topic-dependent research literature as introductory reading in German and English, which can be supplemented independently in a meaningful way. | | | | |
| **Courses** | | | | | |