Handbook of Modules for the Degree Programme

Communication and Information Engineering B.Sc.

Faculty of Communication and Environment

Version 2.6

30.06.2016

Dokumentenhistorie

<table>
<tr><th>Version</th><th>Datum</th><th>Verantw.</th><th>Bemerkung</th></tr>
<tr><td>1.0</td><td></td><td></td><td>Erste eingereichte Version für die Akkreditierung</td></tr>
<tr><td>1.1</td><td></td><td></td><td>Version für die Akkreditierung nach Änderungen durch die neuen Kollegen. Anpassung Beschreibung Analog Signal Processing, Embedded Systems, Digital Signal Processing</td></tr>
<tr><td>1.2</td><td></td><td>CR</td><td>Das Pflichtmodul „Fundamentals of Business Administration“ wurden in Wahlpflichtmodule umgewandelt, das Modul “Introduction into Accounting and Controlling” kann aus dem Wahlpflichtkatalog IBSS gewählt werden.</td></tr>
<tr><td>1.3</td><td></td><td>CR</td><td>Stärkung der praktischen Ausbildung durch
„Laborausbildung: Elektrotechnik“
„Labor: Digitaltechnik und Informatik“.</td></tr>
<tr><td>1.4</td><td></td><td>CR</td><td>Modul „High Frequency Technology“ entfällt</td></tr>
<tr><td>1.4.1</td><td></td><td>CR</td><td>Modul „Software Engineering” wurde ergänzt</td></tr>
<tr><td>2.0</td><td></td><td>CR</td><td>Inhaltliche Überarbeitung folgender Module:
CI_1.03 Fundamentals of Digital Technologies
CI_2.04 Computer Networks
CI_4.01 Analgo and Digital Signal Processing
CI_4.02 Identification and Automation
Geänderte Modulnamen:<table><tr><th>Alter Name</th><th>Neuer Name</th></tr><tr><td>Advanced Computer Networks & Bus Systems</td><td>Computer Networks</td></tr><tr><td>Analog Signal Processing (50%)</td><td>Signals and Systems</td></tr><tr><td>Analog Signal Processing (50%)</td><td>Analog and Digital Signal Processing (50%)</td></tr><tr><td>Digital Signal Processing</td><td>Analog and Digital Signal Processing (50%)</td></tr><tr><td>Middleware Systems</td><td>Programming: Distributed Systems (50%)</td></tr><tr><td>Programming(50%)</td><td>Object Oriented Programming</td></tr><tr><td>Programming(50%)</td><td>Programming: Distributed Systems (50%)</td></tr></table>Anpassung der Modulnummern.</td></tr>
<tr><td>2.1</td><td></td><td>CR</td><td>Anpassung der Gruppengrößen</td></tr>
<tr><td>2.2</td><td></td><td>CR</td><td>Homogenisierung der Begriffswelt in den Modulbeschreibungen</td></tr>
<tr><td>2.3</td><td>27.11.14</td><td>TH / CR</td><td>Anpassung von Lehrinhalten</td></tr>
<tr><td>2.4</td><td>16.12.14</td><td>TH / CR</td><td>Module ergänzt</td></tr>
<tr><td>2.5</td><td>19.01.2015</td><td>AR</td><td>Überschrift geändert (Degree Programm)</td></tr>
<tr><td>2.6</td><td>30.06.2016</td><td>CR</td><td>Deckblatt Studiengangsname angepasst</td></tr>
</table>

Index

Curriculum of the Bachelor Degree Programme “Communication and Information Engineering B.Sc.”

Code No (Kennnr.)	Module	SW (SWS)	Type (Veranstaltungsart)						TE (Prü)	Sum CP	WS 1	WS 2	WS 3	WS 4	WS 5	WS 6	WS 7
			L (VL)	SL (SL)	S (S)	Ex (Ü)	PT (Pra)	Pro (Pro)									
CI_1.01	Physics: Mechanics and Optics Physik: Mechanik und Optik	4	2			2			E	5	4					CIE_24 Internship or semester abroad (30 CP)	CIE_25 Workshop 1: Research Methods (5 CP) CIE_26 Workshop 2: Scientific Writing (5 CP) CIE_27 Workshop 3: Colloquium (5CP) CIE_28 Thesis and Disputation (15 CP)
CI_1.02	Fundamentals of Computer Science and Networks Grundlagen der Informatik und der Computernetzwerke	4	3			1			E	5	4						
CI_1.03	Fundamentals of Digital Technologies Grundlagen der Digitaltechnik	4	2			2			E	5	4						
CI_1.04	Laboratory: Digital Technologies and Computer Science Labor: Digitaltechnik und Informatik	6					6		C	5	6						
CI_1.05	Mathematics: Analysis and discrete mathematic Mathematik: Analysis and Diskrete Mathematik	4	2			2			E	5	4						
CI_1.06	Introduction to Scientific Working Einführung in das wissenschaftliche Arbeiten	4		4					C	5	4						
CI_2.01	Fundamentals of Electrical Engineering: Fields and Circuits Grundlagen der Elektrotechnik: Felder und Schaltungen	4	2			2			E	5		4					
Ci_2.02	Laboratory: Electrical Engineering Laborausbildung: Elektrotechnik	4					4		C	5		4					
CI_2.03	Object Oriented Programming Object Orientierte Programmierung	6	2			2	2		E	5		6					
CI_2.04	Computer Networks Computernetze	4	2			2			E	5		4					
CI_2.05	Mathematics: Linear Algebra and Graph Theory Mathematik: Lineare Algebra und Graphentheorie	4	2			2			E	5		4					
CI_2.06	Project Management and Intercultural Competences Projektmanagement und Interkulturelle Kompetenz	4	2			2			C	5		4					
CI_3.01	Fundamentals of Electrical Engineering: Electricl Networks and Semiconductors Grundlagen der Elektrotechnik: Elektrische Netze und Halbleiterbauelemente	4	2			2			E	5			4				
CI_3.02	Signals and Systems Signale und Systeme	4	2			2			E	5			4				
CI_3.03	Data Management Datenmanagement	4	2			2			E	5			4				
CI_3.04	Programming: Distributed Systems Programmierung: Verteilte Systeme	6	2			2	2		E	5			6				
CI_3.05	Statistics Statistik	4	2			2			E	5			4				
CI_3.06	Higher Mathematics Höhere Mathematik	4	2			2			E	5			4				
CI_4.01	Analgo and Digital Signal Processing Analoge und Digitale Signalverarbeitung	8	4			2	2		E	10				8			
CI_4.02	Identification and Automation Identifikation und Automatisierung	4	2			2			E	5				4			
CI_4.03	Software Engineering Softwareengineering	4	2			2			E	5				4			
CI_5.01	Embedded Systems Eingebettete Systeme	4	2				2		E/C	5					4		
CI_5.02	Communication Systems Nachrichtentechnische Geräte und Systeme	4	2			2			E	5					4		
CI_5.03	Interdisciplinary Project Interdisziplinäres Projekt	6						6	E	10					6		
	Elective courses * Wahlpflichtkurse *	16	8			8			E	20				8	8		
	Semester hours per week (total)	124								150	26	26	26	24	22	30	30

SWS: 124, CP: 150 | SWS: 12, CP:60

Total SWS: 136, CP: 210

Allocation											
	SWS	total	136	26	26	26	24	22	0	12
	CP	total	210	30	30	30	30	30	30	30

Elective courses:

Code No (Kennnr.)	Module	SW (SWS)	Type (Veranstaltungsart)						TE (Prü)	Sum CP
			L (VL)	SL (SL)	S (S)	Ex (Ü)	PT (Pra)	Pro (Pro)		
CI_W.01	Ambient Intelligent Systems Ambient Intelligent Systems	4		2		2			E	5
CI_W.02	Remote Sensing and Noninvasive Methods Fernerkundung und nicht invasive Erkundungsverfahren	4		2		2			E	5
CI_W.03	Communication Security Sicherheit in Kommunikationssystemen	4		2		2			E	5
CI_W.04	Safety Critical Systems Safety Critical Systems	4		2		2			E	5
CI_W.05	Advanced Modelling and Simulation Fortgeschrittene Modelliuerung and Simulationen	4		2		2			E	5
CI_W.06	Fundamentals of Business Administration Grundlagen der Betriebswirtschaft	4		2		2			E	5

List of abbreviations	
SW	Semester hours per week (Semesterwochenstuden)
L	Lecture (Vorlesungs)
SL	Seminaristic lecture (Seminaristische Lehrveranstaltung)
S	Seminar (Seminar)
Ex	Exercise (Übung)
PT	Practical training (Praktikum)
Pro	Project (Projekt)
TE	Type of examination (Prüfungsform)
CP	Credit Points
WS	Winter semester (Wintersemester)
SS	Summer semester (Sommersemester)
E	Examination (Prüfung)
C	Certificate (Testat)

CI_1.01 Physics: Mechanics and Optics

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_1.01	150 h	5 CP	1st semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

This module has introduced students to key principles of Physics. The successful student is able to apply and use the physical concepts, laws and equations he has learned in advanced modules and in his or her professional life. The student is able to describe simple motion mathematically, can decompose forces, and has a sound understanding of the physical concepts work, energy and power. The student has understood the principal of energy conservation and is able to solve given tasks concerning the topics mentioned above. The student is also able to describe simple harmonic oscillation/waves, calculate the natural frequency of simple oscillating systems, has a sound understanding of period and wave length and is able to solve basic tasks including superpositioning of waves. Furthermore the student has understood the behavior and properties of light, including its interactions with matter, geometric optics and physical optics (like diffraction and interference).

Content

- Physical quantities and units
- 1D and 3D motion
- Forces and Newton's laws
- Friction and drag forces
- Work, energy, power
- Linear momentum and impulse
- Angular momentum, moment of inertia and torque
- Oscillations, waves and superposition
- Geometric optics and physical optics

Teaching methods

Lectures and practical classes

Entry requirements

None
Types of assessment Graded examination
Requirements for the award of credit points Passed assessment
Use of module (in other study programs) Same module in "Environment and Energy" and "Communication and Information Engineering"
Weight towards final grade 3.45%
Person in charge of module Prof. Dr. Christian Ressel
Additional information Reading: Tipler P.A.; Mosca G. (2007): Physics for Scientists and Engineers. Enlarged 6th Edition; W.H. Freeman. Halliday D.; Resnick R.; Walker J. (2010): Fundamentals of Physics. 9th Edition; Wiley, John & Sons.

CI_1.02 Fundamentals of Computer Science and Networks

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_1.02	150 h	5 CP	1st semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 45 h / 3 semester hours per week (SWS) Excercise: 15 h / 1 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

This module has introduced students to the key principles of computers and networks. Successful students have gained the ability to identify major hardware and software components of a computer system, to understand their relationship to one another and the importance of these components within the system. They are also able to convert numbers from different numeral systems, which are frequently used by computer systems, and can express conditions and causality using logic.

Furthermore students have gained an understanding of how computer networks work. They are able to explain the ISO/OSI reference model and IP traffic and can set up small networks independently.

Content

- Example for today's use of computers in different environments

- Basic principles: numeral systems, representation of text, logic

- Hardware of a computer system, incl. CPU, motherboard, storage devices, RAID and backup systems

- Introduction to operating systems, incl. common operating systems

- Computer networks: network classifications, ISO/OSI reference model, layers of IP networks, network

devices, basic security

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

None

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Same module in "Environment and Energy" and "Industrial Engineering - Specialization Communication and Information Engineering" and "Mobility and Logistics"

Weight towards final grade

3.45%

Person in charge of module

Prof. Dr. Christian Ressel

Additional information

Reading:

Clements,A.:Principle of Computer Hardware, ISBN 978-0-19-927313-3, Oxford University Press (4th edition)

Mafield,C.: Bebop - to the boolean boogie,ISBN 1856175073, Newnes, 2008 (3rd. edition)

Tannenbaum,A.: Computer Networks, ISBN 0130661023, Prentice Hall, 2002 (4th. edition)

Muller, J.-M. et al.: Handbook of Floting Point Arithmetic, ISBN 081764704X, Springer, 2009

Brent, R. P.; Zimmermann, P.: Arithmetic (Cambridge Monograph on Applied and Computational Mathematics), ISBN 0521194695, Cambridge University Press, 2010

CI_1.03 Fundamentals of Digital Technologies

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_1.03	150 h	5 CP	1st semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Students have gained basic knowledge to realize function specific digital, combinatorial, and sequential circuits according to the latest methods. They are able to apply algebraic methods of digital technology, algebraic models of boolean algebra, and methods to reduce circuits. They have gained knowledge of fundamental digital circuits and their application in electronic systems.

Students are able to develop, minimize, and realize combinatorial as well as simple sequential circuits on the level of logic elements. They have gained first impressions of the complexity of highly integrated digital systems (VLSICs) and relevant development methods.

Content

- Gates, digital cicuits and combinational logic

- Logic synthesis

- Standard Switching Circuits (Adder, Multiplier, Multiplexer, De-Multiplexer)

- Sequential circuits (flip-flops, state control of flip-flops, automata, boolean algorithms, design of sequential

  circuits)

- Digital circuits (Implementation, logic families, characteristics, special elements, programmable logic devices)

- Automata (Moore, Mealy)

- Buses and input/output mechanism

- Structure of a simple CPU

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

None

Types of assessment Graded examination
Requirements for the award of credit points Passed assessment
Use of module (in other study programs)
Weight towards final grade 3.45 %
Person in charge of module Prof. Dr. Christian Ressel
Additional information Reading: Clements, A.: Principle of Computer Hardware, ISBN 978-0-19-927313-3, Oxford University Press (4th edition) S. Salivahanan and S. Arivazhagan: Digital electronics, Vikas Publishing House, 2011 R.H. Katz: Contemporary Logic Design, Addison-Wesley Longman, 1994 Svetlana N. Yanushkevich et al. :Introduction to Logic Design, CRC Press by Taylor&Francis, 2008

CI_1.04 Laboratory Digital Engineering

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_1.04	150 h	5 CP	1st semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Laboratory: 90 h / 6 semester hours per week (SWS)	90 h / 6 SWS	60 h	Practical classes: 25 students

Learning outcomes / Competences and qualifications profile

Students have gained experience in handling real digital electrical components and software to develop and simulate digital circuits. They are able to read and to make use of data sheets and use digital components to realize basic functionalities. They can realise komplex functions by using a microcontroller based board. Furthermore they have been introduced to a Linux system and have learned how to work with it using the console. The module can be seen as a complementary course to the courses "Fundamentals of Digital Technologies" and "Fundamentals of Computer Science and Networks".

Content

- Introduction to the physical concepts of current, electric potential, power
- Circuit design and applications with basic logic gates and sequential logic elements
- Microcontroller basics
- Circuit design for standard I/O microcontroller interfaces
- Fundamentals of the operating system: Linux
- Using Linux in a networked environment

Teaching methods

Tuition in practical classes

Entry requirements

It is recommended to have passed or to take the lectures

CI_1.02 "Fundamentals of Computer Science and Networks" and

CI_1.03 "Fundamentals of Digital Technologies"

in parallel.

Types of assessment

Certificate (Testat)

Requirements for the award of credit points Successful participation in 80 % of all lessons offered
Use of module (in other study programs)
Weight towards final grade None (ungraded)
Person in charge of module Prof. Dr. Christian Ressel
Additional information Reading: Clements, A.: Principle of Computer Hardware, ISBN 978-0-19-927313-3, Oxford University Press (4th edition) S. Salivahanan and S. Arivazhagan: Digital Electronics, Vikas Publishing House, 2011

CI_1.05 Analysis and Discrete Mathematics

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_1.05	150 h	5 CP	1st semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

This lecture has introduced students to the basics of Discrete Mathematics and fundamental topics of Analysis and has therefore enabled them to solve technical and operational problems.

With the knowledge of these mathematical methods and formulas students can solve analytical problems based on discrete or continuous functions and are able to apply their knowledge to their professional context as analysts, planners or engineers.

Additionally students are able to develop advanced solutions to describe and optimize technological functionalities in a mathematical way by using basic trigonometric functions as well as main formulas and procedures of differential and integral calculus.

Content

- Fundamentals of logic, sets and numerative systems
- Fundamentals of relations and functions
- Elementary functions like rational-, potential-, exponential- and logarithm-functions
- Trigonometric functions like sinus, cosinus, tangens, cotangens
- Fundamentals of differential calculus: functional limits, continuity, derivations and rules of derivations
- Fundamentals of integral calculus: anti derivations, integration and rules of integration

Teaching methods

Tuition in lectures and practical classes

Entry requirements

None

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment
Use of module (in other study programs) Same module in "Environment and Energy", "Communication and Information Engineering", and "Mobility and Logistics"
Weight towards final grade 3.45 %
Person in charge of module Prof. Dr. Frank Zimmer
Additional information Reading: James Stewart: Calculus, Early Transcendentals, International Metric Edition, 6th Edition, BrooksCole, 2008; ISBN-13: 9780495382737

CI_1.06 Introduction to Scientific Working

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_1.06	150 h	5 CP	1st semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Seminaristic lecture: 60 h / 4 semester hours per week (SWS)	60 h / 4 SWS	90 h	Seminaristic Lecture: 30 students

Learning outcomes / Competences and qualifications profile

This course enables students to explain the purposes and name the stakeholders of research and science. Students are able to define a topic, border it adequately and find literature on the topic. They have also acquired the skills to evaluate literature efficiently and critically and write a well-structured seminar paper applying either footnotes or Harvard citation style. Furthermore students know what criteria pieces of scientific writing have to meet and can give a convincing and to the point oral presentation about their research findings.

Content

- What is research and science? What purpose do they serve?
- Where is research produced? Different stakeholders in the field of research
- Research methods in economics and business management
- Finding a suitable topic and bordering the topic
- Literature search: Sources and searching methods, relevance of literature, quality of literature
- Reading techniques: Efficient reading, critical reading
- Scientific writing: Different genres of scientific writing - summary, response paper, policy paper, seminar paper, bachelor thesis, master thesis, research proposal, research paper, literature review
- Structuring the topic; the elements of a seminar paper, time management
- Citations: What purpose do citations serve? Citations with footnotes, citations in Harvard Style
- References vs. bibliography: Purposes and formats
- Graphs and tables
- Evaluation criteria for pieces of scientific writing
- Oral presentation of research results: Demands, preparation, methods, evaluation criteria.

Teaching methods

The course is mostly taught in seminaristic lectures in which students discuss different topics of scientific working. Small research and writing exercises will be part of the course to directly apply what

has been learned. In the later part of the course students present their seminar papers. Their results, the scientific approach as well as the style of the oral presentation are discussed.

Entry requirements

None

Types of assessment

Smaller writing assignments during the course, seminar paper with presentation (all ungraded)

Requirements for the award of credit points

Written assignments, seminar papers and oral presentation delivered have to meet quality criteria to pass

Use of module (in other study programs)

Same module in "E-Government", "Industrial Engineering - Specialization Communication and Information Engineering", "International Business and Social Sciences", "Media Communication and Computer Sciences" and "Mobility and Logistics"

Weight towards final grade

None (ungraded)

Person in charge of module

N.N.

Additional information

Reading:

Esselborn-Krummbiegel, H. (2008): Von der Idee zum Text. Eine Anleitung zum wissenschaftlichen Schreiben. 3rd edition. Stuttgart: UTB / Schöningh.

Franck, N. / Stary, J. (2009): Die Technik wissenschaftlichen Arbeitens. 16th edition. Stuttgart: UTB / Schöningh.

Hofmann, A. H. (2010): Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford: Oxford University Press.

Russey, W. E. / Ebel, H. F. / Bliefert, C. (2006): How to Write a Successful Science Thesis: The Concise Guide for Students. Chichester: Wiley.

CI_2.01 Fundamentals of Electrical Engineering: Fields and Circuits

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_2.01	150 h	5 CP	2nd semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Exercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Having passed this module students know fundamental principles in electrical engineering which serves as a basis for the understanding of advanced concepts of subsequent courses. In particular, students are capable of analysing simple electric circuits with passive components such as resistors, capacitors and inductors. Students are familiar with alternating current and have understood the principles of induction.

Content

- Electrical charges and electric fields, electrostatic potential & electric energy
- Current and its cause
- Resistance, Ohm's law, Kirchhoff's laws
- Capacitors
- Magnetic field and electromagnetic induction
- Inductors
- RC and RL circuits
- Alternating current and alternating voltage

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

None

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment
Use of module (in other study programs) Same module in "Environment and Energy", "Communication and Information Engineering"
Weight towards final grade 3.45 %
Person in charge of module Prof. Dr. Christian Ressel
Additional information Reading: Tipler P.A.; Mosca G.: Physics for Scientists and Engineers. enlarged 6th edition; W.H. Freeman. W.D. Stanley, J.R. Hackworth, R.L. Jones: „Fundamentals of electrical engineering and technology“, Delmar Cengage Learning, New York, 2007 R. Kories, H. Schmidt-Walter:“ Electrical Engineering – A pocket reference“, Springer, Berlin, 2003 Halliday D.; Resnick R.; Walker J.: Fundamentals of Physics. 9th Edition; Wiley, John & Sons. Hambley, A.R.;Electrical Engineering: Principles and Applications; 5th Edition,Pearson Prentice Hall

CI_2.02 Laboratory Electrical Engineering

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_2.02	150 h	5 CP	2nd semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Laboratory: 60 h / 4 semester hours per week (SWS)	60 h / 4 SWS	90 h	Practical classes: 25 students

Learning outcomes / Competences and qualifications profile

Students are experienced in handling real electrical components and basic measurment equipment. They are able to use software to develop and test electrical ciruits. Furthermore they have gained fundamental mechanical skills.

Content

- Basics of Electronic Assembly and Packaging
- Basic measurement techniques
- Basic characteristic diagrams of passive and active electronic components
- Circuit design with passive components
- Circuit design with active components
- Circuit analysis with measurement technology
- Circuit design with CAD-Tools

Teaching methods

Tuition in practical classes

Entry requirements

It is recommended to have passed or to take the lecture

CI_2.01 "Fundamentals of Electrical Engineering: Fields and Circuits"

in parallel

Types of assessment

Certificate (Testat)

Requirements for the award of credit points

Successful participation in 80 % of all lessons offered

Use of module (in other study programs)
Weight towards final grade None (ungraded)
Person in charge of module Prof. Dr. Christian Ressel
Additional information Reading:

CI_2.03 Computer Networks

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_2.03	150 h	5 CP	2nd semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Having completed this module, students understand the architectures of computer networks and relevant factors influencing network operation. They have gained an overview of the reasons for having a variety of different types of protocols and networks. They understand distributed networking systems with focus on Internet technologies and Internet operation. Furthermore, students can analyze protocols and can independently consult standards and technical reports concerning computer networks. Students are able to select and configure network technologies that provide fast and reliable communication.

Content

- Computer network architecture with layers and protocols, circuit/packet switched, the Internet architecture: network of networks

- Finite state machines, message sequence charts, wireshark

- Application layer: client-server application architecture, HTTP, E-Mail, DNS

- Transport layer: de-/multiplexing, UDP, flow control, congestion control, TCP

- Networking layer: forwarding and routing, network service models, virtual circuit and datagram networks, router/switch operation, IPv4 and IPv6 addresses, ICMP, multicast, hierarchical routing, BGP

- Link layer: link layer services, switched local area networks: link-layer addressing and ARP, multiple access links and protocols, Ethernet

- Network management tasks and principles, SNMP, virtual private networks, virtual local area networks (VLAN)-switching, link virtualization, multiprotocol label switching (MPLS), data center networking, software defined networks, Internet-standard management framework: structure of management information: SMI, management information base: MIB, SNMP protocol operations and transport mappings, ASN.1

- Wireless links and network characteristics, 802.11 (WLAN): architecture, MAC protocol, and frames

- Mobile: 3G, LTE, mobility management: addressing, routing to a mobile node, mobile IP

- Multimedia and VoIP networking: SIP, RTTP, RTSP

- IP security issues

Teaching methods

Lectures and practical classes

Entry requirements

It is strongly recommended to attend the following module first:

CI_1.02 "Fundamentals of Computer Science and Networks"

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Weight towards final grade

3.45 %

Person in charge of module

Prof. Dr.-Ing. Sandro Leuchter

Additional information

Reading:

Kurose, J.F. & Ross, K.W. (2013). Computer Networking. A Top-Down Approach, Pearson.

Chappell, L. (2013). Wireshark 101. Essential Skills for Network Analysis, Laura Chappell University.

Tannenbaum, A.S. & Wetherall, D.J. (2011). Computer Networks, Pearson.

Anderson, A. & Benedetti, R. (2009). Head First Networking, O'Reilly.

CI_2.04 Object Oriented Programming

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_2.04	150 h	5 CP	2nd semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Exercise: 30 h / 2 SWS Practical Training: 30 h / 2 SWS	90 h / 6 SWS	60 h	Lectures: open Exercises: 40 students Practicals: 25 students

Learning outcomes / Competences and qualifications profile

The course has taught students to code fluently in an object-oriented style using the programming language Java. Students have learned to use standard library classes. Successful students have a sound understanding of the principles and practice of object oriented analyses and design in the construction of small robust, maintable programs. They are able to implement, compile, test and run programs, comprising more than one class to address a particular software problem. They are able to use simple data structures like collections and to make use of functionality of classes found in the standard API (such as the Math class).

Content

- Objects, classes, constructors, attributes, methods, parameters
- Collections, loops, iterators, arrays, conditionals
- Inheritance, polymorphism
- (Multiple) interfaces, abstract classes, adapters
- Exception handling
- Terminal I/O, file I/O
- Threads
- TCP/IP and UDP/IP socket programming
- GUI (Swing)

Teaching methods

Lectures and practical classes

Entry requirements

It is strongly recommended to attend the following module first:

CI_1.02 "Fundamentals of Computer Science and Networks"
Types of assessment Graded examination (project)
Requirements for the award of credit points Passed examination
Use of module (in other study programs)
Weight towards final grade 3.45%
Person in charge of module Prof. Dr.-Ing. Sandro Leuchter
Additional information Reading: Barnes, D.J. & Kölling, M. : Objects First with Java. A Practical Introduction Using BlueJ, Pearson, 2012 Oracle: Java Platform, Standard Edition 8. API Specification. Online available: https://docs.oracle.com/javase/8/docs/api/ (last retrieved Nov 20, 2014)

CI_2.05 Linear Algebra and Graph Theory

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_2.05	150 h	5 CP	2nd semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercises: 40 students

Learning outcomes / Competences and qualifications profile

This lecture has introduced students to mathematical methods of linear algebra and the basics of graph theory which are needed to solve technical and operational problems.

With these mathematical methods and procedures at hand, the students are able to solve linear problems and can therefore apply their knowledge to their professional context as analysts, planners or engineers.

Additionally the students are able to devolop advanced solutions to describe and optimize networks applying the basic rules and procedures of graph theory.

Content

- Introduction of vectors, matrices, vector- and matrix operations
- Vector-spaces and sub-spaces
- Linear transformations
- Linear equation systems
- Procedures to solve linear equation systems (Gauss algorithm, determinants)
- Basic definitions of graphs
- Euler rows, Hamilton circles
- Basic problems ("Bridges of Königsberg", "Travelling Salesman") and possible solutions

Teaching methods

Tuition in lectures and practical classes

Entry requirements

None

Types of assessment

Graded examination

Requirements for the award of credit points Passed examination
Use of module (in other study programs) Same module in "Environment and Energy", "Communication and Information Engineering" and "Mobility and Logistics"
Weight towards final grade 3.45 %
Person in charge of module Prof. Dr. Frank Zimmer
Additional information

CI_2.06 Project Management and Intercultural Competence

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_2.06	150 h	5 CP	2nd semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Exercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Students know about the importance of project management in today´s world. They have developed the skills to plan and conduct projects. In addition to this they have acquired knowledge and skills on how to develop a professional presentation. Students experienced dynamics and pitfalls of team work in projects and gained some routine in presenting and communicating results.

Content

- Defining the project and its scope
- Developping the project plan (defining work packages, setting milestones, developing flow charts and network plans)
- Scheduling the project
- Building, leading, and managing a project team
- Managing resources
- Monitoring project performance
- Controlling the project and managing risk
- International projects
- Project closure and documentation
- Presenting to an audience
- Developing the presentation (developing the material, structuring the presentation, use of presentation software, preparation)
- Presentation techniques and visual aids

Teaching methods

Lectures, accompanied by exercises in which students conduct their own projects (case studies) and

present their results

Entry requirements

None

Types of assessment

Certificate (Testat)

Requirements for the award of credit points

Participation in a project (case study), final presentation and report

Use of module (in other study programs)

Same module in "Environment and Energy", "Communication and Information Engineering", "Information and Communication Design", "International Business and Social Sciences" and "Mobility and Logistics"

Weight towards final grade

None (ungraded)

Person in charge of module

Prof. Dr. Daniel H. Scheible

Additional information

Reading:

Heerkens, G. R. (2002): Project Management. New York: McGraw-Hill.

Hillson, D. (2009): Managing Risk in Projects. Farnham; Burlington: Gower.

Larson, E. W. / Gray, C. F. (2011): Project Management. The Managerial Process. 5th edition. New York: McGraw-Hill.

Raynolds, G. (2008): Presentation Zen. Simple Ideas on Presentation Design and Delivery. Berkeley: New Riders.

Stanton, N. (2009): Mastering Communication. 5th edition. Basingstoke; New York: Palgrave Macmillian.

CI_3.01 Fundamentals of Electrical Engineering: Electrical Networks and Semiconductors

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_3.01	150 h	5 CP	3rd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Exercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Having passed this module, students know fundamental principles in topics which serves as a basis for the understanding of advanced concepts of subsequent courses. In particular, students are capable of handling and analyzing advanced and complex circuit elements and circuits. Furthermore, students have a profound understanding of the working principles and physics of semiconducter circuit elements and are able to apply typical semiconductor circuit elements for different purposes.

Content

-Thevenin & Norton equivalent circuits

- Network analysis

- Two Port Networks

- Semiconductors

- Diodes

- Transistors

- Operational Amplifiers

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

It is strongly recommended to attend the following module first:

CI_2.01 "Fundamentals of Electrical Engineering: Fields and Circuits"

Types of assessment

Graded examination

Requirements for the award of credit points Passed assessment
Use of module (in other study programs)
Weight towards final grade 3.45 %
Person in charge of module Prof. Dr. Christian Ressel
Additional information Reading: Bird, J.: Electrical Circuit Theory and Technology, ISBN 0750657847, Newnes publications Alexander, C.K., Saiku, M.: "Fundamentals of electric circuits", ISBN 978-0-07-35295-4, McGraw-Hill Cathey, J: Schaum's outline series - electronic devices and circuits, ISBN 0-07-139830-9, McGraw-Hill Schwarz, Goldham:"Electrical Engineering", ISBN 13978-0-19-510585-8, Oxford University Press

CI_3.02 Signals and Systems

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_3.02	150 h	5 CP	3rd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Exercise: 15 h / 1 SWS Practical classes: 15 h / 1 SWS	4 SWS / 60 h	90 h	Lecture: open Exercise: 40 students Practical classes: 25 students

Learning outcomes / Competences and qualifications profile

Having passed this module, students know fundamental principles of signals and systems as well as typical circuits (i.e. filters). In particular, students are capable of analyzing systems in time- and frequency domain and of handling fundamental routines of system theory (e.g. convolution, transfer function) for elementary passive circuit systems. By using Fourier Transform or Laplace Transform students can characterize systems and estimate the output based on the magnitude, phase response and a given input. Students know the principle of Linear Time Invariant (LTI) systems and are able to use this knowledge to calculate the output of systems using a given input signal. Moreover students know the basic properties of elementary signals.

Content

- Elementary analog and digital signals
- Signal characterization and properties of elementary signals
- Convolution and Correlation
- Application of Fourier and Laplace Transform for system characterization
- LTI-Systems
- System properties (stability, causality, linearity, …)
- Transfer functions
- Frequency/Phase response
- State description of systems

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

It is strongly recommended to attend the following module first: CI_2.01 "Fundamentals of Electrical Engineering: Fields and Circuits"
Types of assessment Graded examination
Requirements for the award of credit points Passed assessment
Use of module (in other study programs)
Weight towards final grade 3.45 %
Person in charge of module N.N.
Additional information Reading:

CI_3.03 Data Management

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_3.03	150 h	5 CP	3rd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercises: 40 students

Learning outcomes / Competences and qualifications profile

Having passed this module, students are able to make use of abstraction, analyses and modelling methods to design data bases for various applications. The students are able to classify data bases based on the system architectures used. In addition to that students are familiar with normalization and data privacy principles. They can independently express SQL statements to solve given tasks.

Content

- Introduction: file systems and data base systems, migration from file system, client-server-architecture, data base based web-applications

- Abstraction, analysis and modelling methods

- Data models, Entity Relationship Model (ER), Enhanced Entity Relationship Model (primary key, foreign key, integrity constraints ...)

- Theoretical fundamentals of relational data bases: relational algebra, functional dependencies, normalization,

- Structured Query Language

- Semantical modelling and data base design

- Information security and data privacy

- Trends and new technologies: Object oriented data bases, data warehouse, data mining, information retrieval, search engines

- Tuning, backup, distributed data bases

Teaching methods

Lectures and practical classes

Entry requirements

It is strongly recommended to attend the lecture

CI_1.02 "Fundamentals of Computer Science and Networks"

before taking this course.

Types of assessment Written examination paper
Requirements for the award of credit points Passed examination
Use of module (in other study programs) Same module in "Communication and Information Engineering" and "Mobility and Logistics"
Weight towards final grade 3.45%
Person in charge of module Prof. Dr.-Ing. Sandro Leuchter
Additional information Reading: Kroenke, D.M. & Auer, D.J.: Database processing : fundamentals, design, and implementation, Pearson, 2012 Elmasri, R. & Navathe, S.B.: Fundamentals of Database Systems, Pearson, 2011

CI_3.04 Programming: Distributed Systems

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_3.04	150 h	5 CP	3rd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS Practical Training: 30 h / 2 SWS	90 h / 6 SWS	60 h	Lectures: open Exercises: 40 students Practicals: 25 students

Learning outcomes / Competences and qualifications profile

Students have learned to develop complex software systems in Java which are distributed on networked computers. They are skilled in using eclipse or netbeans as integrated development environments. They have experience in using communication middleware systems and in integrating as well as testing of distributed systems. They know architectural patterns for distributed systems and can choose suitable architectural approaches according to environmental requirements. They are familiar with the typical challenges caused by the heterogeneity of enterprise application environments. Middleware systems of various technologies and categories have been practically utilized during exercises.

Content

- JavaDoc, external libraries
- Representation of data (XML, JSON), parsing (SAX)
- Java on Android (anatomy of a simple app)
- Multi-tier architectures
- Classification of middleware: typical requirements and categories
- Enterprise Application Integration (EAI)
- Distributed objects (Java RMI), de-/serialization
- Indirect communication (JGroups, Publish Subscribe, Message Queues)
- Enterprise Java Beans, application servers
- Workflow management: process oriented EAI
- Service-oriented architectures
- Web services
- Service orchestration

- Cloud Computing

Teaching methods

Lectures and practical classes

Entry requirements

It is strongly recommended to attend the following modules first:

CI_2.03 “Object Oriented Programming”

CI_2.04 “Computer Networks”

Types of assessment

Graded examination (project)

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Weight towards final grade

3.45 %

Person in charge of module

Prof. Dr.-Ing. Sandro Leuchter

Additional information

Reading:

- Tanenbaum, A.S. & van Steen, M. (2007). Distributed Systems: Principles and Paradigms, Pearson

- Coulouris, G., Dollimore,J., Kindberg, T., & Blair, G. (2012). Distributed Systems: Concepts and Design, Pearson

- Papazoglou, M. (2012): Web Services and SOA: Principles and Technology. Pearson

- Erl, T. (2007): SOA Principles of Service Design. Prentice Hall International

- Fowler, M. (2002). Patterns of Enterprise Application Architecture. Addison-Wesley

- Gamma, E. et al. (1994). Design Patterns. Elements of Reusable Object-Oriented Software. Addison-Wesley

CI_3.05 Statistics

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_3.05	150 h	5 CP	3rd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semster hours per week (SWS) Exercise: 30 h / 2 SWS	4 SWS / 60 h	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Students who have completed this module successfully, are able to make informed decisions based on business, technical and social data. They can select appropriate statistical techniques for collecting, summarizing and displaying data. They are able to analyze and draw inferences from data using appropriate statistical methods and computer software. Students have developed the skills to interpret and communicate the results of a statistical analysis in the context of a business or technical problem or an empirical investigation of a social phenomenon.

Content

Probability:

- Random phenomena (Probability experiments and events)
- Probability rules
- Conditional probabilities (Bayes-Theorem)
- Combinatorics (Counting techniques)
- Random variables (Discrete und continuous)
- Expected value and variance
- Discrete and continuous probability distributions

Statistics :

Descriptive statistics and correlation analysis:

- Basic concepts (Levels of measurement, univariate data, bivariate data)
- Sampling and data collection
- Graphical and numerical summaries
- Frequency distributions
- Measures of central tendency, measures of position, measures of dispersion

- Grouped data

- Covariance, correlation, regression

Inferential statistics:

- Sampling distribution of a sample mean

- Sampling distribution of a sample proportion

- Point estimates, interval estimates, confidence intervals

- Hypothesentests

Statistical software skills:

- Using Excel, SPSS/R

Teaching methods

Lecture and Exercises. The course will be carried out in a seminar-like, interactive manner. The impartation of the statistical concepts will be supported by the integration of relevant applied examples and the deployment of statistical software (e.g. R, SPSS and/or Excel).

Entry requirements

Completion of the following modules is recommended:

- CI_1.05 "Mathematics: Analysis and Discrete Mathematics"

- CI_2.05 "Mathematics: Linear Algebra and Graph Theory"

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessments

Use of module (in other study programs)

Lecture and exercises are open to students of "Environment and Energy","International Business and Social Science", and "Mobility and Logistics" and "Communication and Information engineering".

Weight towards final grade

3.45 %

Person in charge of module

Dipl.-Biol. Ralf Darius

Additional information

Literature:

Johnson R.; Kuby P. (2008): Elementary Statistics. Tenth Edition, Brooks/Cole.

Michael S. (2005): Fundamentals of Statistics. 3rd Edition, San Francisco: Pearson Education

CI_3.06 Higher Mathematics

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_3.06	150 h	5 CP	3rd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Students are enabled to use advanced mathematical methods such as fundamental knowledge of vector analysis, complex analysis, Fourier analysis and Laplace transformation in given engineering contexts. They are also used to express engineering problems in the language of mathematics and to solve them by using modern calculation and simulation tools such as MATLAB or Octave.

Content

- Analysis in higher dimensions (Partial derivatives, Nabla operator, Laplace operator, Hesse matrix)
- Vector analysis
    -- Vector differential calculus (grad, div, curl)
    -- Vector integral calculus (integral theorems)
- Fourier analysis
- Laplace transform
- Complex analysis
- Introduction to Differential Equations
    -- Ordinary differential equations (first order ODEs, second order ODEs, higher order ODEs)
    -- Partial differential equations
- Numeric analysis
    -- Fundamental numerical concepts (interpolation, numeric integration and differentiation)
    -- Numeric linear algebra
    -- Numerics for ODEs and PDEs
- Probability

Teaching methods

Lectures and practical classes

Entry requirements

It is strongly recommended to attend the following modules first:

- CI_1.05 "Mathematics: Analysis and Discrete Mathematics"

- CI_2.05 "Mathematics: Linear Algebra and Graph Theory"

It is expected that students have knowledge of the principle components of a programming language

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Weight towards final grade

3.45 %

Person in charge of module

Prof. Dr. Frank Zimmer

Additional information

Reading:

Chapra, S.C.; Canale, R.P.: Numerical Methods for Engineers: International Edition, ISBN 007-1244298, McGraw-Hill, 5th ed., 2006

Kreyszig, E.: Advanced Engineering Mathematics: International Edition. ISBN 978-0471728979, John Wiley & Sons, 5th ed., 2005

Stroud, K.A.; Booth, D.J: Engineering Mathematics. ISBN 978-1403942463, Palgrave Macmillan; 6th ed., 2007

Stroud, K.A.; Booth, D.J: Advanced Engineering Mathematics. ISBN 978-0230275485, Palgrave Macmillan; 5th ed., 2011

CI_4.01 Analog and Digital Signal Processing

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_4.01	300 h	10 CP	3rd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 60 h / 4 semester hours per week (SWS) Exercise: 30 h / 2 SWS Practical classes: 30 h / 2 SWS	120 h / 8 SWS	180 h	Lecture: open Exercise: 50 students Practical classes: 20 students

Learning outcomes / Competences and qualifications profile

Having passed this module, students know fundamental principles of analog and digital signal processing and signal characterization. They are able to describe analog and digital signals in the time and frequency domain. Students are able to determine the Fourier and Laplace Transform of digital and analog signals. They are also able to describe the requirements for a lossless conversion from analog to digital domain using time and frequency domain description of the analog-to-digital-conversion process. Moreover, they know the basics of the technical realization of Analog-to-Digital-Converters (ADCs). Students who passed this module are capable of designing filters in the analog and digital domain to achieve a given specification of the filter function. They know the basics of signal modulation and transmission and can describe the modulation process in time and frequency domain.

Content

- Laplace and Fourier Transform of elementary signals
- Linear Time Invariant (LTI) Systems
- Sampling theorem
- Analog signal reconstruction based on digital signal samples
- Technical realization of ADCs
- Two-Terminals
- Filter Design in analog domain using table based approach (especially Butterworth and Chebyshev filters)
- Filter Design in digital domain using e.g. "Windowing Method"
- Signal modulation (Amplitude, Phase and Frequency)

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements It is strongly recommended to attend the following module first: CIE_3.02 "Signals and Systems"
Types of assessment Graded examination
Requirements for the award of credit points Passed assessment
Use of module (in other study programs)
Weight towards final grade 6.90 %
Person in charge of module N.N.
Additional information Reading:

CI_4.02 Identification and Automation

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_4.02	150 h	5 CP	4th semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Students have gained fundamental knowledge of devices and methods, which are used to automate processes. The module enables students to be part of a team which designs systems (e.g. logistical systems) using technology to identify items, measure physical quantities and perform automatic reactions. The taught fundamentals enable students to discuss with suppliers of material flow systems or with suppliers of automated warehouse systems. Furthermore successful students are able to solve easy automating tasks independently.

Content

- Sample applications
- Identification systems:
  - Identification charcteristics
  - Optical charcter recognition
  - 1D barcodes
  - 2D codes
  - coding sementics (ILN, EAN,NVE, UPC,EPC)
  - Error Correction
  - The technology of barcode reader
  - Printing processes
  - Radio Frequency Identification
- Automation
  - Control Theory and control systems (logic controls, state machines, workflow, control loop, feedback mechanism)
  - Hardware components
    - Sensors and actuators

- Automation devices, Controlling devices

- Programming systems used in the automation context

- Communication (bus systems)

- System diagnosis

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

It is strongly recommended to attend the following modules first:

CI_1.02 “Fundamentals of Computer Science and Networks”

CI_2.01 "Fundamentals of Electrical Engieneering: Fields and Circuits" or “Electrical Circuits and Systems”

It is expected that students have knowledge of the principle components of a programming language

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Lecture and exercises are open to students of "Mobility and Logistics" and "Communication and Information engineering.

Weight towards final grade

3.45 %

Person in charge of module

Prof. Dr. Christian Ressel

Additional information

Reading:

Nof, S.Y.: Springer Handbook of Automation. ISBN 3540788301, Berlin, Springer, 2009.

Pearce,S.; Bushnell,R.D.: The Bar Code Implementation Guide: Using Bar Codes in Distribution. ISBN 0941668061,Tower Hill Pr, 2010.

Finkenzeller, K.: RFID Handbook. ISBN 0470695064, Chichester, Wiley, 2010

Fraden J.: Handbook of modern sensors. ISBN 1441964657, New York, Springer, 2010.

CI_4.03 Software Engineering

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_4.03	150 h	5 CP	4th semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Students have gained an overview of the ten knowledge areas of software engineering as defined by the ACM/IEEE Computer Society Software Engineering Body of Knowledge (IEEE 2013) and have been introduced to selected methods. Students are able to decide which software engineering methods should be applied in different situations. Students are able to evaluate the appropriateness of specific methods in the context of specific organizational setting and software product requirements.

Content

- Ethical aspects of software engineering, software engineering as a professional discipline
- Software processes: OMG SPEM, Eclipse Process Framework Composer
- Agile software development: TDD, Scrum
- Requirements engineering
- System modeling, architectural design: UML, Enterprise Architect
- Design Patterns
- Configuration Management, build, continous integrationsoftware factories
- Software testing

Teaching methods

Lectures and practical classes

Entry requirements

It is strongly recommended to attend the following modules first:

CI_2.03 "Object Oriented Programming"

CI_3.03 "Data Management"

CI_3.04 "Programming: Distributed Systems"

Types of assessment Graded examination
Requirements for the award of credit points Passed assessment
Use of module (in other study programs)
Weight towards final grade 3.45 %
Person in charge of module Prof. Dr.-Ing. Sandro Leuchter
Additional information Reading: - IEEE Computer Society (2013): Software Engineering Body of Knowledge (SWEBOK V3). - Sommerville, I. (2011): Software Engineering, Addison-Wesley de Marco, T. (2009): Software Engineering: An Idea Whose Time Has Come and Gone?. IEEE Software, July/August 2009. ISO/IEC 12207:2008: Systems and software engineering - Software life cycle processes. Brooks, F. (1995): The Mythical Man-Month. Addison-Wesley.

CI_5.01 Embedded Systems

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_5.01	150 h	5 CP	5th semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Exercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

Having passed this module students know fundamental principles of embedded systems with emphasis on microcontrollers (MC). They have been introduced to the programming of MCs and their electrical interfacing in practical classes. Interactions of MCs with the user and the environment have been realized, as well as solutions for the machine-to-machine communication. The students are familiar with common development environments and can solve practical problems of moderate complexity. This introductory course equips students with the basic skills necessary for further acquisition of more sophisticated problems.

Content

- Classification of embedded hardware and typical applications: microcontroller, digital signal processor, field programmable gate array, system on chip, embedded computer

- Embedded systems on a programmable chip using FPGAs

- Internal devices: GPIO, ADC, DAC, Timer, Counter, PWM, DMA

- Digital interfaces: UART , I2C, SPI, 1Wire

- Multi-tasking: interrupt handler, scheduler, real-time kernel, operating system

- Programming in C

- In system debugging

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

It is strongly recommended to attend the lectures

CI_1.02 "Fundamentals of Computer Science and Networks" and

CI_1.03 "Fundamentals of Digital Technologies"

CI_2.01 "Fundamentals of Electrical Engineering: Fields & and Circuits"

CI_3.01 "Fundamentals of Electrcial Engineering: Electrical Networks & Semiconductors" before taking this course. It is expected that students have knowledge of the principle components of a programming language.
Types of assessment Graded examination
Requirements for the award of credit points Passed assessment
Use of module (in other study programs)
Weight towards final grade 3.45 %
Person in charge of module N.N.
Additional information Reading :

CI_5.02 Communication Systems

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_5.02	150 h	5 CP	5th semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Exercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Students who successfully passed the module "Communication Systems" are enabled to understand and describe systems for the transmission and processing of discrete and finite signals, to assess their potential and to find new solutions for problems concerning communication systems. Students are able to mathematically describe the modulation process for frequency, phase and amplitude modulation (FM, PM, AM). The can describe the purpose and process of channel coding and know the basic access schemes (i.e. FDMA, TDMA, CDMA) as well as the basics of communication channels like fading, multipath. They can compare common mobile communication systems with respect to access scheme, modulation and general performance values e.g. like data rate and Quality of Service. Students understand the concept and mathematical description of noise in communication systems especially additive white Gaussian noise. They understand and they can calculate and assess the Signal-to-Noise-Ratio of system.

Content

- Theory of communication (Source of information, source and drain, entropy)
- Coding theory (Source coding), compression and encryption
- Channel coding
- Mobile communication and switching technologies
- Access schemes of communication systems (TDMA, FDMA, CDMA)
- Basics and specifications of common mobile communication systems (e.g. LTE, GSM, …)
- Working principle of DDS and PLL
- Free space propagation including simple multipath models
- Fading channels
- Noise and Signal-to-Noise ratio

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

It is strongly recommended to attend the following module first:

CI_3.02 "Signals and Systems"

CI_4.01 "Analog and Digital Signalprocessing"

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Weight towards final grade

3.45 %

Person in charge of module

N.N.

Additional information

Reading:

[1] Proakis, J.G., Communication Systems Engineering, Prentice Hall, 2001.

[2] Haykin, S., Communication Systems, John Wiley and Sons, 4th International Edition, 2000.

[3] Proakis, J.G., et al., Modern Communication Systms Using MATLAB®, CENGAGE Learning, 3rd International Edition, 2013.

CI_5.03 Interdisciplinary Project

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_5.03	300 h	10 CP	5th semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Project	90 h / 6 SWS	210 h	25 students

Learning outcomes / Competences and qualifications profile

In this module students have expanded and deepened the knowledge and skills they have acquired in previous project and modules. The interdisciplinary character of the project encourages students to discover new topics and gather practical experiences in different fields. Having completed this module, students are able to work on questions of theory or praxis in an international and interdisciplinary team. They are able to work scientifically and to produce convincing results in their teams.

Content

The content differs between projects, depending on the study programs which are involved and the teaching staff's background. Depending on students' knowledge, lectures and workshops concerning different topics will be included so that students can attend different lectures of other study programms.

Teaching methods

Sessions for basic information about the project options; project coordination; project counseling provided by teaching staff or project partner from a company; accompanying lectures depending on projects' topics and demand; presentation of results to an interested audience consisting of university staff and students as well as external project partners.

Entry requirements

None

Types of assessment

Graded examination

Requirements for the award of credit points

Project report and presentation of results delivered. Both have to meet quality criteria to pass the module.

Use of module (in other study programs)

Same module for all Bachelor study programs of the faculty

Weight towards final grade

6.90%

Person in charge of module All professors of the faculty
Additional information

CI_6.01 Internship / Semester Abroad

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_6.01	900 h	30 CP	6th semester	Summer or winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
		900 h	Open

Learning outcomes / Competences and qualifications profile

The internship module has enabled students to apply their knowledge in a practical setting. Students have gained insights into a company and into specific practical fields. During their stays as interns they have worked on different tasks in the companies and have taken on responsibility for certain topics.

Students having opted for a semester abroad have gained intercultural competencies. They have improved their foreign language skills or have even studied a new foreign language, have learned how to get along in a foreign educational system and have worked with other students and teaching staff of different nationalities.

Content

Depending on internship company or university abroad. Topics will be discussed beforehand with teaching staff of Rhine-Waal University of Applied Sciences.

Teaching methods

Entry requirements

89 credit points achieved

Types of assessment

Certificate (Testat)

Requirements for the award of credit points

20 weeks of internship have to be completed. Splitting these 20 weeks into parts is not possible. An internship report and and a presentation which have to meet quality criteria have to be delivered.

In case of a semester abroad at least 10 ECTS have to be earned at the foreign university which is based in a non-German speaking country. Exceptions can be made in cases in which the success of the semester abroad is defined in a different way.

Use of module (in other study programs)

Same module in "International Business and Social Sciences", "Communication and Information Engineering", "Information and Communication Design", "Environment and Energy", and "Mobility and

Logistics"
Weight towards final grade None (ungraded)
Person in charge of module All professors of the faculty
Additional information

CI_7.01 Bachelor Workshop I: Research Methods

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_7.01	150 h	5 CP	7th semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Seminaristic lectures: 60 h / 4 semester hours per week (SWS)	60 h / 4 SWS	90 h	35 students

Learning outcomes / Competences and qualifications profile

This is a very applied course aiming to provide students with the skills and knowledge about research methods they need to write their bachelor thesis. Having completed this course, students are able to decide which research method is suited best to explore their chosen bachelor theses topics. They can research available data sets or collect their own data using questionnaires. They can evaluate the data either with SPSS or estimate simple econometric models with EViews.

With regard to qualitative research methods students are able to apply the case study methodology and write convincing case studies. They can also apply interviewing techniques when conducting expert interviews.

Students are aware of quality criteria for both quantitative and qualitative research. They have deepened this understanding through analyzing and criticizing examples of qualitative as well as quantitative research.

Content

Quantitative reasearch methods:

- Own data collection vs. working with available data sets

- Where to find available data sets

- Data quality, dealing with missing observations

- How to design a questionnaire

- How to evaluate a questionnaire

- Statistical analysis using SPSS

- Introduction to econometric methods

- Basic estimations using EViews

- Introduction to event study methodology

- Analysis of examples of quantitative research

Qualitative research methods:

- Quality of qualitative data

- Process of qualitative research

- Case study analysis

- Interview techniques

- Content analysis

- Discourse analysis

- Analysis of examples of qualitative research

Teaching methods

Seminaristic lectures which will include discussions as well as student tasks performed individually, in pairs or in groups. Some PC sessions to practice SPSS as well as EViews software.

Entry requirements

175 credits points achieved (including internship or semester abroad)

Types of assessment

Certificate (Testat)

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Same module in "International Business and Social Sciences", "Communication and Information Engineering", "E-Government", "Environment and Energy", "Media Communication and Computer Sciences" and "Mobility and Logistics"

Weight towards final grade

None (ungraded)

Person in charge of module

All professors of the faculty

Additional information

Reading:

Pallant, J. (2010): SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS. 4th edition. New York: McGraw-Hill.

Saunders, M. / Lewis, P./ Thornhill, A. (2009): Research Methods for Business Students. 5th edition.

London: Financial Times.

Studenmund, A. H. (2010): Using Econometrics: A Practical Guide with Eviews.Upper Saddle River: Pearson Prentice Hall.

Yin, R. K. (2009): Case study research: Design and methods. 4th edition. Thousand Oaks: Sage.

CI_7.02 Bachelor Workshop II: Scientific Writing

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_7.02	150 h	5 CP	7th semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Seminaristic lectures: 60 h / 4 semester hours per week (SWS)	60 h / 4 SWS	90 h	35 students

Learning outcomes / Competences and qualifications profile

Students are able to communicate their results of scientific working in an appropriate written form. They have learned how to write effectively, concisely, and clearly. By practicing the discussed writing techniques they have gained an understanding of and experience in creating a scientific manuscript.

Content

- Writing style
- Writing techniques
- Structure, outline, and first draft
- Organizing the writing process
- How to present methods and results effectively
- Discussing the results
- Putting the fragements together
- Abstract and Introduction
- Rewriting the manuscript
- Editing and publishing the text

Teaching methods

Workshop including seminaristic lectures and many writing exercises. Students discuss their results and support each other.

Entry requirements

175 credits points achieved (including internship or semester abroad)

Types of assessment

Certificate (Testat)

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Same module in "International Business and Social Sciences", "Communication and Information Engineering", "E-Government", "Environment and Energy", "Media Communication and Computer Sciences" and "Mobility and Logistics"

Weight towards final grade

None (ungraded)

Person in charge of module

All professors of the faculty

Additional information

Reading:

Cargill, M. / O'Connor, P. (2009): Writing Scientific Research Articles. Strategy and Steps. Chichester: Wiley-Blackwell.

Glasman-Deal, H. (2010): Science Research Writing for Non-Native Speakers of English. A Guide for Non-Native Speakers of English. London: Imperial College Press.

Hofmann, A. H. (2010): Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford: Oxford University Press.

Russey, W. E. / Ebel, H. F. / Bliefert, C. (2006): How to Write a Successful Science Thesis. The Concise Guide for Students. Weinheim: Wiley-VCH.

CI_7.03 Bachelor Workshop III: Colloquium

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_7.03	150 h	5 CP	7th semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Seminaristic lectures: 60 h / 4 semester hours per week (SWS)	60 h / 4 (SWS)	90 h	35 students

Learning outcomes / Competences and qualifications profile

Students have received feedback, advice and guidance for their bachelor thesis. Each student has presented his or her own research findings in a short presentation (20-30 minutes). Together with two other students, who had received the respective presentation earlier, he/she has discussed the current state of research findings, methodology etc. That way students have learned to present their research in a convincing way, to professionally defend their research and to accept feedback or criticism from their peers. At the same time students have learned to give feedback, provide ideas and advice for the work of others and formulate criticism in a fair way.

Content

- How to present research findings in a professional way

- How to comment and criticize the research of others

- How to moderate a group discussion

- Students´ presentations of their own findings followed by two discussant contributions and an open group

discussion

Teaching methods

Students present their own research. Group discussions about the findings and methods applied.

Entry requirements

175 credits points achieved (including internship or semester abroad)

Types of assessment

Certificate (Testat)

Requirements for the award of credit points

Individual student´s presentation of his/her own research findings. Contribution to the discussion of two other students' researches.

Use of module (in other study programs)

Same module in "International Business and Social Sciences", "Communication and Information Engineering", "Environment and Energy", and "Mobility and Logistics"
Weight towards final grade None (ungraded)
Person in charge of module All professors of the faculty
Additional information

CI_7.04 Bachelor Thesis and Disputation

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_7.04	450 h	15 CP	7th semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Bachelor Thesis: 12 CP Disputation: 3 CP	Depends on need and demand		

Learning outcomes / Competences and qualifications profile

Students have conducted their own studies examining a research question from their scientific discipline, developing an appropriate methodological approach, and reflecting their research design and findings critically.

During the disputation students have proven their competencies in evaluating the topic and reflecting on its impact on real-life problems.

Content

Depends on the topic; inter alia:

- Researching and evaluating literature
- Developing a research question and deriving hypotheses
- Operationalizing constructs
- Analyzing methodological strengths and weaknesses of different research approaches
- Developing research designs
- Conducting the studies
- Evaluating the results / Implementation
- Writing the thesis
- Presenting and defending the findings

Teaching methods

Individual supervision and support

Entry requirements

175 credits points achieved (including internship or semester abroad)

Types of assessment

Written Bachelor thesis and oral disputation
Requirements for the award of credit points Passed Bachelor thesis and disputation as well as successful completion of all other modules of the curriculum
Use of module (in other study programs)
Weight towards final grade 10.34 %
Person in charge of module All professors of the faculty
Additional information

CI_W.01 Ambient Intelligent Systems

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_W.01	150 h	5 CP	4th or 5th semester	Once a year	1 semester

Courses	Teaching time	Self-study	Planned group size
60 h / 4 semester hours per week (SWS)	60 h / 4 SWS	90 h	20 students

Learning outcomes / Competences and qualifications profile

Ambient Intelligence envisions a world where people are surrounded by sensors and intelligent, intuitive interfaces embedded in the everyday objects around them. This enables the environment to identify individuals or objects and to response to their presence and behaviour in an appropriate and perhaps personalized way.

In this module the students have been introduced to the vision of ambient intelligent systems. They have gained a sound understanding of enabling technologies and they got an overview of applications and experiments. The application field Ambient Assisted Living (AAL) has been discussed in detail. The students have learned how new technology can be used to improve care processes and to increase the personal mobility and comfort of elderly people. They also got a brief idea of other socio-cultural impacts. At the end of this course students are able to come up with new ideas and to start innovative projects in this area.

Content

- Vision, history and predecessor technologies/visions
- Knowledge-based systems
- Machine learning
- Adaptive multimodal interfaces
- Context: modelling, automatic detection and recognition
- Ideas and current research in the area of AAL

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

It is strongly recommended to attend the lectures

CI_1.02, ML_1.04 "Fundamentals of Computer Science and Networks"

CI_2.06, ML_2.06 "Project Management and Intercultural Competence"

CI_2.01/CI_3.01 "Fundamentals of Electrical Engineering" or ML_2.03"Electrical Circuits and Systems"

before taking this course.

It is expected that students have knowledge of the principle components of a programming language

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Open to students of other study programs

Weight towards final grade

3.45 %

Person in charge of module

Prof. Dr. Christian Ressel

Additional information

Reading:

Corchado,J.M. et al: 3rd Symposium of Ubiquitous Computing and Ambient Intelligence 2008. ISBN 978-3-540-85866-9, Berlin, Springer, 2008

Corchado,J.M. et al: Ambient Intelligence and Future Trends -: International Symposium on Ambient Intelligence 2010. ISBN 3642132677, Berlin, Springer 2010

Omatu, S. et al: Distributed Computing, Artificial Intelligence, Bioinformatics, Soft Computing, and Ambient Assisted Living: 10th International Work-Conference. ISBN 3642024807, Berlin, Springer, 2009

Verhaegh, W.; Aarts,E.; Korst,J.: Algorithms in ambient intelligence. ISBN 978-1402017575,Springer Netherlands, 2004.

Bravo, J. et al: Ambient Assisted Living: Third International Workshop, IWAAL 2011. ISBN 3642213022, Berlin, Springer, 2011.

Vasilakos,A.; Pedrycz, W.: Ambient intelligence, wireless networking, and ubiquitous computing. ISBN 1-580-53963-7,Boston, Artech House Inc, 2006

CI_W.02 Remote Sensing and Non-Invasive Methods

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_W.02	150 h	5 CP	5th semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Exercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 50 students

Learning outcomes / Competences and qualifications profile

Having passed this module students are familiar with basic principles of remote sensing and its application. They know a collection of relevant electromagnetic and optical sensors with emphasis on imaging instruments. Students are aware of problems related to image quality influenced by sensor performance and environmental conditions, image analysis and interpretation. In practical exercises students perform the major steps of the whole processing chain from sensor via various correction algorithms to final remote sensing product for the end user.

Content

- Relevance and application of remote sensing
- Satellite and airborne systems
- Unmanned aerial vehicles
- Imaging sensors
- Active and passive microwave sensors, radars
- Thermography
- Optical instruments
- Spectroscopy and hyperspectral imaging
- Calibration, radiometric, geometric and atmospheric correction
- Image analysis

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

None

Types of assessment Graded examination
Requirements for the award of credit points Passed assessment
Use of module (in other study programs)
Weight towards final grade 3.45 %
Person in charge of module Prof. Dr. Rolf Becker
Additional information Reading:

CI_W.03 Communication Security

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_W.03	150 h	5 CP	4th semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 50 students

Learning outcomes / Competences and qualifications profile

Students have gained fundamental knowledge of security terms and concepts, such as threats, vulnerabilities, protection and incident handling. The purpose of the course is to provide the student with an overview of the field of communication / information security and respective implementation issues for communication systems. The students will be exposed to the spectrum of security activities, its methods, methodologies and mechanisms.

Coverage will include cryptographic functions, inspection and protection of assets, detection of and reaction to threats to communication systems, and analysis of incident procedures. Another focus will be set on security related organizational structures and product / system certification with respect to standardized security evaluation crietria.

Content

- Legal, Ethical, and Professional Issues in Information Security
- Cryptography
- Operating System Vulnerabilities and Resolutions
- Communication Security, Tunneling
- Cryptographic Protocols
- Malware, Anti-Virus
- Firewalls and (virtual) Private Networks
- IDS and Access Control
- Trustworthy Hardware
- Physical Security
- Cryptographic Protocols
- Audits
- Implementing Security

- Security Certification

- Information Security Management

Teaching methods

Lectures and practical classes

Entry requirements

It is strongly recommended to attend the following module first:

CI_1.02 “Fundamentals of Computer Science and Networks"

CI_2.03 "Advanced Computer Networks "

It is expected that students have knowledge of a programming language and of the fundamentals of operating systems.

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Open to students of other study programs

Weight towards final grade

3.45 %

Person in charge of module

Prof. Dr. Ulrich Greveler

Additional information

Reading:

Paar	Understanding Cryptography	978-3642041006
Schneier	Applied Cryptography	978-0471117094
Anderson	Security Engineering	978-0470068526

CI_W.04 Safety Critical Systems

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_W.04	150 h	5 CP	5th semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Physical integrity or even lifes are at stake if a safety critical system should have a malfunction. Safety critical systems are (often socio-) technical systems. The development of such systems needs special attention and methodology. Different approaches have evolved in some application domains. Students know challenges in designing, implementing, and testing of safety critical systems with a focus on software intensive safety critical systems. They can apply different methodological approaches for steps in the development and life cycle of safety critical systems. In case studies they have gained experience in identifying and dealing with critical issues in the development and have set up development processes that comply to regulations.

Content

- Systems engineering, reliability, availability, maintainability and safety (RAMS) analysis: hazard analysis (HA), failure modes (and) effects (and criticality analysis) (FME(C)A), fault tree analysis (FTA), mean time between failure (MTBF), mean time to repair (MTTR) and mean down time (MDT) calculations

- Security engineering: system evaluation and assurance

- Human factors: human error, cognitive workload, ironies of automation, (shared) situation/mode awareness, trust/complacency, human centred design: parallel-iterative approach

- Safety integrity levels (SIL) and development processes in different application domains (avionics, medical, railway, automotive, …) MIL STD 882, IEC 61508/ISO 26262, DO-178B/C, software engineering for embedded systems

- Programming techniques: defensive programming, e.g. MISRA-rule sets

- Safety critical systems development and maturity models (SPICE, CMMI)

- Quality assurance: model based verification,human/model in the loop, audits/assessments

- Operating systems for safety critical and realtime systems

Teaching methods

Group work on case studies

Entry requirements

It is strongly recommended to attend the following modules first:

CI_4.03 ”Software Engineering"

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Weight towards final grade

3.45 %

Person in charge of module

Prof. Dr.-Ing. Sandro Leuchterr

Additional information

Reading:

- Leveson, N.G. (2012). Engineering a Safer World: Systems Thinking Applied to Safety, MIT Press.

- Bozzano, M. & Villafiorita, A. (2010). Design and Safety Assessment of Critical Systems, Auerbach.

- Smith, D. & Simpson, K.G.L. (2010). Safety Critical Systems Handbook: A Straightfoward Guide to Functional Safety, IEC 61508 and Related Standards, Butterworth Heinemann.

- Salas, E., Jentsch, F., & Maurino, D. (2010). Human Factors in Aviation, Academic Press.

- Anderson, R. (2008). Security Engineering. A Guide to Building Dependable Distributed Systems, Wiley.

- Börcsök , J. (2007). Functional Safety: Basic Principles of Safety-Related Systems, Hüthig.

- Strauch, B. (2004). Investigating Human Error: Incidents, Accidents, and Complex Systems, Ashgate.

- Ericson, C.A. (2005). Hazard Analysis Techniques for System Safety, Wiley.

CI_W.05 Advanced Modelling and Simulation

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_W.05	150 h	5 CP	4th semester or 5th semester	Winter semester or summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 20 students

Learning outcomes / Competences and qualifications profile

Students are able to model technical systems and analyze them via simulations. In detail, the students can model technical problems, describe them mathematically and find solutions. They know the appropriate use of models and simulations and their limits and understand the steps of the simulation process. Students are familiar with modern modelling and simulation techniques as well as common tools. They understand the modelling and simulation technology as a useful tool to understand technical systems and they can apply them in different contexts.

Content

- Introduction: Meaning of modelling and simulation in the context of technical systems, the simulation chain

- Discrete and continuous simulations, dimensionless variables, implementation with Octave, Matlab/Simulink,

Scilab, R; (e.g. signal processing, queuing systems, optimization); introduction to partial differential equations

(e.g. solving heat conduction equation by using FEM or FDM, …)

- Stochastic simulations (Monte Carlo simulations, ...)

- Advanced data processing (multivariate statistics, cluster analysis and data mining)

Teaching methods

Tuition in seminars, lectures and practical classes

Entry requirements

It is strongly recommended to attend the following modules first:

CI_1.05 "Mathematics: Analysis and Discrete Mathematics"

CI_2.02 "Object Oriented Programming"

CI_2.05 "Mathematics: Linear Algebra and Graph Theory"

CI_3.06 "Higher Mathematics"

It is expected that students have knowledge of the principle components of a programming language

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Open to students of other study programs

Weight towards final grade

3.45 %

Person in charge of module

Prof. Dr. Frank Zimmer

Additional information

Reading:

Campbell, S.L.; Chancelier, J.-P.; Nikoukhah, R.: Modeling and Simulation in Scilab/Scicos with ScicosLab 4.4, ISBN 978-1441955265, Berlin, Springer, 2nd ed., 2009

Kreyszig, E.: Advanced Engineering Mathematics: International Edition, ISBN 978-0471728979, John Wiley & Sons, 5th ed., 2005

Jones, O.; Maillardet, R.; Robinson, A.: Introduction to Scientific Programming and Simulation Using R, CRC Press, Taylor & Francis Group, Boca Raton, FL, 2009

Quarteroni, A. M. ; Saleri, F. ; Gervasio, P.: Scientific Computing with MATLAB and Octave. 3rd edition, Berlin: Springer, 2009

Stroud, K.A.; Booth, D.J: Engineering Mathematics, ISBN 978-1403942463, Palgrave Macmillan, 6th ed., 2007

Stroud, K.A.; Booth, D.J: Advanced Engineering Mathematics, ISBN 978-0230275485, Palgrave Macmillan, 5th ed., 2011

Tyagi, A.K.: MATLAB and Simulink for Engineers, ISBN 978-0198072447, Oxford Univ Pr, Pap/Cdr, 2011

CI_W.06 Fundamentals of Business Administration

Code	Workload	Credits	Level of module	Frequency of offer	Duration
CI_W.06	150 h	5 CP	4th semester or 5th semester	Winter semester or summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Exercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 40 students

Learning outcomes / Competences and qualifications profile

Students have gained an understanding of fundamental concepts of business administration and the basic functions of organizations. They have a good grasp of important terms, concepts, and methods and are able to apply them to real-life problems. They have discussed the impacts of globalization and can describe its influence on business processes.

Content

- An organization and its goals
- Corporate organization and organizational structure
- Principles of strategic management and planning
- The operations function: the process of production, costs and planning, production logistics
- Fundamentals of marketing: the marketing mix
- Principles of finance
- The controlling function
- Fundamentals of human resource management and leadership

Teaching methods

Lectures, accompanied by exercises in which case studies and problems in practice are presented

Entry requirements

None

Types of assessment

Graded examination

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

Same module in "Environment and Energy", "Communication and Information Engineering", "International Business and Social Sciences" and "Mobility and Logistics"

Weight towards final grade

3.45%

Person in charge of module

Prof. Dr. Daniel H. Scheible

Additional information

Reading:

Gamble, J. E. / Thompson, A. A. (2011): Essentials of Strategic Management. The Quest for Competitive Advantage. 2nd edition. New York: McGraw-Hill.

Hill, C. W. L. (2009): International Business. Competing in the Global Marketplace. 7th edition. New York: McGraw-Hill.

Kotler, P. / Armstrong, G. (2010): Principles of Marketing. 13th edition. Upper Saddle River: Pearson Prentice Hall.

Luthans, F. / Doh, J. P. (2009): International Management. Culture, Strategy, and Behavior. 7th edition. New York: McGraw-Hill.

Robbins, Stephen P. / DeCenzo, David A. / Coulter, Mary (2011): Fundamentals of Management. Essential Concepts and Applications. 7th edition. Upper Saddle River: Pearson Prentice Hall.

Slack, N. / Chambers, S. / Johnston, R. (2010): Operations Management. 6th edition. Harlow: Pearson Prentice Hall.