FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Module handbook

for a consecutive, study program in

Information Technology (viersemestrig)

M.Eng.

Department 2: Computer Science and Engineering

Table of Contents

1. Qualification Objectives

On successful completion of the Master-Program “Information Technology (viersemestrig)” the students have acquired a post graduate qualification to be technical specialists and technical managers for positions in the information technology industry.

The students have gathered profound knowledge in advanced mathematics, information and communication technology and IT-Security. They have improved and enhanced their knowledge in advanced theoretical methods of engineering and specialized their applied engineering knowledge in hard- and software of communication systems, which serve as a base for further innovative approaches. Students of multicultural origins have reflected cultural aspects and ethics standards. They have familiarized themselves with the German university and business environment .They have acquired a proven level of knowledge and understanding of the fundamentals of Information Technology which builds on the Bachelor’s level and significantly consolidates and extends it.

Graduates are competent and qualified to think in a multi- and interdisciplinary way when applying laws and principles of information technology in order to solve challenging and complex technical problems, particularly in reference to the development of new technologies, products, and services. They possess skills and experiences in digital communication systems, optical and microwave systems or in intelligent systems, intelligent sensors and pattern recognition.

Specific courses like "Software Engineering" and the "Project Course" enable the Students to be qualified in the design of projects, processes, the mastering of change management and the creation of new strategic approaches. They will be able to contribute to the enhancement of technical knowledge and lead and manage international teams and projects. They are able to master complex and unpredictable problems with innovative solutions.

By experiencing a variety of situations in laboratories during specific project work, the students acquire specific skills in innovative engineering methods and strategies and will be reflective practitioners.

The students identify and reflect the professional requirements and are prepared for lifelong learning. They are able to use presentation skills, apply self and project management, gather information that is suited for academic discussion, and describe requirements, problems and results in English language. They dispose of key competences in technical English, in social interaction (team work, project work) and in professional presentation and communication.

The prospective engineers are qualified for positions in academia, public administration and industry e.g. technical specialists or technical managers or for pursuing a PhD.

They have acquired and applied different methods that allow them to work in research and development of integrated product and service concepts in the area of information technology. Career opportunities include research and development of technical systems and the management of such projects. They qualified as technical specialists and technical managers in the information technology industry.

2. Module Overview of Degree Program

Information Technology (viersemestrig) (M.Eng.)							FRANKFURT UNIVERSITY OF APPLIED SCIENCES
							ECTS Punkte (CP)
Semester 4	13 **Master Thesis and Colloquium** 30 cp						30
Semester 3	7 **Machine Learning** 5 cp	8 **Mobile Computing** 5 cp	9 **Field Theory for Optical and Microwave Communication Systems** 5 cp	10 **Autonomous Intelligent Systems** 5 cp	11 **Optional Technical Subject** 5 cp	12 **Project** 5 cp	30
Semester 2	1 **Vector Analysis** 5 cp	2 **Stochastic Signals and Systems** 5 cp	3 **Digital Baseband Transmission and Modulation Methods** 5 cp	4 **Cloud Computing** 5 cp	5 **Digital Switching and Routing** 5 cp	6 **Computational Intelligence** 5 cp	30
Semester 1	A **Methods, Systems and Networks for Digital Communication** 5 cp	B **Circuit Design for Communication Systems** 5 cp	C **Software Engineering** 5 cp	D **Image Processing and Identification of Dynamic Systems** 5 cp	E **IT-Security** 5 cp	F **Cultural Diversity and Business Ethics** 5 cp	30

Information Technology (viersemestrig) (M.Eng.)

3. ECTS/Workload overview

Nr.	Module Title	ECTS (CP)	Duration [Sem.]	Examination Type	Language	Weight
Semester 1						
A	Methods, Systems and Networks for Digital Communication	5	1	Written examination	English	1
B	Circuit Design for Communication Systems	5	1	Written examination	English	1
C	Software Engineering	5	1	Written project report, presentation	English	1
D	Image Processing and Identification of Dynamic Systems	5	1	Written examination	English	1
E	IT-Security	5	1	Written examination	English	1
F	Cultural Diversity and Business Ethics	5	1	Written paper, presentation	English	1
Semester 2						
1	Vector Analysis	5	1	Written examination	English	1
2	Stochastic Signals and Systems	5	1	Written examination	English	1
3	Digital Baseband Transmission and Modulation Methods	5	1	Written examination	English	1
4	Cloud Computing	5	1	Written project report, presentation	English	1
5	Digital Switching and Routing	5	1	Written examination	English	1
6	Computational Intelligence	5	1	Written paper, presentation	English	1
Semester 3						
7	Machine Learning	5	1	Written project report, presentation	English	1
8	Mobile Computing	5	1	Written project report, presentation	English	1

Nr.	Module Title	ECTS (CP)	Duration [Sem.]	Examination Type	Language	Weight
9	Field Theory for Optical and Microwave Communication Systems	5	1	Written examination	English	1
10	Autonomous Intelligent Systems	5	1	Written project report	English	1
11	Optional Technical Subject*	5	1	Written project report, presentation	English	1
12	Project	5	1	Written project report, presentation	English	1
Semester 4						
13	Master Thesis and Colloquium	30	1	Master Thesis and colloquium	English	6

*Zwei unterschiedliche Wahlpflichtmodule werden aus einem vom Fachbereichsrat beschlossenen Pool ausgewählt. Zu diesem Pool gehören u.a. die nachfolgend aufgeführten Module:
11.1. Engineering of Microwave Systems
11.2. Engineering of Optical Systems

4. Module Descriptions

Module A

Module title	Methods, Systems and Networks for Digital Communication
Module number	A
Module code	
Study program	Information Technology (viersemestrig)
Module usability	
Module duration	One semester
Recommended semester	1st semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	None
Module prerequisites	None
Module examination requirements	None
Module examination	Written examination, 90 minutes
Learning outcomes and skills	Students from different countries and different backgrounds have harmonized their knowledge and acquired comparable skills in the fundamentals of telecommunication and network technologies. They have substantial knowledge of the functionalities, network nodes and architectures of modern telecommunication systems and networks and know details about the essential communication protocols. Upon completion of the module the students are able to: - analyse different network technologies and protocols - specify network nodes and architectures - recognize and analyse relationships in modern communication networks and to highlight optimization opportunities.
Module contents	Lectures in Methods, Systems and Networks for Digital Communication
Module teaching methods	Lectures combined with exercises
Module language	English
Module availability	Winter semester
Module coordination	Trick
Comments	

Unit A.1: Lectures in Methods, Systems and Networks for Digital Communication

Unit title	Lectures in Methods, Systems and Networks for Digital Communication
Code	
Module title	Methods, Systems and Networks for Digital Communication
Unit contents	Overview: • telecommunications technologies, • signals, • protocols, • services • networks Telecommunication Networks in detail: • general architecture of a telecommunication network, • ISDN, LAN, Internet, GSM and UMTSTCP/IP: Ethernet, IP, TCP, HTTP Next Generation Networks: • Voice over IP and SIP: • real-time communication in IP networks, • SIP and SDP, • SIP network elements and network architectures
Teaching methods	Lecture / Exercises
Semester periods (hours) per week	4
Workload (h)	150 h
Class hours	60 h
Total time of examination incl. preparation (h)	30 h
Total time of individual study (h)	60 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Trick
Recommended reading	Trick, Ulrich; Weber, Frank: SIP und Telekommunikationsnetze – Next Generation Networks und Multimedia over IP – konkret. De Gruyter Oldenbourg, 2015 Tanenbaum, Andrew S.; Wetherall, David: Computer Networks. Pearson, 2010 Poikselkä, Miikka; Mayer, Georg: The IMS: IP Multimedia Concepts and Services. Wiley, 2009 Johnston, Alan B.: SIP: Understanding the Session Initiation Protocol.

	Artech House, 2015 Additional up-to-date reading information will be announced at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Module B

Module title	Circuit Design for Communication Systems
Module number	B
Module code	
Study program	Information Technology (viersemestrig)
Module usability	
Module duration	One semester
Recommended semester	1st semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	None
Module prerequisites	None
Module examination requirements	None
Module examination	Written examination (120 minutes)
Learning outcomes and skills	Upon completion of the module the students are able to: • explain the underlying technologies of communication systems, • compare technical solutions for their merits in terms of functional requirements in communication systems • select and apply suitable techniques of analysis and design to develop technical solutions • exercise professional responsibility in designing and assessing the effectiveness of solutions developed
Module contents	Circuit Design for Communication Systems Lecture
Module teaching methods	Lecture with combined exercises
Module language	English
Module availability	Winter semester
Module coordination	Prof. Dr.-Ing. Gernot Zimmer
Comments	None

Unit B.1: Circuit Design for Communication Systems Lecture

Unit title	Circuit Design for Communication Systems Lecture
Code	

Module title	Circuit Design for Communication Systems
Unit contents	• Overview of communication systems, standards, frequencies and circuit technologies • Transmission line theory and scattering parameters, • Amplifier design, low-noise amplifier, power amplifier, voltage controlled oscillators , phase lock-loops, transceiver requirements. • Examples of radio frequency ICs
Teaching methods	Lecture with combined exercises
Semester periods (hours) per week	4
Workload (h)	150 h
Class hours	60 h (of which exercises 15)
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	90 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Zimmer
Recommended reading	Medley M.,W.: Microwave and RF Circuits, Analysis, Synthesis and Design; Artech House, Boston Robertson, I.D.; Lucyszn, S.: RFIC and MMIC design and technology Institution of Electrical Engineers, London Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Modul C

Module title	Software Engineering
Module number	C
Module code	
Study program	Information Technology (viersemestrig)
Module usability	
Module duration	One semester
Recommended semester	1st semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Programming
Module prerequisites	None
Module examination requirements	None
Module examination	written project report (submission period 8 weeks, processing time 20 hours) with presentation (min. 5, max. 10 minutes)
Learning outcomes and skills	The students will be able to explain software engineering techniques and achieve the ability to evaluate the engineering perspective of software projects. Upon completion of the module the students are able to: 1. Prepare and analyze the entire software lifecycle 2. Gather compare and contrast appropriate information needed to perform a requirements specification 3. Write requirements specification documents 4. Design and develop software 5. Plan and create suitable software tests, create appropriate test data and run a software integration test, a system test or a component test 6. Manage and judge a software prototyping process as well as a conventional software development process 7. Evaluate quality management techniques to a software development process
Module contents	Software Engineering Lecture Software Engineering Project
Module teaching methods	Lecture, project
Module language	English
Module availability	Winter semester
Module coordination	Prof. Dr. Andreas Pech
Comments	None

Unit C.1: Software Engineering Lecture

Unit title	Software Engineering Lecture
Code	
Module title	Software Engineering
Unit contents	Software Engineering models and activities. This course covers the entire software development life-cycle including planning, requirements analysis, requirements specification, and design. Emphasis is placed on advanced topics including prototyping, verification and validation, testing, and quality management. At least one of the following models: actor model, waterfall model, V-model, spiral model, iterative processes.
Teaching methods	Lecture
Semester periods (hours) per week	2
Workload (h)	30 h
Class hours	30 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	0 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Pech, Dobric
Recommended reading	Sommerville I.: Software Engineering, 10th Edition, Pearson 2016 Hay, D.: UML and Data Modeling, Technics Publications 2015 Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Unit C.2: Software Engineering Project

Unit title	Software Engineering Project
Code	

Module title	Software Engineering
Unit contents	Application of Software Engineering models and methods
Teaching methods	Project
Semester periods (hours) per week	2
Workload (h)	120 h
Class hours	30 h
Total time of examination incl. preparation (h)	The individual study (see below) includes the time of examination incl. preparation
Total time of individual study (h)	80 h
Total time of practical training (h)	10 h
Unit language	English
Lecturer	Pech, Dobric
Recommended reading	Sommerville I.: Software Engineering, 10th Edition, Pearson 2016 Hay, D.: UML and Data Modeling, Technics Publications 2015 Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Module D

Module title	Image Processing and Identification of Dynamic Systems
Module number	D
Module code	
Study program	Information technology (viersemestrig)
Module usability	None
Module duration	One semester
Recommended semester	1st semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Basics of Digital Signal Processing , Basics of Higher Mathematics
Module prerequisites	None
Module examination requirements	None
Module examination	Written examination, 90 minutes
Learning outcomes and skills	Upon completion of the module, the students are able to • create models of real world observations by using methods of image processing and methods of dynamic systems identification. • to plan and operate image processing systems under real world conditions and estimate parameters of discrete-time models of static and dynamic processes. • set up digital parametric test processes to evaluate the correctness of self-made or commercial software results. • use and explain methods of signal and process modelling to detect faults, failures and malfunctions and to operate fault diagnosis systems in the field of machine supervision
Module contents	Lectures combined with exercises in Image Processing Lectures combined with exercises in Identification of Dynamic Systems
Module teaching methods	Lectures combined with exercises
Module language	English
Module availability	Winter semester
Module coordination	Prof. Dr. Jungke
Comments	

Unit D.1: Lectures combined with exercises in Image Processing

Unit title	Lectures combined with exercises in Image Processing
Code	
Module title	Image Processing and Identification of Dynamic Systems
Unit contents	• modelling illumination and imaging • image transfer function, • spatial resolution, • contrast enhancement through illumination, • optics, camera technology, • image acquisition, image memory, image processing hardware, • pattern recognition algorithms for image
Teaching methods	Lectures combined with exercises
Semester periods (hours) per week	3
Workload (h)	90 h
Class hours	45 h, thereof exercises 15 h
Total time of examination incl. preparation (h)	The individual studies (see below) include the preparation for the module examination
Total time of individual study (h)	45 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Dr. Goerick
Recommended reading	Jähne, B: Digital Image Processing, Springer Bovik, A: Handbook of Imaging and Video Processing, Academic Press Gonzalez, R; Woods, R: Digital Image Processing, Prentice Hall Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Unit D.2: Lectures and Exercises in Identification of Dynamic Systems

Unit title	Unit 2: Lectures and Exercises in Identification of Dynamic Systems
Code	

Module title	Image Processing and Identification of Dynamic Systems
Unit contents	• Theoretical and experimental modelling of dynamic systems, • system identification using discrete deterministic and discrete stochastic signals, • least-squares estimation, • tasks and terminology of supervision and fault management of processes, • fault models, • discrete time dynamic process models, • signal models, • fault detection with signal models, • fault detection with process identification models
Teaching methods	Lectures combined with exercises
Semester periods (hours) per week	2
Workload (h)	60 h
Class hours	30 h (of which exercises 10h)
Total time of examination incl. preparation (h)	The individual studies (see below) include the preparation for the module examination
Total time of individual study (h)	30 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Prof. Dr. Jungke
Recommended reading	Isermann, Rolf: Identification of Dynamic Systems, Springer Press Vachtsevanos, George et al.: Intelligent Fault Diagnosis and Prognosis for Engineering Systems, Wiley – VCH Verlag Isermann, Rolf: Fault-Diagnosis Systems, Springer Press Additional up-to-date reading information will be provided at the beginning of the lecture period.
Assessment type and form of	
Assessment grading	
Comments	

Module E

Module title	IT-Security
Module number	E
Module code	
Study program	Information Technology (viersemestrig)
Module usability	
Module duration	One semester
Recommended semester	1st semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	
Module prerequisites	None
Module examination requirements	None
Module examination	Written examination (90 minutes)
Learning outcomes and skills	Upon completion of the module the students are able to : - explain and compare advanced concepts of IT Security - identify IT Security aims and risks - implement IT security solutions, concepts and methods - apply structured problem solving approaches - outline and assess the economic and social impact of IT security - demonstrate advanced technical English writing skills
Module contents	IT Security Lecture IT Security Exercise
Module teaching methods	Lecture, Excercise
Module language	English
Module availability	Winter semester
Module coordination	Prof. Dr.-Ing. Sven Kuhn
Comments	

Unit E.1: IT Security Lecture

Unit title	IT Security Lecture
Code	
Module title	IT Security

Unit contents	Selection from areas such as, but not limited to: - Cryptographical principles and methods - Authentification - Operating system security - Application security - Malware - Network security - Firewalls - Virtual private networks - Network surveillance - Availability - Network applications - Security of realtime communications - Local network security - Standards - Practical implications
Teaching methods	Lecture
Semester periods (hours) per week	2
Workload (h)	70 h
Class hours	30 h
Total time of examination incl. preparation (h)	10 h
Total time of individual study (h)	30 h
Total time of practical training (h)	
Unit language	English
Lecturer	N.N.
Recommended reading	Martin Kappes, Netzwerk- und Datensicherheit, Teubner Verlag, Wiesbaden, 2007. Claudia Eckert, IT-Sicherheit: Konzepte, Verfahren, Protokolle, Oldenbourg-Verlag, München, 2009.
Assessment type and form of	
Assessment grading	
Comments	

Unit E.2: IT Security Exercise

Unit title	Exercise IT Security
Code	
Module title	IT-Security
Unit contents	Selection from areas such as, but not limited to: - Cryptographical principles and methods - Authentification - Operating system security - Application security - Malware - Network security - Firewalls - Virtual private networks - Network surveillance - Availability - Network applications - Security of realtime communications - Local network security - Standards - Practical implications
Teaching methods	Exercise
Semester periods (hours) per week	2
Workload (h)	80 h
Class hours	30 h
Total time of examination incl. preparation (h)	10 h
Total time of individual study (h)	40 h
Total time of practical training (h)	
Unit language	English
Lecturer	N.N.
Recommended reading	Martin Kappes, Netzwerk- und Datensicherheit, Teubner Verlag, Wiesbaden, 2007. Claudia Eckert, IT-Sicherheit: Konzepte, Verfahren, Protokolle, Oldenbourg-Verlag, München, 2009.
Assessment type and form of	
Assessment grading	

Comments	

Module F

Module title	Cultural Diversity and Business Ethics
Module number	F
Module code	
Study program	Information Technology (viersemestrig)
Module usability	
Module duration	One semester
Recommended semester	1st semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	None
Module prerequisites	None
Module examination requirements	None
Module examination	Written paper (submission period 4 weeks) with presentation (min. 15, max. 30 min)
Learning outcomes and skills	The students will be able to • define and describe the concepts "culture", "cultural diversity" and "cultural diversity management" (e.g. the concepts of Schein & Adler, Hofstede, Trompenaars) • apply core-concepts of the relevant theory to cross-cultural situations • explore and use different standards of verbal and nonverbal communication styles (e.g. styles for greetings and partings, initiating and concluding business discussions, body language, personal space, listening) • analyze and reflect on his / her own communication style • reflect on his / her own attitudes and biases • specify the requirements of managers working in intercultural environment • perceive and understand German characteristics (e.g. history, democracy, values, dignity, clichés) • distinguish between ethics and morale • describe and apply ethical theories and principles • describe and assess Business Ethics Management strategies and instruments They will be able to apply these insights so they can

	• show sensitivity regarding cultural and ethical issues • comprehend the complexity of cultural and ethical problems • take decisions regarding cultural and ethical dilemmas and reflect them
Module contents	Cultural Diversity Business Ethics
Module teaching methods	Lecture
Module language	English
Module availability	Winter semester
Module coordination	Prof. Dr. Barbara Lämmlein
Comments	

Unit F.1: Cultural Diversity

Unit title	Cultural Diversity
Code	
Module title	Cultural Diversity and Business Ethics
Unit contents	• Cultural diversity and cultural diversity management (definition, advantages, risks) • Culture and culture dimensions (e.g. definitions of Schein & Adler, Hofstede, Trompenaars) • Communicating effectively across cultures • Intrapersonal and interpersonal awareness • Intercultural management • Introduction to German characteristics
Teaching methods	Seminar type class with exercises
Semester periods (hours) per week	2
Workload (h)	75 h
Class hours	30 h
Total time of examination incl. preparation (h)	11 h
Total time of individual study (h)	34 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Prof. Dr. Barbara Lämmlein Prof. Dr. Martina Voigt Associated lecturers

Recommended reading	• Hampden-Turner, C., & Trompenaars, F. (2012). Riding the Waves of Culture: Understanding cultural diversity in business. New York: McGraw-Hill. • Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). Cultures and Organizations - Software of the Mind: Intercultural cooperation and its importance for survival (3 ed.). New York: McGraw-Hill. • Solomon, C., & Schell, M. S. (2009). Managing Across Cultures: The Seven Keys to Doing Business with a Global Mindset. New York: McGraw-Hill. • UNESCO World Report: Investing in Cultural Diversity and Intercultural Dialogue.
Assessment type and form of	
Assessment grading	
Comments	

Unit F.2: Business Ethics

Unit title	Business Ethics
Code	
Module title	Cultural Diversity and Business Ethics
Unit contents	• Differentiation between ethics and morale • Ethical theories and principles • Diverging interests of stakeholders and ethical dilemmas • Situational and non-situational factors of ethical behavior • Implications on leadership • Instruments of business ethics management (e.g. CSR, corruption prevention, whistleblowing) • Case studies (current topics)
Teaching methods	Seminar type class with exercises
Semester periods (hours) per week	2
Workload (h)	75 h
Class hours	30 h
Total time of examination incl. preparation (h)	11 h
Total time of individual study (h)	34 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Prof. Dr. Barbara Lämmlein

	Associated lecturers
Recommended reading	• Holmes, R. (2018). *Introduction to Applied Ethics.* London: Bloomsbury. • O'Sullivan, P., Smith, M., & Esposito, M. (Eds.). (2012). *Business Ethics. A Critical Approach: integrating ethics across the business world* London, New York: Routledge. • Schwartz, M. S. (2017). *Business Ethics. An Ethical Decision-Making Approach.* West Sussex: Wiley. • *Business Ethics: A European Review*. Wiley. • The Journal of Business Ethics. Springer.
Assessment type and form of	
Assessment grading	
Comments	

Module 1

Module title	Vector Analysis
Module number	1
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	2nd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	The module is based on knowledge or skills in Analysis and Linear Algebra acquired in an appropriate Bachelor course for this Master course.
Module prerequisites	none
Module examination requirements	none
Module examination	Written examination (90 minutes)
Learning outcomes and skills	Upon completion of the module the students are able to: • summarize the basic ideas of Vector Spaces. • explain the concepts of Linear Independency, Coordinates and Bases of Vector Spaces. • use the scalar product and dot product in Euclidian Spaces to solve geometric problems in 3 dimensional spaces. • Apply vector equations of lines and planes to describe geometric problems. • recognize vector functions in the subject-specific environment of the program and apply the methods of integral and differential calculus to them. In particular, describe movements, speeds and accelerations of objects in space using parametric curves and determine their properties such as arc length and curvature. name and explain the concepts of scalar fields and vector fields • describe the extensions of the Differential Calculus to scalar fields. • compute extrema and extrema with constraints of scalar fields. • name the concepts of multiple integrals. • apply Iterated Integrals and integration by substitution to calculate volumes. • recognize the different types of integrals volume (integral, line integral and surface and the integral theorems) relating to these types of integrals. • transfer the integral theorems to applications and to the context of electrical engineering. transfer the mathematical knowledge about scalar and vector fields to describe and solve engineering problems.

Module contents	Vector analysis
Module teaching methods	Lectures combined with exercises in Vector Analysis
Module language	English
Module availability	Winter semester
Module coordination	Prof. Dr. Egbert Falkenberg
Comments	

Unit 1.1: Lectures combined with exercises in Vector Analysis

Unit title	Lectures combined with exercises in Vector Analysis
Code	1
Module title	Vector Analysis

Unit contents	• Vector Calculus
	  ○ Definition and Examples of Vector Spaces and Subspaces
	  ○ Linear Independence, Coordinates and Bases
	  ○ Euclidean Spaces
	• Vector Functions
	  ○ Definition, Limits, Continuity
	  ○ Derivatives and Integrals
	  ○ Arc Length and Curvature
	  ○ Basic properties of Curves
	• Scalar Fields: Function of Several Variables
	  ○ Definition, Examples and Visualizations
	  ○ Limits and Continuity
	  ○ Partial Derivatives
	  ○ Tangent Plane
	  ○ Chain Rule
	  ○ Implicit Functions
	  ○ Extremas
	  ○ Extrema with Constraints
	• Vector Fields
	  ○ Definition and Examples
	  ○ Gradient Fields
	  ○ Line Integrals
	  ○ Independence of the Path
	  ○ Existence of Potentials
	  ○ Conservation of Energy
	  ○ Green's Theorem
	  ○ Surface Integrals
	  ○ Stokes Theorem
	  ○ Divergence Theorem

Teaching methods	Lectures combined with exercises
Semester periods (hours) per week	4
Workload (h)	150 h
Class hours	60 h, including 15 h exercises
Total time of examination incl. preparation (h)	10 h

Total time of individual study (h)	80 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Falkenberg
Recommended reading	• H. Anton, Calculus A new horizon, 9th Edition, John Wiley and Sons, New York, 2009 • H. Anton, Elementary Linear Algebra, 10th edition, John Wiley and Sons, New York, 2010 • J. Stewart, Calculus Early Transcendentals, Sixth Edition, Thomson Brooks/Cole, Canada, 2008
Assessment type and form of	
Assessment grading	
Comments	

Module 2

Module title	Stochastic Signals and System
Module number	2
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	2nd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Probability calculus Matlab
Module prerequisites	None
Module examination requirements	Exercises (processing time: 30 hours)
Module examination	Written examination (120 minutes)
Learning outcomes and skills	Upon completion of the module the students are able to: • analyze stochastic processes in information and communication systems, judge estimation methods for parameter estimation on stochastic signals, summarize the theory of non-recursive and recursive optimum systems, • choose appropriate optimum systems for information and communication, • create recursive estimators and predictors, describe colored noise as well as correlated measurement noise, create extended Kalman filters.
Module contents	Stochastic Signals and Systems Lecture Stochastic Signals and Systems Exercises
Module teaching methods	Lectures, exercises
Module language	English
Module availability	Summer semester
Module coordination	Prof. Dr. Andreas Pech
Comments	

Unit 2.1: Stochastic Signals and Systems Lecture

Unit title	Stochastic Signals and Systems Lecture

Code	
Module title	Stochastic Signals and Systems
Unit contents	Random processes: • Fundamentals of linear and nonlinear systems. • Fundamentals of estimation and prediction. • Maximum likelihood estimation and other estimation methods and their properties. Optimum systems: • Optimum non-recursive estimation. • Wiener-Hopf equation. • Optimum recursive estimation. • Kalman filter. • Colored noise, correlated measurement noise. • Nonlinear minimum variance estimation. • Extended Kalman filter.
Teaching methods	Lecture
Semester periods (hours) per week	3
Workload (h)	60 h
Class hours	45 h
Total time of examination incl. preparation (h)	The individual study (see below) includes the time of examination incl. preparation
Total time of individual study (h)	15 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Pech
Recommended reading	Ash, C.: The probability Tutoring Book, IEEE Press 1993. Cariolaro, G.: Unified Signal Theory, Springer 2011. Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Unit 2.2: Stochastic Signals and Systems Exercises

Unit title	Stochastic Signals and Systems Exercises

Code	
Module title	Stochastic Signals and Systems
Unit contents	Six exercises on Stochastic Signals and Systems
Teaching methods	Exercise
Semester periods (hours) per week	2
Workload (h)	90 h
Class hours	30 h
Total time of examination incl. preparation (h)	The individual study (see below) includes the time of examination incl. preparation
Total time of individual study (h)	60 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Pech
Recommended reading	Ash, C.: The probability Tutoring Book, IEEE Press 1993. Cariolaro, G.: Unified Signal Theory, Springer 2011. Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	The students submit each exercise solution within one week after issue. Each submitted exercise will be assessed (“passed” or “failed”).
Assessment grading	4 or more passed exercises: “passed” Less than 4 passed exercises: “failed”
Comments	

Module 3

Module title	Digital Baseband Transmission and Modulation Methods
Module number	3
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	one semester
Recommended semester	2nd semester
Module type	compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Basics of Transmission / Communications Engineering, Basics of Higher Mathematics
Module prerequisites	None
Module examination requirements	None
Module examination	Written examination, 90 minutes
Learning outcomes and skills	Upon completion of the module the students are able to • explain the purpose for modulation either in baseband or in another frequency band. • choose an appropriate transmission method for a given use case. • design the system architecture and specify the hardware and the software structure of transmission nodes. • justify the choice of the modulation technique according to the transmission channel. • estimate the correctness of the received signals.
Module contents	Digital Baseband Transmission and Modulation Methods Lectures
Module teaching methods	Lectures combined with exercises
Module language	English
Module availability	Summer semester
Module coordination	Prof. Dr.-Ing. Kira Kastell
Comments	Parts of the lecture may contain online content

Unit 3.1: Digital Baseband Transmission and Modulation Methods Lectures

Unit title	Digital Baseband Transmission and Modulation Methods Lectures

Code	
Module title	Digital Baseband Transmission and Modulation Methods
Unit contents	Digital baseband transmission: • pulse shaping, • eye-diagram, • sampling, • Nyquist criteria, • special filters, • line coding. Modulation: • amplitude shift keying (ASK), • frequency shift keying (FSK), • phase shift keying (PSK), • continuous phase frequency shift keying (CPFSKK), • amplitude phase shift keying (APK), • continuous phase modulation (CPM), • prerequisites for demodulation basics of optical transmission, • probability considerations for the choice of modulation methods and demodulation
Teaching methods	Lectures combined with exercises
Semester periods (hours) per week	4
Workload (h)	150 h
Class hours	60 h
Total time of examination incl. preparation (h)	10 h
Total time of individual study (h)	80 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Kastell, Dankmeier
Recommended reading	Haykin, Simon; Moher, Michael: An Introduction to Digital and Analog Communications, Wiley 2006. Proakis, John G.; Salehi, Masoud: Digital Communications, McGraw-Hill Education 2007. Proakis, John G.; Salehi, Masoud: Fundamentals of Communication Systems, Pearson 2013. Lecture notes
Assessment type and form of	None
Assessment grading	None

Comments	None

Module 4

Module title	Cloud Computing
Module number	4
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	2nd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Programming
Module prerequisites	Module C: Software Engineering
Module examination requirements	None
Module examination	written project report (submission period 8 weeks, processing time 20 hours), with presentation (min. 5, max. 10 minutes)
Learning outcomes and skills	Upon completion of the module the students are able to: • analyze, design, validate and judge cloud computing systems, • facilitate situation-specific problem-solving solutions by acting in a constructive and conceptual manner, • assess their own project management capabilities, • use fact-based frameworks of actions and decisions autonomously and develop them further under guidance, • present results to a specialist audience and discuss conclusions, • assess the ethical and societal dimensions of applications.
Module contents	Cloud Computing Lecture Cloud Computing Project
Module teaching methods	List the forms of teaching of the individual units (PO/ER)
Module language	English
Module availability	Summer semester
Module coordination	Prof. Dr. Andreas Pech
Comments	

Unit 4.1: Cloud Computing Lecture

Unit title	Cloud Computing Lecture
Code	
Module title	Cloud Computing
Unit contents	• Introduction (Software as a Service etc.), • cloud storage, • computation (virtual machine, jobs, containers, serverless computation); • Actor programming model, • Architecture of cloud solutions.
Teaching methods	Lecture
Semester periods (hours) per week	2
Workload (h)	30 h
Class hours	30 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	0 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Pech, Dobric
Recommended reading	Erl, T; Mahmood, Z..; Puttini, R..: Cloud Computing, Prentice Hall, 2014. Kavis, M.J.: Architecting the Cloud, Wiley 2014 .
Assessment type and form of	
Assessment grading	
Comments	

Unit 4.2: Cloud Computing Project

Unit title	Cloud Computing Project
Code	
Module title	Cloud Computing
Unit contents	Creation of a cloud computing application

Teaching methods	Project
Semester periods (hours) per week	2
Workload (h)	120 h
Class hours	30 h
Total time of examination incl. preparation (h)	The individual study (see below) includes the time of examination incl. preparation
Total time of individual study (h)	80 h
Total time of practical training (h)	10 h
Unit language	English
Lecturer	Pech, Dobric
Recommended reading	Erl, T; Mahmood, Z..; Puttini, R..: Cloud Computing, Prentice Hall, 2014. Kavis, M.J.: Architecting the Cloud, Wiley 2014.
Assessment type and form of	
Assessment grading	
Comments	

Module 5

Module title	Digital Switching and Routing
Module number	5
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	2nd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Recommended prerequisites: Modul A – Methods, Systems and Networks for Digital Communication
Module prerequisites	None
Module examination requirements	Laboratory exercises (processing time 20 hours)
Module examination	Written examination, 90 minutes
Learning outcomes and skills	Upon completion of the module the students are able to: • explain the development, planning and operation of switching and routing systems; • analyse, specify and develop protocols and network nodes for switching and routing • identify correlations in complex systems • analyse systems and their optimization potential • manage application-oriented projects in a largely self-directed manner. • integrate existing – Ethernet, IPv4, MPLS – and new knowledge – IPv6, SDN – and handle complexity in networks based on the mentioned technologies • apply switching and routing networks in a largely self-directed manner • assess the ethical and societal dimensions of massive networking
Module contents	Lectures in Digital Switching and Routing Digital Switching and Routing Laboratory
Module teaching methods	Lectures combined with exercises Lab experiments
Module language	English
Module availability	Summer semester

Module coordination	Trick
Comments	

Unit 5.1: Lectures in Digital Switching and Routing

Unit title	Lectures in Digital Switching and Routing
Code	
Module title	Digital Switching and Routing
Unit contents	Ethernet switching: bridge, switch, backward learning, spanning tree protocol IP-Routing: IP network structure, routing, routing strategies, routing protocols QoS: overprovisioning, traffic engineering, IntServ, DiffServ IPv6: IPv6 versus IPv4, IPv6 header, IPv6 addresses, ICMPv6, NDP, DHCPv6, IPv4-IPv6 migration, different migration mechanisms MPLS (Multiprotocol Label Switching): architecture, functionality, protocols SDN (Software Defined Networking): architecture, functionality, protocols
Teaching methods	Lecture / Exercises
Semester periods (hours) per week	3
Workload (h)	75 h
Class hours	45 h
Total time of examination incl. preparation (h)	15 h
Total time of individual study (h)	15 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Trick
Recommended reading	Trick, Ulrich; Weber, Frank: SIP und Telekommunikationsnetze – Next Generation Networks und Multimedia over IP – konkret. De Gruyter Oldenbourg, 2015 Stallings, William: Data and Computer Communications. Pearson, 2010 Tanenbaum, Andrew S.; Wetherall, David: Computer Networks. Pearson, 2010 Monge, Antonio; Szarkowicz, Krzysztof: MPLS in the SDN Era – Interoperable Scenarios to Make Networks Scale to New Services. O´Reilly, 2016

	Göransson, Paul; Black, Chuck: Software Defined Networks – A Comprehensive Approach. Morgan Kaufmann, 2016 Additional up-to-date reading information will be announced at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Unit 5.2: Digital Switching and Routing Laboratory

Unit title	Digital Switching and Routing Laboratory
Code	
Module title	Digital Switching and Routing
Unit contents	Experiment 1: SIP based communication infrastructure Experiment 2: IPv4 and IPv6 Experiment 3: Routing
Teaching methods	Lab Experiments
Semester periods (hours) per week	3
Workload (h)	75 h
Class hours	15 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	30 h
Total time of practical training (h)	30 h
Unit language	English
Lecturer	Trick
Recommended reading	Trick, Ulrich; Weber, Frank: SIP und Telekommunikationsnetze – Next Generation Networks und Multimedia over IP – konkret. De Gruyter Oldenbourg, 2015 Stallings, William: Data and Computer Communications. Pearson, 2010 Tanenbaum, Andrew S.; Wetherall, David: Computer Networks. Pearson, 2010 Monge, Antonio; Szarkowicz, Krzysztof: MPLS in the SDN Era – Interoperable Scenarios to Make Networks Scale to New Services. O´Reilly, 2016 Göransson, Paul; Black, Chuck: Software Defined Networks – A

	Comprehensive Approach. Morgan Kaufmann, 2016 Worksheets. Additional up-to-date reading information will be announced at the beginning of the lecture.
Assessment type and form of	Laboratory exercises (processing time 20 hours)
Assessment grading	Passed/failed
Comments	

Module 6

Module title	Computational Intelligence
Module number	6
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Mechatronik und Robotik (Master), Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	2nd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Differential calculus Discrete-time systems Programming Module 4: Image Processing and Identification of Dynamic Systems
Module prerequisites	None
Module examination requirements	None
Module examination	Written paper (submission period 6 weeks, processing time 20 hours) with presentation (min. 15, max. 20 minutes)
Learning outcomes and skills	Upon completion of the module the students are able to: • describe the theory of computational intelligence, • analyze real-world problems to develop strategies and algorithms for a problem solution and specify the respective hardware and software structure, • communicate their conclusions, the underlying assumptions and their reasoning to specialists and non-specialists both clearly and unambiguously on the basis of the state of research and application, • assess sociological aspects of intelligent algorithms, • analyze and reflect on his / her own communication style.
Module contents	Computational Intelligence Seminar
Module teaching methods	Presentation and supervised discussion
Module language	English
Module availability	Summer semester
Module coordination	Prof. Dr. Andreas Pech
Comments	

Unit 6.1: Computational Intelligence Seminar

Unit title	Computational Intelligence Seminar
Code	
Module title	Computational Intelligence
Unit contents	• Computational intelligence and knowledge • Uncertain knowledge • Machine Learning • Artificial neural networks • Convolutional neural networks • Deep learning • Additional topics, e.g. Fuzzy systems, reasoning system, classification, quantum computing, swarm intelligence, pattern recognition systems, learning strategies and algorithms, applications.
Teaching methods	Seminar
Semester periods (hours) per week	4 h
Workload (h)	150 h
Class hours	60 h
Total time of examination incl. preparation (h)	The individual study (see below) includes the time of examination incl. preparation
Total time of individual study (h)	90 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Pech
Recommended reading	Kruse, R. et al.: Computational Intelligence, Springer 2016. Goodfellow, I.; Bengio, Y.; Courville, A.: Deep Learning, MIT Press 2016.
Assessment type and form of	
Assessment grading	
Comments	

Module 7

Module title	Machine Learning
Module number	7
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	3rd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Module 6: Computational Intelligence Programming
Module prerequisites	Module 2: Stochastic Signals and Systems
Module examination requirements	Module 2: Stochastic Signals and Systems
Module examination	Written project report (submission period 8 weeks, processing time 20 hours) and presentation (min. 5, max. 10 minutes).
Learning outcomes and skills	Upon completion of the module the students are able to: • explain, compare and choose machine learning algorithms, • predict the efficiency of machine learning strategies, integrate existing and new knowledge, • handle complexity, even on the basis of limited information, • acquire new knowledge and skills independently, • develop research questions, • choose adequate ways of operationalizing research and explain their choices, • explain research results and interpret them critically, • present problem solutions in a structured manner, • communicate their conclusions, and the acquired knowledge to specialist and non-specialist audiences in a clear and unambiguous way, • evaluate the social-economic and ethical consequences of deep learning.
Module contents	Machine Learning Project
Module teaching methods	Project
Module language	English
Module availability	Winter semester

Module coordination	Prof. Dr. Andreas Pech
Comments	None

Unit 7.1: Machine Learning Project

Unit title	Machine Learning Project
Code	
Module title	Machine Learning
Unit contents	Individual Project
Teaching methods	Project
Semester periods (hours) per week	2 h
Workload (h)	150 h
Class hours	30 h
Total time of examination incl. preparation (h)	The individual study (see below) includes the time of examination incl. preparation
Total time of individual study (h)	120 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Pech
Recommended reading	Kubat, M.: An Introduction To Machine Learning, Springer 2017. Goodfellow, I.; Bengio, Y.; Courville, A.: Deep Learning, MIT Press 2016.
Assessment type and form of	
Assessment grading	
Comments	

Module 8

Module title	Mobile Computing
Module number	8
Module code	Module code
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	3rd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Recommended prerequisites: Modul 1 – Methods, Systems and Networks for Digital Communication, Module 3 – Software Engineering, Module 11 – Digital Switching and Routing
Module prerequisites	None
Module examination requirements	None
Module examination	software project report (submission period 10 weeks, processing time 20 hours) with presentation (min. 15, max. 20 minutes)
Learning outcomes and skills	Upon completion of the module the students are able to: • define and interpret the special features, limits, terminologies and schools of thought in the area of mobile computing communication technologies, GSM/UMTS cellular mobile networks, 5 G incl. NFV and SDN • communicate project results, conclusions as well as the underlying assumptions and reasoning to a specialist audience • manage an application-oriented project acc. to Mobile Computing topics in a largely self-directed manner • assess the ethical and societal dimensions of ubiquitous computing
Module contents	Lectures in Mobile Computing Mobile Computing Project incl. Presentation
Module teaching methods	Lectures Project
Module language	English
Module availability	Winter semester
Module coordination	Trick
Comments	

Unit 8.1: Lectures in Mobile Computing

Unit title	Lectures in Mobile Computing
Code	
Module title	Mobile Computing
Unit contents	Areas acc. to Mobile Computing, types of mobility, handover/roaming, mobility support at various layers, Mobile Computing communication technologies, GSM/UMTS cellular mobile networks, 5G incl. NFV (Network Functions Virtualisation), SDN (Software Defined Networking) Presentations on topics of Mobile Computing
Teaching methods	Lecture
Semester periods (hours) per week	2
Workload (h)	45 h
Class hours	30 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	15 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Trick
Recommended reading	Trick, Ulrich; Weber, Frank: SIP und Telekommunikationsnetze – Next Generation Networks und Multimedia over IP – konkret. De Gruyter Oldenbourg, 2015 Kamal, Devi: Mobile Computing. Oxford Univ. Pr., 2012 Zhang, Ying: Network function virtualization – Concepts and applicability in 5G Networks, Wiley, 2018 3GPP standards ETSI standards ITU-T standards Additional up-to-date reading information will be announced at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Unit 8.2: Mobile Computing Project

Unit title	Mobile Computing Project
Code	
Module title	Mobile Computing
Unit contents	Individual Mobile Computing Project
Teaching methods	Project
Semester periods (hours) per week	1
Workload (h)	105 h
Class hours	15 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	45 h
Total time of practical training (h)	45 h
Unit language	English
Lecturer	Trick
Recommended reading	Trick, Ulrich; Weber, Frank: SIP und Telekommunikationsnetze – Next Generation Networks und Multimedia over IP – konkret. De Gruyter Oldenbourg, 2015 Kamal, Devi: Mobile Computing. Oxford Univ. Pr., 2012 Zhang, Ying: Network function virtualization – Concepts and applicability in 5G Networks, Wiley, 2018 3GPP standards ETSI standards ITU-T standards Worksheets Additional up-to-date reading information will be announced at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Module 9

Module title	Field Theory for Optical and Microwave Systems
Module number	9
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	3rd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Vector analysis
Module prerequisites	None
Module examination requirements	None
Module examination	Written examination, 90 minutes
Learning outcomes and skills	By the end of the course, students are able to: • explain Maxwell's Equations, • formulate all boundary conditions, • formulate and solve the wave equation of a plane wave, • classify different wave solutions, • explain the modes of different wavequides • explain radiation of different antennas
Module contents	Lecture of Field Theory and Microwave Systems
Module teaching methods	Lecture, exercises
Module language	English
Module availability	Summer semester
Module coordination	Prof. Dr.-Ing. Gernot Zimmer
Comments	None

Unit 9.1: Field Theory for Optical and Microwave Systems Lecture

Unit title	Field Theory for Optical and Microwave Systems Lecture
Code	
Module title	Field Theory for Optical and Microwave Systems
Unit contents	• Introduction to Microwave and optical Systems,

	• History and application of electromagnetic spectrum, • Maxwell's equation in time and frequency domain, • constitutive relations, • boundary conditions, • plane wave, • Poynting vector, • classification of waves, • TEM TM and TE modes in different structures, • Hertzian dipol, • Radiation of linear and aperture antennas
Teaching methods	Lecture combined with exercises
Semester periods (hours) per week	4
Workload (h)	150 h
Class hours	60 h (of which exercises 15 h)
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	90 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Zimmer
Recommended reading	Collin, R.E.: Foundations for microwave engineering, McGraw Hill, NewYork Olver, A. D.: Microwave and Optical Transmission, John Wiley, New York Unger, H. G.: Elektromagnetische Theorie für die Hochfrequenztechnik, Hüthig-Verlag Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Module 10

Module title	Autonomous Intelligent Systems
Module number	10
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	3rd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	None
Module prerequisites	None
Module examination requirements	None
Module examination	Written project report (submission period 14 weeks, processing time 20 hours)
Learning outcomes and skills	Upon completion of the module the students are able to: • identify and explain the architecture, hardware and software of autonomous systems, • generate intelligent algorithms and apply them to intelligent sensors, action planning and decision making, • structure, write and deliver a project report within a given timeframe, • judge the impact of decision making in autonomous systems on society, • evaluate the social economic consequences of an industry highly automated by autonomous systems.
Module contents	Lectures in Autonomous Intelligent Systems Project in Autonomous Intelligent Systems
Module teaching methods	Lectures and project
Module language	English
Module availability	Winter semester
Module coordination	Prof. Dr. P. Nauth
Comments	

Unit 10.1: Lectures in Autonomous Intelligent Systems

Unit title	Lectures in Autonomous Intelligent Systems
Code	
Module title	Autonomous Intelligent Systems
Unit contents	Autonomous Systems: • Architecture, • hardware, • environmental sensing, • sensor fusion, • autonomous decision making, • planning, plan execution, • human machine interaction, • programming of autonomous systems Intelligent Sensors for Autonomous Systems: • Technology and characteristics of microcontrollers for intelligent sensors, • design of intelligent sensors, • programming of algorithms for signal processing and pattern recognition, • examples of intelligent sensors for applications in autonomous systems Actors: • Types of actors, actor control
Teaching methods	Lecture
Semester periods (hours) per week	2
Workload (h)	45 h
Class hours	30 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	15 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Prof. Dr. P. Nauth
Recommended reading	H.-N.Teodorescu, D.Mlynek, A.Kandel, H.-J.Zimmermann: Intelligent Systems and Interfaces, Springer Verlag, 2000 P. Nauth: Embedded Intelligent Systems, Oldenbourg Verlag, 2005 Additional up-to-date reading information will be provided at the

	beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Unit 10.2: Project in Autonomous Intelligent Systems

Unit title	Project in Autonomous Intelligent Systems
Code	
Module title	Autonomous Intelligent Systems
Unit contents	Projects regarding design, programming and application of autonomous systems
Teaching methods	Project
Semester periods (hours) per week	1
Workload (h)	105 h
Class hours	15 h
Total time of examination incl. preparation (h)	The self-study (see below) includes the preparation for the module examination.
Total time of individual study (h)	90 h
Total time of practical training (h)	The self-study and contact time (see above) includes the practical training.
Unit language	English
Lecturer	Prof. Dr. Nauth
Recommended reading	H.-N. Teodorescu, D. Mlynek, A. Kandel, H.-J. Zimmermann: Intelligent Systems and Interfaces, Springer Verlag, 2000 P. Nauth: Embedded Intelligent Systems, Oldenbourg Verlag, 2005 Worksheets
Assessment type and form of	
Assessment grading	
Comments	

Optional Module 11.1

Module title	Engineering of Microwave Systems
Module number	11.1
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	3rd semester
Module type	Elective module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Circuit Design for Communication Systems
Module prerequisites	None
Module examination requirements	None
Module examination	Written project report (submission period 8 weeks, processing time 20 hours) with presentation (min. 10, max. 20 minutes)
Learning outcomes and skills	Upon completion of the module the students are able to: • describe, explain and compare different system architectures in the field of microwaves • identify the requirements of a selected system architecture and illustrate the design process • communicate project results, conclusions as well as the underlying assumptions and reasoning to a specialist audience • to do independent work in the domain of microwave engineering.
Module contents	Engineering of Microwave Systems Lecture Engineering of Microwave Systems Project
Module teaching methods	Lecture, project
Module language	English
Module availability	Winter semester
Module coordination	Prof. Dr.-Ing. Gernot Zimmer
Comments	None

Unit 11.1.1: Engineering of Microwave Systems Lecture

Unit title	Engineering of Microwave Systems Lecture
Code	

Module title	Engineering of Microwave Systems
Unit contents	System architecture of different microwave systems e.g. Wireless LANs, microwave sensors; component requirements to design and build the physical layers
Teaching methods	Lecture
Semester periods (hours) per week	3
Workload (h)	45 h
Class hours	45 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	0 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Zimmer
Recommended reading	Collin, R.E.: Foundations for microwave engineering, McGraw Hill, NewYork Olver, A. D.: Microwave and Optical Transmission, John Wiley, New York Unger, H. G.: Elektromagnetische Theorie für die Hochfrequenztechnik, Hüthig-Verlag Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Unit 11.1.2: Engineering of Microwave System Project

Unit title	Engineering of Microwave System Project
Code	
Module title	Engineering of Microwave System
Unit contents	Application of Microwave Engineering models and methods
Teaching methods	Project
Semester periods (hours) per week	1

Workload (h)	105 h
Class hours	15 h
Total time of examination incl. preparation (h)	The individual study (see below) includes the time of examination incl. preparation
Total time of individual study (h)	75 h
Total time of practical training (h)	15 h
Unit language	English
Lecturer	Zimmer
Recommended reading	Collin, R.E.: Foundations for microwave engineering, McGraw Hill, NewYork Olver, A. D.: Microwave and Optical Transmission, John Wiley, New York Unger, H. G.: Elektromagnetische Theorie für die Hochfrequenztechnik, Hüthig-Verlag Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Optional Module 11.2

Module title	Engineering of Optical Systems
Module number	11.2
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	3rd semester
Module type	Elective module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	Circuit Design for Communication Systems
Module prerequisites	None
Module examination requirements	None
Module examination	Written project report (submission period 8 weeks, processing time 20 hours) with presentation (min. 10, max. 20 minutes)
Learning outcomes and skills	Students acquire knowledge of different theoretical system architectures in the field of optics. They understand the design process and the requirements of the selected system architectures. They acquire practical knowledge to develop computer supported optical design. On successful completion of the Module the students are able to: • Calculate and measure system parameters of optical systems • Research appropriate information to perform requirements specification • Analyze and optimize optical systems • Consider the different specifications of optical systems and realize a computer supported optical systems They are able to organize a technical project and work together in a team. They are able to present and discuss the approach.
Module contents	Engineering of Optical Systems Lecture Engineering of Optical Systems Project
Module teaching methods	Lecture, project
Module language	English
Module availability	Winter semester
Module coordination	Prof. Dr.-Ing. Gernot Zimmer

Comments	None

Unit 11.2.1: Engineering of Optical Systems Lecture

Unit title	Engineering of Optical Systems Lecture
Code	
Module title	Engineering of Optical Systems
Unit contents	Selected system architectures in the domain of optical engineering e.g. modulation and noise behaviour of semiconductor lasers and photo detectors; system architecture of different optical systems e.g. optical LANs or optical sensors; component requirements to design and build the physical layers
Teaching methods	Lecture
Semester periods (hours) per week	3
Workload (h)	45 h
Class hours	45 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	0 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Zimmer
Recommended reading	Collin, R.E.: Foundations for microwave engineering, McGraw Hill, NewYork Olver, A. D.: Microwave and Optical Transmission, John Wiley, New York Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Unit 11.2.2: Engineering of Optical Systems Project

Unit title	Engineering of Optical Systems Project
Code	

Module title	Engineering of Optical Systems
Unit contents	Application of Optical Engineering models and methods
Teaching methods	Project
Semester periods (hours) per week	1
Workload (h)	105 h
Class hours	15 h
Total time of examination incl. preparation (h)	The individual study (see below) includes the time of examination incl. preparation
Total time of individual study (h)	75 h
Total time of practical training (h)	15 h
Unit language	English
Lecturer	Zimmer
Recommended reading	Collin, R.E.: Foundations for microwave engineering, McGraw Hill, NewYork Olver, A. D.: Microwave and Optical Transmission, John Wiley, New York Additional up-to-date reading information will be provided at the beginning of the lecture.
Assessment type and form of	
Assessment grading	
Comments	

Module 12

Module title	Project
Module number	12
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	3rd semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	5 CP / 150 h
Recommended previous knowledge	
Module prerequisites	None
Module examination requirements	None
Module examination	Written project report (submission period 22 weeks, processing time 20 hours) with presentation (min. 10, max. 20 minutes)
Learning outcomes and skills	Upon completion of the module the students are able to • do requirements engineering and to evolve problem solution strategies, • present technical projects to an expert audience, • integrate existing and new knowledge, • handle complexity, even on the basis of limited information, • acquire new knowledge and skills independently, • develop research questions, choose adequate ways of operationalizing research and explain their choices, • explain research results and interpret them critically, • respect cultural and social aspects of project work in international R&D teams.
Module contents	Project
Module teaching methods	Project
Module language	English
Module availability	Every semester
Module coordination	Prof. Dr. Andreas Pech
Comments	None

Unit 12.1: Project

Unit title	Project
Code	
Module title	Project
Unit contents	Depending on project subject
Teaching methods	Project
Semester periods (hours) per week	0 h
Workload (h)	150 h
Class hours	0 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	150 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	Pech
Recommended reading	
Assessment type and form of	
Assessment grading	
Comments	

Module 13

Module title	Master Thesis and Colloquium
Module number	13
Module code	
Study program	Information Technology (viersemestrig)
Module usability	Information Technology (dreisemestrig)
Module duration	One semester
Recommended semester	4th semester
Module type	Compulsory module
ECTS (CP) / Workload (h)	30 CP / 900 h
Recommended previous knowledge	
Module prerequisites	Successful completion of modules A to F and 1 to 12
Module examination requirements	Successful completion of modules A to F and 1 to 12
Module examination	Master Thesis (processing time 22 weeks) and colloquium (min. 30, max. 45 minutes)
Learning outcomes and skills	Upon completion of the master thesis the student is able to: • plan, organize, develop, operate and present information technology systems answering to real world requirements. • assess the science-based correctness by weighing up scientific and methodological considerations. • solve practical and scientific problems by taking into account these considerations.
Module contents	Master Thesis
Module teaching methods	Master Thesis
Module language	English
Module availability	Every semester
Module coordination	Prof. Dr. Andreas Pech
Comments	None

Unit 13.1: Master Thesis

Unit title	Master Thesis
Code	
Module title	Master Thesis and Colloquium

Unit contents	Depending on master thesis subject
Teaching methods	Master Thesis
Semester periods (hours) per week	0 h
Workload (h)	880 h
Class hours	0 h
Total time of examination incl. preparation (h)	0 h
Total time of individual study (h)	0 h
Total time of practical training (h)	0 h
Unit language	English
Lecturer	All professors of the Information Technology program
Recommended reading	
Assessment type and form of	
Assessment grading	
Comments	

Unit 13.2: Colloquium

Unit title	Colloquium
Code	
Module title	Master Thesis and Colloquium
Unit contents	Colloquium
Teaching methods	
Semester periods (hours) per week	0 h
Workload (h)	20 h
Class hours	0 h
Total time of examination incl. preparation (h)	20 h
Total time of individual study (h)	0 h
Total time of practical training (h)	0 h
Unit language	English

Lecturer	All professors of the Information Technology program
Recommended reading	
Assessment type and form of	
Assessment grading	
Comments	