B.Sc. Biomedical Engineering (PO 2018)

Module manual
Date: 01.09.2021

TECHNISCHE UNIVERSITÄT DARMSTADT

Department of Electrical Engineering and Information Technology

Module manual: B.Sc. Biomedical Engineering (PO 2018)

Date: 01.09.2021

Department of Electrical Engineering and Information Technology
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Contents

1 Fundamentals of Electrical Engineering and Information Technology

Module name Electrical Engineering and Information Technology I					
Module Nr. 18-hs-1070	**Credit Points** 7 CP	**Workload** 210 h	**Self study** 135 h	**Duration** 1	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr.-Ing. Jutta Hanson		

1	**Content** Units and Equations: Unit systems, equation writing. Basic definitions: Charge, current, voltage, resistance, energy and power. Currents and voltages in electrical circuits: Ohmic law, node and mesh equations, parallel and series connections, current and voltage measurement, linear and nonlinear elements, superposition method, star-delta-transformation, node and mesh analysis in linear circuits, controlled sources. AC systems: Time-dependent currents and voltages, steady-state mode sinusoidal currents and voltages in linear RLC-circuits, phasor diagrams, resonances in RLC circuits, AC power, locus diagrams, two-port networks, transformer, polyphase systems.
2	**Learning objectives / Learning Outcomes** Students will be able after visiting this lecture * to utilize the basic equations in electrical engineering, * to determine the currents and voltages in linear and nonlinear circuits, * to analyze DC and AC systems, * to calculate simple filter and resonant circuits, * to apply the complex calculation in electrical AC systems.
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Weighting: 100 %)
6	**Usability of this module** BSc. ETiT, BSc iST, BSc MEC, BSc. Wi-ETiT, BSc CE, LA Physik/Mathematik
7	**Grade bonus compliant to §25 (2)**
8	**References** Frohne, H. u.a. Moeller Grundlagen der Elektrotechnik Clausert, H. u.a. Grundgebiete der Elektrotechnik 1 + 2
Courses	

	Course Nr. 18-hs-1070-vl	**Course name** Electrical Engineering and Information Technology I		
	Instructor Prof. Dr.-Ing. Jutta Hanson		**Type** Lecture	**SWS** 3
	Course Nr. 18-hs-1070-ue	**Course name** Electrical Engineering and Information Technology I		
	Instructor Prof. Dr.-Ing. Jutta Hanson		**Type** Practice	**SWS** 2

Module name Electrical Engineering and Information Technology Lab I					
Module Nr. 18-kn-1040	**Credit Points** 4 CP	**Workload** 120 h	**Self study** 60 h	**Duration** 2	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr. Mario Kupnik		

1 Content

After a safety instruction for electrical equipment, students dolab experiments covering foundations of electrical engineering by using theoretical and experimental instructions to improve basic electrical understanding. Building up a test set autonomously and performing of measurements and evaluations in the form of logs to confirm the theoretical knowledge and lead to independent work in practice.
The following experiments are performed:

- Investigate real behavior of ohmic resistors
- Investigate real behavior of capacitors and inductors
- Calculate impedances of basic two-terminal circuits using network theory
- Measure of electrical power in AC circuits and investigate in the real behaviour of transformers
- DC technology, capacity and inductors, AC technology - Impedances and two-terminal circuits, transformer & power;

2 Learning objectives / Learning Outcomes

After preparing the afternoons independently and self-implementing the measurement setup and measurement tasks by active participation in the practical group and by thorough preparation of the associated measurement protocols, you should be able to:

- Perform the measurement of basic electrical parameters of DC and AC circuits, independently and in compliance with safety rules
- measuring the frequency response of passive electrical networks and resonant circuits, and electric power measurement
- the measurement of circuits for the determination of magnetic, electro-thermal and high-frequency. You have to be able to build and run your own measurements
- interpretations of the measurement results in terms of its technical meaning, but also their accuracy and error sources safely.

3 Recommended prerequisite for participation

Parallel attending the lectures and exercises, “Electrical Engineering I and II”

4 Form of examination

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

5 Grading

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

6 Usability of this module

BSc ETiT

7 Grade bonus compliant to §25 (2)

8 References

detailed script with instructions for the experiments; Clausert, H. / Wiesemann, G.: Grundgebiete der Elektrotechnik, Oldenbourg,1999

Courses

	Course Nr. 18-kn-1040-pr	**Course name** Electrical Engineering and Information Technology Lab I A		
	Instructor Prof. Dr. Mario Kupnik		**Type** Internship	**SWS** 2
	Course Nr. 18-kn-1041-pr	**Course name** Electrical Engineering and Information Technology Lab I B		
	Instructor Prof. Dr. Mario Kupnik		**Type** Internship	**SWS** 2
	Course Nr. 18-kn-1040-tt	**Course name** Electrical Engineering and Information Technology I, Safety instructions and rules		
	Instructor Prof. Dr. Mario Kupnik		**Type** Tutorial	**SWS** 0

Module name Electrical Engineering and Information Technology II					
Module Nr. 18-gt-1020	**Credit Points** 7 CP	**Workload** 210 h	**Self study** 135 h	**Duration** 1	**Cycle offered** SoSe
Language German			**Module owner** Prof. Dr.-Ing. Gerd Griepentrog		

1	**Content** Electrostatic fields; stationary electrical flow fields; stationary magnetic fields; temporally variable magnetic fields; capacitor networks, transmission lines
2	**Learning objectives / Learning Outcomes** The students have detached themselves from the conception that all electrical procedures are line- bound; they have a clear idea of the field term, can read and interpret field plots and also design simple field plots themselves; they understand the difference between a curl and a divergence field, can describe this difference mathematically and are able to recognize the field type from a mathematical description, respectively; they are able to calculate field distributions for simple rotationally symmetric arrangements analytically; they can deal surely with the definitions of the electrostatic, the electrical quasi-static, the magnetostatic and the magneto-electric field; they have recognized the connection and dualism of electricity and magnetism; they control the mathematical apparatus necessary for their description and can apply it to simple examples; they can calculate with nonlinear magnetic circuits; they can compute inductance, capacity and resistance of simple geometrical arrangements and understand them now as physical characteristics of the respective arrangement; they have recognized, how different forms of energy can be transferred into each other and are thereby already able to solve simple scientific engineering problems; they have understood the underlying physical backgrounds for many applications of electrical engineering and are able to describe them mathematically, develop it further in a simple way and apply it to other examples; they are familiar with the system of Maxwell's equations and can transfer them from the integral into the differential form; they have a first idea of the importance of Maxwell's equations for all conceptual formulations of electrical engineering and they understand the propagation of electromagnetic waves in the free space and on transmission lines
3	**Recommended prerequisite for participation** Electrical Engineering and Information Technology I
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Weighting: 100 %)
6	**Usability of this module** BSc ETiT, BSc MEC, BSc Wi-ETiT, LA Physik/Mathematik, BSc CE, BSc iST
7	**Grade bonus compliant to §25 (2)** Notenverbesserung entsprechend §25 (2) APB TU Darmstadt
8	**References** • Downloadable slides • Clausert, Wiesemann, Hinrichsen, Stenzel: „Grundgebiete der Elektrotechnik I und II"; ISBN 978-3-486-59719-6 • Prechtl, A.: „Vorlesungen über die Grundlagen der Elektrotechnik – Band 2" ISBN: 978-3-211-72455-2
Courses	

	Course Nr. 18-gt-1020-vl	**Course name** Electrical Engineering and Information Technology II		
	Instructor Prof. Dr.-Ing. Gerd Griepentrog		**Type** Lecture	**SWS** 3
	Course Nr. 18-gt-1020-ue	**Course name** Electrical Engineering and Information Technology II		
	Instructor Prof. Dr.-Ing. Gerd Griepentrog, M.Sc. Daniel Großmann		**Type** Practice	**SWS** 2

Module name Deterministic Signals and Systems					
Module Nr. 18-kl-1010	**Credit Points** 7 CP	**Workload** 210 h	**Self study** 135 h	**Duration** 1	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr.-Ing. Anja Klein		

1	**Content** Fourier Series: Motivation; Fourier series with real coefficients; Fourier series with complex coefficients;examples and applications Fourier Transform: Motivation - Derviation from Fourier series - Dirichlet conditions - delta function - step function - properties of F-transform - special cases - examples and applications - transmissions systems-expansion into partial fractions Convolution: Time invariant systems - convolution in frequency domain- Parseval's theorem - properties-examples and applications Systems and Signals: Bandlimited and time limited systems - systems with only one energy store - examples and applications Laplace Transform: Motivation - single sided L-transform - inverse L-transform - theorems of L- transform - examples and applications Linear differential equations: Time invariant systems - rules - general differentiation - linear passive electrical networks - equivalent circuits for passive electrical elements - examples and applications z-Transform: motivation - sampling - numerical order - definition - examples - transfer function - sampling theorem - examples and applications Discrete Fourier Transform: motivation, derivation sampling, examples and applications
2	**Learning objectives / Learning Outcomes** The student should understand the principles of integral transformations. He should apply them for the solution of physical problems. The techniques of this lecture are essential tools which will be needed in many follow-up lectures and exercises.
3	**Recommended prerequisite for participation** Elektrotechnik und Informationstechnik I und Elektrotechnik und Informationstechnik II
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Weighting: 100 %)
6	**Usability of this module** BSc ETiT, BSc MEC, BSc Wi-ETiT, LA Physik/Mathematik, BSc CE, BSc iST
7	**Grade bonus compliant to §25 (2)**
8	**References**

A script of the lecture or slides respectively, will be provided in electronic form.
Basic Literature:
Wolfgang Preuss, “Funktionaltransformationen”, Carl Hanser Verlag, 2002; Klaus-Eberhard Krueger "Transformationen", Vieweg Verlag, 2002;
H. Clausert, G. Wiesemann "Grundgebiete der Elektrotechnik 2", Oldenbourg, 1993; Otto Föllinger "Laplace-, Fourier- und z-Transformation", Hüthig, 2003;
T. Frey, M. Bossert, Signal- und Systemtheorie, Teubner Verlag, 2004
Further Literature:
Dieter Mueller-Wichards "Transformationen und Signale", Teubner Verlag, 1999
Exercises:
Hwei Hsu "Signals and Systems", Schaum’s Outlines, 1995

Courses

Course Nr.	**Course name**		
18-kl-1010-vl	Deterministic Signals and Systems		
Instructor		**Type**	**SWS**
Prof. Dr.-Ing. Anja Klein, Prof. Dr.-Ing. Marius Pesavento		Lecture	3
Course Nr.	**Course name**		
18-kl-1010-ue	Deterministic Signals and Systems		
Instructor		**Type**	**SWS**
Prof. Dr.-Ing. Anja Klein, Prof. Dr.-Ing. Marius Pesavento		Practice	2

Module name Application of Electrodynamics					
Module Nr. 18-kb-1040	**Credit Points** 5 CP	**Workload** 150 h	**Self study** 90 h	**Duration** 1	**Cycle offered** SoSe
Language German			**Module owner** Prof. Dr.-Ing. Harald Klingbeil		

1	**Content** Vector calculus, Maxwell's equations, electrostatics, magnetostatics, fields of stationary currents, electromagnetic waves and ultrasonic waves, analytical and numerical calculation techniques, wave propagation, reflection and transmission, diffraction, interference and polarization, applications of electromagnetic and ultrasonic waves in medical technology
2	**Learning objectives / Learning Outcomes** The students get knowledge and intuition on electromagnetic fields and wave propagation phenomena. They are able to recognize and calculate field and wave phenomena in an electrical engineering context. They are familiar with the required mathematical tools. The students have a feeling for the application of electromagnetic fields and waves in medical engineering.
3	**Recommended prerequisite for participation** Recommended: "Elektrotechnik und Informationstechnik II" (18-gt-1020), "Mathematics II" (04-00-0109), and "Mathematics III" (04-00-0111)
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Weighting: 100 %)
6	**Usability of this module** *B.Sc. Biomedical Engineering*
7	**Grade bonus compliant to §25 (2)**
8	**References** Lecture slides can be downloaded. Further references will be given in the lecture.

Courses

Course Nr. 18-kb-1040-vl	**Course name** Application of Electrodynamics		
Instructor Prof. Dr.-Ing. Harald Klingbeil		**Type** Lecture	**SWS** 2
Course Nr. 18-kb-1040-ue	**Course name** Application of Electrodynamics		
Instructor Prof. Dr.-Ing. Harald Klingbeil		**Type** Practice	**SWS** 2

2 Fundamentals of Mathematics

Module name Mathematics I (Electrical Engineering)					
Module Nr. 04-00-0108	**Credit Points** 9 CP	**Workload** 270 h	**Self study** 180 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Apl. Prof. Dr. rer. nat. Steffen Roch		

1	**Content** Basics, real and complex numbers, real funktions, continuity, differential and integral calculus in one variable, vector spaces, linear mappings, systems of linear equations
2	**Learning objectives / Learning Outcomes**
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Technical Examination, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)
6	**Usability of this module**
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

Course Nr. 04-00-0126-vu	**Course name** Mathematics I (Electical Engineering)	
Instructor Apl. Prof. Dr. rer. nat. Steffen Roch	**Type** Lecture & Practice	**SWS** 6

Module name Mathematics II (Electrical Engineering)					
Module Nr. 04-00-0109	**Credit Points** 9 CP	**Workload** 270 h	**Self study** 180 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Apl. Prof. Dr. rer. nat. Steffen Roch		

1	**Content** Determinants, eigenvalues, quadratic forms, sequences and series of functions, Taylor and Fourier series, differentiala calculus in R^n , extrema, inverse and implicit functions, path integrals, integration in R^n
2	**Learning objectives / Learning Outcomes**
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Technical Examination, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)
6	**Usability of this module**
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

Course Nr. 04-00-0079-vu	**Course name** Mathematics II (Electrical Engineering)	
Instructor Apl. Prof. Dr. rer. nat. Steffen Roch	**Type** Lecture & Practice	**SWS** 6

Module name					
Mathematics III (Electrical Engineering)					
Module Nr.	**Credit Points**	**Workload**	**Self study**	**Duration**	**Cycle offered**
04-00-0111	9 CP	270 h	210 h	1	Every 2. Sem.
Language			**Module owner**		
German			Apl. Prof. Dr. rer. nat. Steffen Roch		

1	**Content** integral calculus: surface integrals, integral theorems; ordinary differential equations: linear and non-linear differential equations, existence and uniqueness of solutions, elementary techniques, linear systems with constant coefficients, Laplace transform; Complex Analysis: complex functions, complex differentiation, Cauchy's integral formula, power series and Laurent series, residues, residue theorem
2	**Learning objectives / Learning Outcomes**
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Technical Examination, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)
6	**Usability of this module**
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

	Course Nr.	**Course name**		
	04-00-0127-vu	Mathematics III (Electrical Engineering)		
	Instructor		**Type**	**SWS**
	Apl. Prof. Dr. rer. nat. Steffen Roch		Lecture & Practice	4

3 More Fundamentals

Module name Mentoring for Biomedical Engineering					
Module Nr. 18-de-1033	**Credit Points** 2 CP	**Workload** 60 h	**Self study** 45 h	**Duration** 1	**Cycle offered** WiSe
Language German			**Module owner** PD Dr.-Ing. Oktay Yilmazoglu		

1	**Content** This module addresses the main features of work techniques, studying methods and time management methods. In addition the specificity of interdisciplinary collaboration and individual challenges arising from it are discussed.
2	**Learning objectives / Learning Outcomes** Mentoring enables students to learn, to identify and to train working methods and learning methods. They realize the importance of application of time management methods in learning processes and acquire the ability to implement them target-oriented for enhancement of learning success. Students reflect their own actions in learning processes and receive feed-back from the mentor to gain a higher level of self-competence. After completion of this module students have the ability to optimize time management for learning success, to develop the personal learning style and methods and apply learning methods adequate to the met situation and conditions. Students have the ability to analyse reasons for personal understanding and solve them by means of adequate actions and methods, as well as shape further learning processes autonomously.
3	**Recommended prerequisite for participation** None
4	**Form of examination** Module Final Examination: • Module Examination (Study Achievement, Special Form, Pass/Fail Grading System) Module final exam: *Module exam (Study achievements, Special form, pass/fail grading system)
5	**Grading** Module Final Examination: • Module Examination (Study Achievement, Special Form, Weighting: 100 %)
6	**Usability of this module** BSc Biomedical Engineering
7	**Grade bonus compliant to §25 (2)**
8	**References** Kurt Landau, Arbeitstechniken für Studierende der Ingenieurswissenschaften; Verlag ergonomia oHG, Stuttgart, ISBN 3-935089-65-1 Kurt Landau, Besser studieren! Übungsbuch zum Werk Arbeitstechniken; Verlag ergonomia oHG, Stuttgart, ISBN 3-935089-67-X Other relevant materials are provided in Moodle.
Courses	

	Course Nr.	Course name		
	18-de-1033-vl	Mentoring for Biomedical Engineering		
	Instructor		**Type**	**SWS**
	Prof. Dr. rer. nat. Andreas Schürr		Lecture	1

Module name Physics I					
Module Nr. 05-91-1024	**Credit Points** 4 CP	**Workload** 120 h	**Self study** 75 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. rer. nat. Joachim Enders		

1	**Content**
2	**Learning objectives / Learning Outcomes**
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Weighting: 100 %)
6	**Usability of this module**
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

	Course Nr. 05-11-0054-vl	**Course name**		
	Instructor		**Type** Lecture	**SWS** 2
	Course Nr. 05-13-0054-ue	**Course name**		
	Instructor		**Type** Practice	**SWS** 1

Module name Physics II					
Module Nr. 05-91-1025	**Credit Points** 4 CP	**Workload** 120 h	**Self study** 75 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. rer. nat. Joachim Enders		

1	**Content**
2	**Learning objectives / Learning Outcomes**
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Weighting: 100 %)
6	**Usability of this module**
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

	Course Nr. 05-11-0055-vl	**Course name**		
	Instructor		**Type** Lecture	**SWS** 2
	Course Nr. 05-13-0055-ue	**Course name**		
	Instructor		**Type** Practice	**SWS** 1

Module name Measuring Technique					
Module Nr. 18-kn-1011	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 105 h	**Duration** 1	**Cycle offered** SoSe
Language German			**Module owner** Prof. Dr. Mario Kupnik		

1 Content

The module includes theoretical discussion and practical application of the measuring chain in detail on example the electrical variables (current, voltage, impedance, power) and selected non-electrical variables (frequency, time, force, pressure and acceleration).
In the lecture the following chapter will be thematically treated measuring signals and measuring equipment (oscilloscope, laboratory testing equipment), static measurement error and disturbance variables (especially temperature), basic measurement circuits, AD conversion principles and filtering, measurement method non-electrical variables and the statistics of measurements (distributions, statist safe tests).
The topics of the lecture are discussed in the exercise of the module. Examples are analyzed and their application in measurement scenarios are practiced.
The practicum of the module consists of five experiments which are time closely matched in time to the lecture:

- Measuring of signals in the time range with digital storage oscilloscope, trigger conditions
- Measuring of signals in the frequency range with digital storage oscilloscope, error of measurement (aliasing / subsampling, leackage) and window functions
- Measuring of mechanical dimensions with suitable primary sensors, sensor electronics / amplifier circuits
- computer-based measuring
- Importing of sensor signals, whose processing and the resulting automated control of a process using a programmable logic controller (PLC)

2 Learning objectives / Learning Outcomes

The students know the structure of the measuring chain and the specific properties of the corresponding elements. They know the structure of electronic measuring instruments and basic measuring circuits for electrical and selected non-electrical variables and can apply them. They know the basics of capturing, processing, transferring and storage of measurement data and can describe error sources and quantifying their influences.
In the practicum, the students deepen the basis of the measurements with the oscilloscope, the understanding of the relationship between time and frequency range. Methodically they are able to document and evaluate the data during laboratory measuring.

3 Recommended prerequisite for participation

Basics of ETiT I-III, Math I-III, Electronic

4 Form of examination

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

Module Eccompanying Examination:

- [18-kn-1011-pr] (Study Achievement, Optional, Standard BWS)

5 Grading

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 4)

Module Eccompanying Examination:

- [18-kn-1011-pr] (Study Achievement, Optional, Weighting: 2)

6 Usability of this module

BSc ETiT, BSc Wi-ETiT, BSc MEC

7	**Grade bonus compliant to §25 (2)**			
8	**References** • Slide set of lecture • Textbook and exercise book Lerch: „Elektrische Messtechnik“, Springer • Exercise documents • Practical experiment manuals			
Courses				
	Course Nr. 18-kn-1011-vl	**Course name** Measuring Technique		
	Instructor Prof. Dr. Mario Kupnik		**Type** Lecture	**SWS** 2
	Course Nr. 18-kn-1011-pr	**Course name** Measuring Technique Lab		
	Instructor Prof. Dr. Mario Kupnik		**Type** Internship	**SWS** 2
	Course Nr. 18-kn-1011-ue	**Course name** Measuring Technique		
	Instructor Prof. Dr. Mario Kupnik		**Type** Practice	**SWS** 1

Module name					
Electronics					
Module Nr.	**Credit Points**	**Workload**	**Self study**	**Duration**	**Cycle offered**
18-ho-1011	7 CP	210 h	135 h	1	WiSe
Language			**Module owner**		
German			Prof. Dr.-Ing. Klaus Hofmann		

1 Content

18-ho-1011-vl bzw. –ue:

Semiconductor Elements: Diode, MOSFET, Bipolartransistor. Electronic Circuit Design; Basic Analog Circuits and their properties, Behavior and properties of operational amplifiers, circuit simulation with SPICE, small signal amplification, single stage amplifiers, frequency response; digital circuits: CMOS-logic

18-ho-1011-pr:

Practical experiments in the fields:

- digital circuits: FPGA-programming
- analog circuits: basic building blocks, amplifiers, operational amplifiers, filters and demodulators

2 Learning objectives / Learning Outcomes

A student is after successful attending the lecture able to

- analyse the behavior of diodes, MOS- and Bipolartransistors in simple circuits,
- assess the properties of single-transistor amplifiers (MOSFET and BJT), such as small signal behavior, input- and output-resistance;
- design inverting and non-inverting operational amplifiers with passive components and knows the ideal and non-ideal properties;
- calculate the frequency response of simple transistor circuits;
- knows the different circuit techniques (CMOS, NMOS) of logical gates and knows the basic functions (inverter, NAND, NOR).

A student is after successful attending the lab able to

- perform measurements in time and frequency domain using an oscilloscope on simple operational amplifiers;
- design and realize a traffic light controller based on a finite state machine using a FPGA as the target implementation;
- mount passive and active components on a PCB (including preparation of components, soldering) and put the system to function,
- simulate a circuit (filter) using SPICE and perform measurements on the realization.

3 Recommended prerequisite for participation

Basics of Electrical Engineering

4 Form of examination

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

Module Eccompanying Examination:

- [18-ho-1011-pr] (Study Achievement, Optional, Standard BWS)

5 Grading

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 4)

Module Eccompanying Examination:

- [18-ho-1011-pr] (Study Achievement, Optional, Weighting: 3)

6 Usability of this module

BSc ETiT, BSc Wi-ETiT, BSc iST, BEd

7	**Grade bonus compliant to §25 (2)**			
8	**References**			
Courses				
	Course Nr. 18-ho-1011-vl	**Course name** Electronics		
	Instructor Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann		**Type** Lecture	**SWS** 2
	Course Nr. 18-ho-1011-pr	**Course name** Electronics Lab		
	Instructor Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Ferdinand Keil		**Type** Internship	**SWS** 2
	Course Nr. 18-ho-1011-ue	**Course name** Electronics		
	Instructor Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann		**Type** Practice	**SWS** 1

Module name					
System Dynamics and Automatic Control Systems I					
Module Nr.	**Credit Points**	**Workload**	**Self study**	**Duration**	**Cycle offered**
18-ko-1010	6 CP	180 h	120 h	1	WiSe
Language			**Module owner**		
German			Prof. Dr.-Ing. Ulrich Konigorski		

1 Content

Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization

2 Learning objectives / Learning Outcomes

Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems.

3 Recommended prerequisite for participation

4 Form of examination

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

5 Grading

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

6 Usability of this module

BSc ETiT, BSc MEC, MSc Informatik

7 Grade bonus compliant to §25 (2)

8 References

Skript Konigorski: “Systemdynamik und Regelungstechnik I”, Aufgabensammlung zur Vorlesung, Lunze: "Regelungstechnik 1: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen",
Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen",
Unbehauen: "Regelungstechnik I:Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme, Fuzzy-Regelsysteme", Föllinger: "Laplace-, Fourier- und z-Transformation",
Jörgl: "Repetitorium Regelungstechnik",
Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden",
Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise",
Schneider: "Regelungstechnik für Maschinenbauer",
Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnaher Grundlage"

Courses

Course Nr.	Course name		
18-ko-1010-vl	System Dynamics and Automatic Control Systems I		
Instructor		**Type**	**SWS**
Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand		Lecture	3
Course Nr.	**Course name**		
18-ko-1010-tt	System Dynamics and Automatic Control Systems I- Auditorium Exercise		
Instructor		**Type**	**SWS**
Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand		Tutorial	1

Module name Fundamentals of Signal Processing					
Module Nr. 18-zo-1030	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 120 h	**Duration** 1	**Cycle offered** SoSe
Language German			**Module owner** Prof. Dr.-Ing. Abdelhak Zoubir		

1 Content

The course covers the following topics:

- The basic concepts of stochastic
- The sampling theorem
- Discrete-time noise processes and their properties
- Description of noise processes in the frequency domain
- Linear time-invariant systems: FIR and IIR filters
- Filtering of noise processes: AR, MA, and ARMA models
- The Matched filter
- The Wiener filter
- Properties of estimators
- The method of least squares

2 Learning objectives / Learning Outcomes

The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory.

3 Recommended prerequisite for participation

4 Form of examination

Module Final Examination:

- Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)

In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase.

5 Grading

Module Final Examination:

- Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100 %)

6 Usability of this module

BSc ETiT, BSc MEC

7 Grade bonus compliant to §25 (2)

8 References

Lecture notes and slides can be downloaded here:

- http://www.spg.tu-darmstadt.de
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schafer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River,1999.

Courses

Course Nr.	**Course name**		
18-zo-1030-vl	Fundamentals of Signal Processing		
Instructor		**Type**	**SWS**
Prof. Dr.-Ing. Abdelhak Zoubir		Lecture	3
Course Nr.	**Course name**		
18-zo-1030-ue	Fundamentals of Signal Processing		
Instructor		**Type**	**SWS**
Prof. Dr.-Ing. Abdelhak Zoubir		Practice	1

Module name Laboratory of Biomedical Engineering					
Module Nr. 18-kp-1050	**Credit Points** 2 CP	**Workload** 60 h	**Self study** 30 h	**Duration** 1	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr. techn. Heinz Köppl		

1	**Content** This module addresses the different branches of biomedical engineering. Contents of lab experiments cover current topics of biomedical engineering like medical robotics, measuring and sensor technology, biomechanics, radiotherapy, imaging techniques, biosignal-monitoring, gerontology or Lab-on-a-Chip.
2	**Learning objectives / Learning Outcomes** After successful completion of this module students will be familiar with practical applications of medical engineering and have learnt to identify necessary practical methods and work techniques and to implement them correctly. They will also have gained experience in experimental works in autonomous small groups from a medical engineering context.
3	**Recommended prerequisite for participation** Recommended are „Electrical Engineering and Information Technology I“, and „Electrical Engineering and Information Technology II“
4	**Form of examination** Module Final Examination: • Module Examination (Study Achievement, Optional, Duration: 60 min, Standard Grading System) Module final exam: * Module exam (Study achievements, oral/written, Duration: 30 min. for oral examination / Duration: 60 min. for written examination, standard grading system)
5	**Grading** Module Final Examination: • Module Examination (Study Achievement, Optional, Weighting: 100 %)
6	**Usability of this module** BSc Biomedical Engineering
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

	Course Nr. 18-kp-1050-pr	**Course name** Laboratory of Biomedical Engineering		
	Instructor Prof. Dr. techn. Heinz Köppl		**Type** Internship	**SWS** 2
	Course Nr. 18-kp-1050-tt	**Course name** Preliminary		
	Instructor Prof. Dr. techn. Heinz Köppl		**Type** Preliminary Discussion	**SWS** 0

Module name Materials Science for Medical Engineering					
Module Nr. 11-01-4501	**Credit Points** 3 CP	**Workload** 90 h	**Self study** 60 h	**Duration** 1	**Cycle offered** SoSe
Language German			**Module owner** Prof. Dr. Ralf Riedel		

1	**Content** In this module, the fundamentals of materials science and engineering are taught. Particular focus is on the structure, mechanical and surface properties of metals ceramics amd polymers and how these properties determine the behaviour as an implant material under mechanical and corrosive load. The following topics will be discussed: -Chemical bonding and structure of materials, -classes of material (metals, ceramics, glasses, polymers, semiconductors, and compo-site materials), -mechanical properties of materials, -polymeric, metallic and ceramic materials in medical technology.
2	**Learning objectives / Learning Outcomes** The students know and understand chemical bonding in materials and the resulting structural and functional properties. They are able to apply and analyze the structure property rela-tions of metallic, ceramic and polymeric materials. Students can evaluate the properties of materials in biomedical engineering.
3	**Recommended prerequisite for participation** “Physics I” and “Physics II”
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) Module final exam: *Module exam (Technical examination, Written Examination, duration: 120 Min., standard grading system)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Weighting: 100 %)
6	**Usability of this module** BSc Medizintechnik
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

Course Nr.	**Course name**		
11-01-4501-vl	Materials Science for Medical Engineering		
Instructor Prof. Dr. Ralf Riedel		**Type** Lecture	**SWS** 2

Module name Technical Mechanics for Electrical Engineering					
Module Nr. 16-26-6400	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 105 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr.-Ing. Tobias Melz		

1 Content

Statics: force, moment (torque), free body diagram, equilibrium equations, center of gravity, truss, beams, adhesion and friction.
Mechanics of elastic bodies: stress and deformation, tension, torsion, bending.
Kinematics: point and rigid body movement.
Kinetics: dynamic force and moment equilibrium equations, energy and work, linear oscillators, momentum and angular momentum conservation laws, impact.

2 Learning objectives / Learning Outcomes

In this course the students will learn the basic concepts of technical mechanics. They should be able to analyze the statics of simple statically determinate planar systems, to carry out elementary elastomechanical calculations of statically determinate and statically indeterminate structures, to describe and analyze movements, and to solve planar motion problems, oscillation and shock phenomena with the laws of kinetics.

3 Recommended prerequisite for participation

4 Form of examination

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Standard Grading System)

5 Grading

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

6 Usability of this module

7 Grade bonus compliant to §25 (2)

8 References

Markert, Norrick: Einführung in die Technische Mechanik, ISBN 978-3-8440-3228-4
Exercises are embodied in the book.
Further reading:
Markert: Statik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3279-6
Markert: Elastomechanik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3280-2
Markert: Dynamik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-2200-1
Gross, Hauger, Schröder, Wall: Technische Mechanik 1 - 3. Springer-Verlag Berlin (2012-2014).
Hagedorn: Technische Mechanik, Band 1 - 3. Verlag Harri Deutsch Frankfurt.

Courses

Course Nr. 16-26-6400-vl	**Course name** Technical Mechanics for Electrical Engineering		
Instructor		**Type** Lecture	**SWS** 3

	Course Nr.	Course name		
	16-26-6400-ue	Technical Mechanics for Electrical Engineering		
	Instructor		**Type**	**SWS**
			Practice	2

Module name General Computer Science I					
Module Nr. 20-00-0304	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 150 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. rer. nat. Karsten Weihe		

1	**Content**
2	**Learning objectives / Learning Outcomes** • Basic Knowledge of Computer Science Concepts • Practical Work with computers • Fundamental Programming Skills
3	**Recommended prerequisite for participation** -
4	**Form of examination** Module Eccompanying Examination: • [20-00-0304-iv] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0304-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module**
7	**Grade bonus compliant to §25 (2)**
8	**References** David J. Barnes und Michael Kölling, Objects First with Java: A Practical Introduction using BlueJ, Fifth edition, Prentice Hall/Pearson Education, 2012, ISBN 978-013-249266-9

Courses

	Course Nr. 20-00-0304-iv	**Course name** General Computer Science I		
	Instructor		**Type** Integrated Course	**SWS** 2

Module name Bioinformatics I					
Module Nr. 18-kp-1020	**Credit Points** 3 CP	**Workload** 90 h	**Self study** 60 h	**Duration** 1	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr. techn. Heinz Köppl		

1 Content

- Biomolecular foundations of high-throughput measurement techniques (Microarrays, RNA-Seq, genome sequencing, proteinarrays, mass-spectrometry, flow-cytometry, mass-cytometry, genomics, proteomics, metabolomics)
- Foundations of statistics and machine learning (decision theory, regression, classification and clustering)
- Exact substring search, dynamic programming, algorithms for sequence comparison (PAM, BLAST, BLAST2, etc), alignment of multiple sequences (ClustalW, DAlign, etc)
- Important databases in bioinformatics and their use in medicine and biology (GenBank, Gene Expression Omnibus, Rfam, UniProt, Pfam, KEGG, BRENDA, Pathway Commons)
- Analysis of interaction networks (modularity, graph partitioning, spanning trees, differential network analysis, network motifs, STRING database, PathBLAST)
- Introduction to structural biology, structure prediction for RNA and proteins, Protein Data Bank (PDB)

2 Learning objectives / Learning Outcomes

After successful completion students are aware of frequently used high-throughput methods in molecular biology and are familiar with the resulting data format. They know the most important bioinformatics databases and acquired the necessary background to understand standard bioinformatics algorithms and to implement them from scratch in R or Matlab. Students are familiar with the basics of structural analysis and with structure prediction. With respect to communication skills, students learned to exchange informatio, ideas, problems and solutions related to bioinformatics with experts and with lay persons.

3 Recommended prerequisite for participation

Recommended is „General Computer Science I“

4 Form of examination

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

5 Grading

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

6 Usability of this module

BSc Biomedical Engineering

7 Grade bonus compliant to §25 (2)

8 References

Courses

Course Nr. 18-kp-1020-vl	**Course name** Bioinformatics I		
Instructor Prof. Dr. techn. Heinz Köppl		**Type** Lecture	**SWS** 2

4 Medical Fundamentals

Module name Terminology, Medical Morphology and Applied Anatomy					
Module Nr. 18-mt-1010	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 120 h	**Duration** 2	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr. Thomas Vogl		

1	**Content** The module deals with the fundamentals of the morphology of the human body, its tissue structures and their relationships. In particular, human organs are discussed in their microscopic and macroscopic anatomy including the sensory systems, the musculoskeletal system, the cardiovascular system, the digestive system, the nervous system and the stomatognathic system. This includes the knowledge transfer of medical and dental terminology. Anatomical structures and functional relationships are explained on the basis of common clinical cases and thus the direct reference to the clinic is established. At the same time, the module discusses methods and devices that can be used to represent the anatomy and functions of the body, such as medical imaging. In addition, the participants gain initial knowledge about the organizational structures of diagnostic processes. On the basis of a discussion of medical methods and theoretical approaches in surgical disciplines, the participant learns central medical problems.
2	**Learning objectives / Learning Outcomes** After successfully completing the module, the students understand the basics of medical terminology and can tap into the most important and common medical terms. They are familiar with the fundamentals of the microscopic and macroscopic anatomy of important body systems and have acquired a deeper understanding of common medical problems, especially in the fields of surgery, internal medicine and dentistry. They know various media for obtaining information about the morphology of the body and can assess their differential diagnostic reliability. In addition, the students are familiar with important clinical pictures, can explain them in diagnostics and therapy as an example and discuss them with medical professionals and as well as with laypersons.
3	**Recommended prerequisite for participation** None
4	**Form of examination** Module Eccompanying Examination: • [18-mt-1010-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS) • [18-mt-1011-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [18-mt-1010-vl] (Technical Examination, Written Examination, Weighting: 50 %) • [18-mt-1011-vl] (Technical Examination, Written Examination, Weighting: 50 %)
6	**Usability of this module** BSc Biomedical Engineering
7	**Grade bonus compliant to §25 (2)**
8	**References** Caspar: Medizinische Terminologie, Thieme Verlag Schünke/Schumacher/Schulte: Prometheus – Lernpaket Anatomie, Thieme Verlag Vogl: Diagnostische und Interventionelle Radiologie, Springer Verlag

Courses				
	Course Nr. 18-mt-1010-vl	**Course name** Terminology and Medical Morphology		
	Instructor Prof. Dr. Thomas Vogl		**Type** Lecture	**SWS** 2
	Course Nr. 18-mt-1011-vl	**Course name** Applied Anatomy		
	Instructor Prof. Dr. Thomas Vogl		**Type** Lecture	**SWS** 2

Module name Natural Scientific Principles for Medical Engineering					
Module Nr. 18-mt-1020	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 90 h	**Duration** 2	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr. Ingrid Fleming		

1	**Content** This module deals with medical biological fundamentals, which are the basis for the application of engineering methods to living systems in biology, medicine and dentistry. In addition to the fundamentals of terminology, cell biology, chemistry and genetics, basic knowledge about chemical and biochemical procedures and processes are also conveyed. Hereon building up, the participants gain insight into first physiological processes within the human body and their relationships. Physiological and exemplary pathophysiological functional relationships are explained on the basis of common clinical pictures and thus the direct clinical reference is established. At the same time, the participants gain their first knowledge of diagnostic procedures in medicine and dentistry and get an overview of the organizational structures of diagnostic processes. On the basis of discussion of medical methods and theoretical approaches in conservative or metabolically-related disciplines, the participants learn key medical questions.
2	**Learning objectives / Learning Outcomes** Students who have successfully completed this module can understand the biological, biochemical and physiological context and apply it to the development and evaluation of biomedical diagnostic and therapeutic systems. In addition, the students, having understood cell and molecular biological processes acquired in this module, will be prepared to discuss medical content with medical professionals and laymen and to understand the basic biomedical literature. They know various media for gathering information about metabolic processes in the body and can assess their reliability.
3	**Recommended prerequisite for participation** None
4	**Form of examination** Module Eccompanying Examination: • [18-mt-1022-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS) • [18-mt-1021-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS) • [18-mt-1020-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS) Module final exam: *Module exam (per course one Technical examination, Written examination, Duration: 60 min, standard grading system)
5	**Grading** Module Eccompanying Examination: • [18-mt-1022-vl] (Technical Examination, Written Examination, Weighting: 1) • [18-mt-1021-vl] (Technical Examination, Written Examination, Weighting: 1) • [18-mt-1020-vl] (Technical Examination, Written Examination, Weighting: 1)
6	**Usability of this module** BSc Biomedical Engineering
7	**Grade bonus compliant to §25 (2)**
8	**References** Buselmeier: Biologie für Mediziner, Springer-Verlag Zeek, Zeek, Gromd: Chemie für Mediziner, Elsevier-Verlag Müller-Esterl: Biochemie, Spektrum Verlag Walter, Huippelsberg: Kurzlehrbuch der Physiologie, Thieme Verlag
Courses	

	Course Nr. 18-mt-1022-vl	**Course name** Physiology		
	Instructor Prof. Dr. Ingrid Fleming		**Type** Lecture	**SWS** 2
	Course Nr. 18-mt-1021-vl	**Course name** Biochemistry		
	Instructor Prof. Dr. Ingrid Fleming		**Type** Lecture	**SWS** 2
	Course Nr. 18-mt-1020-vl	**Course name** Cell Biology		
	Instructor Prof. Dr. Ingrid Fleming		**Type** Lecture	**SWS** 2

Module name Biomechanics and Biomaterials					
Module Nr. 18-mt-1030	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 90 h	**Duration** 1	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr. Ingo Marzi		

1	**Content** This module deals with the basics of biomechanics. Basis for this is the anatomy of the musculoskeletal system. Among these is integrated the introduction into rigid bodies, multi-body models of human body parts, different modeling variants or the determination of the reaction forces and moments in human joints. In addition, this module deals with material sciences for considering the human body and with materials that are used in particular in medical technology. These include medical-grade materials used to make implants that remain temporarily or permanently in the body, as well as biomaterials used to replace body tissues (skin, bones, cartilage, etc.). In the areas of biomechanics and biomaterials, the basics of osteosynthesis techniques with implants and endoprosthetics are presented as well as basic principles of tissue engineering in the fields of medicine and dentistry.
2	**Learning objectives / Learning Outcomes** After successfully completing this module, students gain knowledge and understanding of the biomechanical basis of human body functions. They shall be able to independently and critically use biomechanical methods. Students are familiar with the basic materials and their mechanical and biological properties used in the human body. In particular, students are familiar with the requirement profile for material behavior regarding medical engineering. They are able to independently select materials for an application from medical engineering, to assess their advantages and disadvantages and to explain them in an argumentative manner.
3	**Recommended prerequisite for participation** Recommended is „ Terminology, Medical Morphology and Applied Anatomy“
4	**Form of examination** Module Eccompanying Examination: • [18-mt-1030-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS) • [18-mt-1031-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS) Module final exam: *Module exam (per course one Technical examination, Written examination, Duration: 60 min, standard grading system)
5	**Grading** Module Eccompanying Examination: • [18-mt-1030-vl] (Technical Examination, Written Examination, Weighting: 50 %) • [18-mt-1031-vl] (Technical Examination, Written Examination, Weighting: 50 %)
6	**Usability of this module** BSc Biomedical Engineering
7	**Grade bonus compliant to §25 (2)**
8	**References** Sommerfeld, Klein: Biomechanik der menschlichen Gelenke, Elsevier-Verlag Frobin, Brinckmann, Leivseth: Musculosceletal Biomechanics, Thieme Verlag Grifka, Krämer: Orthopädie-Unfallchirurgie, Springer-Verlag Hausamen: Mund-Kiefer-Gesichtschirurgie, Elsevier-Verlag Epple: Biomaterialien und Biomineralisation, Springer Verlag Curtis, Watson: Dental Biomaterials, Elsevier-Verlag
Courses	

	Course Nr. 18-mt-1030-vl	**Course name** Biomechanics		
	Instructor Prof. Dr. Ingo Marzi		**Type** Lecture	**SWS** 3
	Course Nr. 18-mt-1031-vl	**Course name** Biomaterials		
	Instructor Prof. Dr. Ingo Marzi		**Type** Course	**SWS** 3

Module name Biomedical Engineering					
Module Nr. 18-mt-1040	**Credit Points** 9 CP	**Workload** 270 h	**Self study** 135 h	**Duration** 2	**Cycle offered** SoSe
Language German			**Module owner** Prof. Dr. Kai Zacharowski		

1	**Content** Biomedical engineering supports medicine with technical solutions in the areas of prevention, diagnostics and therapy. This module focuses on applications in the fields of anesthesiology, internal medicine, neurology and dentistry. Punctually, other disciplines complement the program. In particular, current research and development projects in the field of device technology are presented, taking into account the underlying biotechnology. In addition, anatomy and functional processes in the human body are presented and discussed in the context of common clinical pictures. By this, the transfer of scientific questions from a fundamental area and theory into real clinical application will be illustrated by practical examples. Methods and devices with which the anatomy and functions of the body can be represented, are in a particular focus. One core area is the understanding and application of medical imaging and image processing such as segmentation, filtering and image reconstruction. The use and importance of different devices and methods are presented in a problem-oriented manner. This includes the use of interventional procedures that includes invasive patient treatment by imaging support. The second core area is presentation and application of intracorporeal sensory and actuarial systems detecting and affecting body functions minimal invasively.
2	**Learning objectives / Learning Outcomes** After successful completion of the module, the students gained insights into the implementation and application of medical devices and biotechnological procedures. They are informed about the current R & D-status of medical device technologies and special biotechnology. In addition, they can independently apply their acquired knowledge to interdisciplinary questions in medicine and engineering and thus express a position related to a specific field.
3	**Recommended prerequisite for participation** Recommended are „ Terminology, Medical Morphology and Applied Anatomy“ and „ Natural Scientific Principles for Medical Engineering“
4	**Form of examination** Module Eccompanying Examination: • [18-mt-1041-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS) • [18-mt-1042-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS) • [18-mt-1043-vl] (Technical Examination, Written Examination, Duration: 60 min, Standard BWS) Module final exam: *Module exam (per course one Technical examination, Written examination, Duration: 60 min, standard grading system)
5	**Grading** Module Eccompanying Examination: • [18-mt-1041-vl] (Technical Examination, Written Examination, Weighting: 1) • [18-mt-1042-vl] (Technical Examination, Written Examination, Weighting: 1) • [18-mt-1043-vl] (Technical Examination, Written Examination, Weighting: 1)
6	**Usability of this module** BSc Biomedical Engineering
7	**Grade bonus compliant to §25 (2)**
8	**References** Leonhardt, Steffen, Walter, Marian: Medizintechnische Systeme, Springer-Verlag, einschlägige Lehrbücher und Fachartikel zu den verschiedenen klinischen Einsatzgebieten
Courses	

	Course Nr. 18-mt-1041-vl	**Course name** Biomedical Engineering II		
	Instructor Prof. Dr. Kai Zacharowski		**Type** Lecture	**SWS** 3
	Course Nr. 18-mt-1042-vl	**Course name** Biosensors		
	Instructor Prof. Dr. Kai Zacharowski		**Type** Lecture	**SWS** 2
	Course Nr. 18-mt-1040-vl	**Course name** Biomedical Engineering I		
	Instructor Prof. Dr.-Ing. Christoph Hoog Antink		**Type** Lecture	**SWS** 2
	Course Nr. 18-mt-1043-vl	**Course name** Medical Imaging		
	Instructor Prof. Dr. Kai Zacharowski		**Type** Lecture	**SWS** 2

Module name					
Clinical Practical Courses					
Module Nr.	**Credit Points**	**Workload**	**Self study**	**Duration**	**Cycle offered**
18-mt-1120	6 CP	180 h	180 h	2	WiSe
Language			**Module owner**		
German			Prof. Dr. Dr. Robert Sader		

1	**Content** In small groups, students have the opportunity to participate in the everyday clinical practice of various medical disciplines and to experience the use of medical devices in daily use as well as to experience the possibilities and limitations of the device technologies. They participate in various everyday clinical situations in a hospital and learn the clinical communication channels, workflows and treatment strategies.
2	**Learning objectives / Learning Outcomes** Students know the day-to-day work of a physician and the communication structures of a hospital. They understand the terminology and "language" of a medical doctor and can communicate with them sufficiently. They are familiar with a wide range of applications of medical devices and products and are informed about the current state of development of medical devices.
3	**Recommended prerequisite for participation** Recommended are „ Terminology, Medical Morphology and Applied Anatomy" and „ Natural Scientific Principles for Medical Engineering" und „Biomedical Engineering". As well as being vaccinated against measles, mumps, varicella, tetanus and hepatitis B according to the recommendation of the Standing Committee on Vaccinations.
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Report, Pass/Fail Grading System) Module final exam: *Module exam (Technical examination, Presentation, pass/fail grading system) After course II the examinee compiles a two-page summary of a medical device, describing functional principle and possible applications but also its limitations in the medical field.
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Report, Weighting: 100 %)
6	**Usability of this module** BSc Biomedical Engineering
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

Course Nr. 18-mt-1120-pr	**Course name** Clinical Practical Courses I		
Instructor Prof. Dr. Dr. Robert Sader		**Type** Internship	**SWS** 0
Course Nr. 18-mt-1121-pr	**Course name** Clinical Practical Courses II		
Instructor Prof. Dr. Dr. Robert Sader		**Type** Internship	**SWS** 0

Module name Medical Law, Forensic Medicine and Ethics					
Module Nr. 18-mt-1140	**Credit Points** 3 CP	**Workload** 90 h	**Self study** 45 h	**Duration** 1	**Cycle offered** SoSe
Language German			**Module owner** Prof. Dr. med. Dr. habil. Markus Parzeller		

1	**Content** This module deals with the legal foundations of the (inter-) national health system and the medical law (among these the medical drug law (AMG), the medical device law (MPG), the transplantation law (TPG)) and practical aspects, e. g. in forensic medicine. It will also cover the basics of medical ethics and bioethics, which will give a closer look to the ethical aspects of research on humans and the development of medical technologies in a legal-ethical context.
2	**Learning objectives / Learning Outcomes** Upon successful completion of this module, students are sensitized to legal issues, current case law and ethical aspects in medical engineering and (bio) medicine, including actual and future research projects. They can derive scientifically based judgments that take into account social, legal, scientific, ethical and practical knowledge.
3	**Recommended prerequisite for participation** None
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Duration: 60 min, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Weighting: 100 %)
6	**Usability of this module** BSc Biomedical Engineering
7	**Grade bonus compliant to §25 (2)**
8	**References** Legal commentaries and textbooks of relevant areas of law, current case-law from legal databases, ethic and legal medicine basic literature.

Courses

Course Nr. 18-mt-1140-vl	**Course name** Medical Law, Forensic Medicine and Ethics	
Instructor Prof. Dr. med. Dr. habil. Markus Parzeller	**Type** Lecture	**SWS** 3

5 Optional Subjects Mechanical Engineering

Complete Catalogue of all modules FB 16 Mechanical Engineering

6 Optional Subjects Computer Science and Programming

Module name Laboratory Matlab/Simulink I					
Module Nr. 18-ko-1030	**Credit Points** 3 CP	**Workload** 90 h	**Self study** 45 h	**Duration** 1	**Cycle offered** WiSe/SoSe
Language German			**Module owner** Prof. Dr.-Ing. Ulrich Konigorski		

1	**Content** In this lab tutorial, an introduction to the software tool MatLab/Simulink will be given. The lab is split into two parts. First the fundamentals of programming in Matlab are introduced and their application to different problems is trained. In addition, an introduction to the Control System Toolbox will be given. In the second part, the knowledge gained in the first part is applied to solve a control engineering specific problem with the software tools.
2	**Learning objectives / Learning Outcomes** Fundamentals in the handling of Matlab/Simulink and the application to control engineering tasks.
3	**Recommended prerequisite for participation** The lab should be attended in parallel or after the lecture “System Dynamics and Control Systems I”
4	**Form of examination** Module Final Examination: • Module Examination (Study Achievement, Optional, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Study Achievement, Optional, Weighting: 100 %)
6	**Usability of this module** BSc ETiT; BSc MEC
7	**Grade bonus compliant to §25 (2)** In case of E-Learning: Possibility to improve the grade up to 1,0
8	**References** Lecture notes for the lab tutorial can be obtained at the secretariat Lunze; Regelungstechnik I Dorp; Bishop: Moderne Regelungssysteme Moler: Numerical Computing with MATLAB

Courses

Course Nr. 18-ko-1030-pr	**Course name** Laboratory Matlab/Simulink I	
Instructor Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Alexander Steinke	**Type** Internship	**SWS** 3

Module name Programming in Automatic Control (C/C++)					
Module Nr. 18-ad-1020	**Credit Points** 2 CP	**Workload** 60 h	**Self study** 30 h	**Duration** 1	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr.-Ing. Jürgen Adamy		

1	**Content** Programming in LINUX, Makefiles, C - Programming (Program structures in C, pointer, developer environment and debugger), C++ (object oriented programming)
2	**Learning objectives / Learning Outcomes** After attending the lecture, a student is capable of: 1. operating LINUX computers, 2. assembling and using makefiles, 3. recalling and applying the syntax for standard C-blocks, 4. explaining and applying the use of pointers, 5. explaining the concept of object oriented programming in C++
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Technical Examination, Written Examination, Weighting: 100 %)
6	**Usability of this module** BSc ETiT, BSc iST, MSc MEC, MSc Wi-ETiT
7	**Grade bonus compliant to §25 (2)**
8	**References** Adamy: Lecture notes

Courses

	Course Nr. 18-ad-1020-vl	**Course name** Programming in Automatic Control (C/C++)		
	Instructor Dr. rer. nat. Tatiana Tatarenko		**Type** Lecture	**SWS** 1
	Course Nr. 18-ad-1020-ue	**Course name** Programming in Automatic Control (C/C++)		
	Instructor Dr. rer. nat. Tatiana Tatarenko		**Type** Practice	**SWS** 1

Module name Software Lab					
Module Nr. 18-st-1020	**Credit Points** 4 CP	**Workload** 120 h	**Self study** 75 h	**Duration** 1	**Cycle offered** WiSe
Language German			**Module owner** Prof. Dr. rer. nat. Florian Steinke		

1 Content

The lab covers the following basic software development skills:

- working together and software development in teams
- lightweight software engineering process eXtreme Programming (XP)
- training of advanced OO/Java programming skills and coding standards
- software documentation using JavaDoc
- the basics of the development tool eclipse
- regression testing methods (test framework JUnit) to increase software quality
- more sophisticated data structures and algorithms

2 Learning objectives / Learning Outcomes

Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems.

3 Recommended prerequisite for participation

Basics in Java (as taught in Introduction to Computer Science for Engineers).
Windows-Account of the ETiT PC-Pool

4 Form of examination

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

5 Grading

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

6 Usability of this module

BSc ETiT, BSc Wi-ETiT

7 Grade bonus compliant to §25 (2)

8 References

www.es.tu-darmstadt.de/lehre/sp/

Courses

Course Nr. 18-st-1020-pr	**Course name** Software Lab	
Instructor Prof. Dr. rer. nat. Florian Steinke	**Type** Internship	**SWS** 3

Module name					
Software Engineering - Introduction					
Module Nr.	**Credit Points**	**Workload**	**Self study**	**Duration**	**Cycle offered**
18-su-1010	6 CP	180 h	120 h	1	WiSe
Language			**Module owner**		
German			Prof. Dr. rer. nat. Andreas Schürr		

1 Content

The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's "Guide to the Software Engi-neering Body of Knowledge" - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of soft-ware architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).
During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of requirements, definition of a design and eventually the implementation of executable (proof-of-concept) code.

2 Learning objectives / Learning Outcomes

This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.
After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Furthermore, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal.

3 Recommended prerequisite for participation

sound knowledge of an object-oriented programming language (preferably Java)

4 Form of examination

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

5 Grading

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

6 Usability of this module

BSc ETiT, BSc iST, BSc Wi-ETiT

7 Grade bonus compliant to §25 (2)

8 References

www.es.tu-darmstadt.de/lehre/se-i-v/

Courses

Course Nr.	Course name		
18-su-1010-vl	Software Engineering - Introduction		
Instructor		**Type**	**SWS**
Prof. Dr. rer. nat. Andreas Schürr		Lecture	3
Course Nr.	**Course name**		
18-su-1010-ue	Software Engineering - Introduction		
Instructor		**Type**	**SWS**
Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Fritsche		Practice	1

Module name C/C++ Programming Lab					
Module Nr. 18-su-1030	**Credit Points** 3 CP	**Workload** 90 h	**Self study** 45 h	**Duration** 1	**Cycle offered** SoSe
Language German			**Module owner** Prof. Dr. rer. nat. Andreas Schürr		

1	**Content** The six-day programming lab is divided into two sections. In the first four days, the programming languages C and C++ are taught with practical tasks and lectures. All covered aspects are extensively practiced under supervision. Based on the fundamental basics of C++, manual memory management and dynamic data structures are handled from a procedural as well as from an object-oriented perspective. Object orientation with C++ is extensively addressed by treating multiple inheritance, polymorphism and parametric polymorphism. The last two days are dedicated to microcontroller programming in C including the opportunity of programming of a distributed application (via a CAN-bus).
2	**Learning objectives / Learning Outcomes** During the lab, the students acquire a fundamental understanding of the programming languages C and C++ with emphasis not only on procedural but also on object-oriented characteristics. The students gain hands-on experience with applying C++ and discover the challenges of using C++ safely and properly especially in the context of embedded system software development.
3	**Recommended prerequisite for participation** Java skills
4	**Form of examination** Module Final Examination: • Module Examination (Study Achievement, Optional, Standard Grading System)
5	**Grading** Module Final Examination: • Module Examination (Study Achievement, Optional, Weighting: 100 %)
6	**Usability of this module** BSc ETiT, BSc MEC, BSc iST, BSc Wi-ETiT
7	**Grade bonus compliant to §25 (2)**
8	**References** http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/c-und-c-p

Courses

Course Nr. 18-su-1030-pr	**Course name** C/C++ Programming Lab	
Instructor Prof. Dr. rer. nat. Andreas Schürr	**Type** Internship	**SWS** 3

Module name General Computer Science II					
Module Nr. 20-00-0290	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 120 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. rer. nat. Karsten Weihe		

1	**Content** In this course, students learn fundamental algorithms and data structures using advanced concepts of the programming language Java. Recapitulation Basic Java: * Variables, Types, Classes, Program Flow * Inheritance, Abstract Classes, Interfaces * Arrays and Collections Advanced Programming Concepts * Graphical User Interfaces * Input/Output * Error Handling and Exceptions Algorithms and Data Structures * Recursion * Sorting algorithms * Stacks, Lists, Queues, * Search * Trees and Graphs
2	**Learning objectives / Learning Outcomes** After completion of this course, students are able to - write larger programs in Java - use fundamental algorithms and data structures of computer science - estimate and compare the quality of elementary algorithms with respect to complexity and run-time
3	**Recommended prerequisite for participation** General Computer Science I or - elementary programming skills in Java - basic knowledge in computer science - working with computers
4	**Form of examination** Module Eccompanying Examination: • [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module**
7	**Grade bonus compliant to §25 (2)**
8	**References**

Java lernen mit BlueJ: Eine Einführung in die objektorientierte Programmierung David J. Barnes, Michael Kölling Pearson Studium 4., aktualisierte Auflage, 2009
ISBN-13: 978-3-8689-4001-5
Algorithmen in Java
Robert Sedgewick
Pearson Studium
3. überarbeitete Auflage, 2003
ISBN-13: 978-3-8273-7072-3
Einführung in die Programmierung mit Java Robert Sedgewick, Kevin Wayne Pearson Studium 1. Auflage, 2011
ISBN-13: 978-3-8689-4076-3

Courses

Course Nr.	**Course name**		
20-00-0290-iv	General Computer Science II		
Instructor		**Type** Integrated Course	**SWS** 4

Module name Information Management					
Module Nr. 20-00-0015	**Credit Points** 5 CP	**Workload** 150 h	**Self study** 105 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. phil. nat. Marc Fischlin		

1 Content

Information Management Concepts:
Information systems concepts
Information storage/retrieval, searching, browsing, navigational vs. declarative access
Quality issues: consistency, scalability, availability, reliability
Data Modeling:
Conceptual data models (ER/UML structure diagr.)
Conceptual design
Operational models (relational model)
Mapping from conceptual to operational model
Relational Model:
Operators
Relational algebra
Relational calculus
Implications on query languages derived from RA and RC
Design theory, normalization
Query Languages
SQL (in detail)
QBE, Xpath, rdf (high level)
Storage media
RAID, SSDs
Buffering, caching
Implementation of relational operators:
Implementation algorithms
Cost functions
Query optimization:
Heuristic query optimization
Cost based query optimization
Transaction processing (concurrency control and recovery):
Flat transactions
Concurrency control, correctness criteria: serializability, recoverability, ACA, strictness
Isolation levels
Lock-based schedulers, 2PL
Multiversion concurrency control
Optimistic schedulers
Logging
Checkpointing
Recovery/restart
New trends in data management
Main memory databases
Column stores
NoSQL

2 Learning objectives / Learning Outcomes

	After successfully attending the course, students are familiar with the fundamental concepts of information management. They understand the techniques for realizing information management systems and can apply the models, algorithms and languages to independently use and (partially) implement information management systems that fulfill the given requirements. They are able to evaluate such systens in a number of quality metrics.
3	**Recommended prerequisite for participation** Recommended: Participation of lecture „Funktionale und Objektorientierte Programmierkonzepte“ and „Algorithmen und Datenstrukturen“, respective according knowledge.
4	**Form of examination** Module Eccompanying Examination: • [20-00-0015-iv] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0015-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik B.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik May be used in other degree programs.
7	**Grade bonus compliant to §25 (2)** In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.
8	**References** Will be updated regularly, an example might be: Haerder, Rahm, “Datenbanksysteme - Konzepte und Techniken der Implementierung”, Springer 1999 Elmasri, R., Navathe, S. B.: Fundamentals of Database Systems, 3rd. ed., Redwood City, CA: Benjamin/Cummings Ullman, J. D.: Principles of Database and Knowledge-Base Systems, Vol. 1 Computer Science

Courses

	Course Nr.	**Course name**		
	20-00-0015-iv	Information Management		
	Instructor		**Type** Integrated Course	**SWS** 3

Module name Computer Security					
Module Nr. 20-00-0018	**Credit Points** 5 CP	**Workload** 150 h	**Self study** 105 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. phil. nat. Marc Fischlin		

1	**Content** Part I: Cryptography - Background in Mathematics for cryptography - Security objectives: Confidentiality, Integrity, Authenticity - Symmetric and Asymmetric Cryptography - Hash functions and digital signatures - Protocols for key distribution Part II: IT-Security and Dependability - Basic concepts of IT security - Authentication and biometrics - Access control models and mechanisms - Basic concepts of network security - Basic concepts of software security - Dependable systems: error tolerance, redundancy, availability
2	**Learning objectives / Learning Outcomes** After successfully attending the course, students are familiar with the basic concepts, methods and models in the areas of cryptography and computer security. They understand the most important methods that allow to secure software and hardware systems against attackers and are able to apply this knowledge to concrete application scenarios.
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Eccompanying Examination: • [20-00-0018-iv] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0018-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik B.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik B.Sc. Informationssystemtechnik May be used in other degree programs.
7	**Grade bonus compliant to §25 (2)** In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.
8	**References** - J. Buchmann, Einführung in die Kryptographie, Springer-Verlag, 2010 - C. Eckert, IT-Sicherheit, Oldenbourg Verlag, 2013 - M. Bishop, Computer Security: Art and Science, Addison Wesley, 2004

Courses

	Course Nr. 20-00-0018-iv	**Course name** Computer Security		
	Instructor		**Type** Integrated Course	**SWS** 3

Module name Computational Engineering and Robotics					
Module Nr. 20-00-0011	**Credit Points** 5 CP	**Workload** 150 h	**Self study** 105 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. phil. nat. Marc Fischlin		

1	**Content** - Foundations of modelling and simulation - Problem specification and system description for computational engineering - Model generation for the example of mechanical systems - Model analysis for the example of mechanical systems - Implementations of simulations for the example of robots and other systems - Interpretation and validation using measurement data - Applications in simulation and control of robots as well as in physically based animation and computer games
2	**Learning objectives / Learning Outcomes** Upon successful completion of this class, students will be able to develop first models and simulations and can perform first simulation studies within robotics. They know the necessary key steps needed to construct simulations (problem specification, model generation, model analysis, implementation, and validation) and can use them to construct first simulations to meet the specification requirements.
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Eccompanying Examination: • [20-00-0011-iv] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0011-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik B.Sc. Wirtschaftsinformatik B.Sc. Computational Engineering B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik B.Sc. Informationssystemtechnik May be used in other degree programs.
7	**Grade bonus compliant to §25 (2)** In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.
8	**References** F. Föllinger: Einführung in die Zustandsbeschreibung dynamischer Systeme (Oldenbourg, 1982) P. Corke: Robotics, Vision & Control, Springer, 2011 F.L. Severance: System Modeling and Simulation: An Introduction, J. Wiley & Sons, 2001
Courses	

	Course Nr. 20-00-0011-iv	**Course name** Computational Engineering and Robotics		
	Instructor		**Type** Integrated Course	**SWS** 3

Module name Visual Computing					
Module Nr. 20-00-0014	**Credit Points** 5 CP	**Workload** 150 h	**Self study** 105 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. phil. nat. Marc Fischlin		

1 Content

- Basics of perception
- Basic Fourier transformation
- Images, filtering, compression & processing
- Basic object recognition
- Geometric transformations
- Basic 3D reconstruction
- Surface and scene representations
- Rendering algorithms
- Color: Perception, spaces & models
- Basic visualization

2 Learning objectives / Learning Outcomes

After successful participation in the course students are able to describe the foundational concepts as well as the basic models and methods of visual computing. They explain important approaches for image synthesis (computer graphics & visualization) and analysis (computer vision) and can solve basic image synthesis and analysis tasks.

3 Recommended prerequisite for participation

Recommended:
Participation of lecture “Mathematik I/II/III”.

4 Form of examination

Module Eccompanying Examination:

- [20-00-0014-iv] (Technical Examination, Written/Oral Examination, Standard BWS)

5 Grading

Module Eccompanying Examination:

- [20-00-0014-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)

6 Usability of this module

B.Sc. Informatik
B.Sc. Wirtschaftsinformatik
B.Sc. Psychologie in IT
Joint B.A. Informatik
B.Sc. Sportwissenschaft und Informatik
M.Sc. Sportwissenschaft und Informatik
B.Sc. Computational Engineering
B.Sc. Informationssystemtechnik
May be used in other degree programs.

7 Grade bonus compliant to §25 (2)

In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.

8 References

Literature recommendations will be updated regularly, an example might be:
- R. Szeliski, “Computer Vision: Algorithms and Applications”, Springer 2011
- B. Blundell, “An Introduction to Computer Graphics and Creative 3D Environments”, Springer 2008

Courses

	Course Nr. 20-00-0014-iv	**Course name** Visual Computing		
	Instructor		**Type** Integrated Course	**SWS** 3

Module name Computer Networks and Distributed Systems					
Module Nr. 20-00-0016	**Credit Points** 5 CP	**Workload** 150 h	**Self study** 105 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. phil. nat. Marc Fischlin		

1	**Content** Overview of Net-Centric Computing (NCC), a basic element of modern computer science. Fundamental network concepts of modeling, planning and evaluating net-centric systems - Foundations: Service, protococols, connection, layer model - protocol mechanisms for media access, routing, broad-/multicast - Multimedia Data Handling - Aspects of continuous data streams and their processing - Quality of service: definition and mechanisms - Multimedia - Synchronisation: Basics - Compression procedures;
2	**Learning objectives / Learning Outcomes** - Overview knowledge of relevant areas and basic problems of net-centric computing (NCC) - Reproducible comprehension of selected, elementary algorithms, protocols and procedures used in the internet - Applicable methodological knowledge of widely applied elements of the modeling and engineering of NCC-systems NCC is, in this context, understood as “internet technology in the broadcast sense”. It covers, in particular, themes of the "classical areas" constituted by computer networks, distributed systems, multimedia and mobile communication/ mobile computing, as those from "modern areas", such as ubiquitous/pervasive computing, peer-to-peer-computing or ambient intelligence. The canonical lecture "Introduction to NCS" focusses on the area of computer networks, the understanding of which is fundamental for all other listed areas; the latter will be the subject matter of advanced lectures in the area of NCS.
3	**Recommended prerequisite for participation** Recommended: Funktionale und objektorientierte Programmierkonzepte“, „Algorithmen und Datenstrukturen“, „Betriebssysteme“, „Einführung in den Compilerbau“, „Rechnerorganisation“ und „Systemnahe and parallele Programmierung“.
4	**Form of examination** Module Eccompanying Examination: • [20-00-0016-iv] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0016-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik B.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik B.Sc. Informationssystemtechnik May be used in other degree programs.
7	**Grade bonus compliant to §25 (2)**

	In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.
8	**References** Main literature: - A. Tanenbaum, D. Wetherall: Computernetzwerke, 5te Aufl., Pearson Studium 2012 - (englisch: Computer Networks, 5th Ed., Prentics Hall 2010) - J. Kurose, K. Ross: Computernetzwerke; Pearson Studium 2012 (also in english by Prentice Hall) Selected chapters of: - G. Coulouris, J. Dollimore, T. Kindberg: Distributed Systems – Concept and Design, Pearson Studium - G. Krüger, D. Reschke: „Lehr- und Übungsbuch Telematik“ - L. Kleinrock: Queueing Systems, vol. 1 (Wiley) - W.R. Stevens: Unix Network Programming, Volume 1: The Sockets Networking API (Addison Wesley)

Courses

	Course Nr.	**Course name**		
	20-00-0016-iv	Computer Networks and distributed Systems		
	Instructor		**Type** Integrated Course	**SWS** 3

Module name Modeling, Specification and Semantics					
Module Nr. 20-00-0013	**Credit Points** 5 CP	**Workload** 150 h	**Self study** 105 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. phil. nat. Marc Fischlin		

1 Content

- introduction to modeling using predicate logic and algebraic concepts
- interpretation and faithfulness of formal models
- systematic construction of models and making of design decisions
- abstraction, refinement, composition, and decomposition of models
- syntax and operational semantics of programming languages
- elementary proof techniques and their use
- introduction to specification languages
- syntax and denotational semantics of specification languages
- modeling communication and coordination in concurrent systems
- taxonomy of system properties

2 Learning objectives / Learning Outcomes

After successfully participating in this course, students know basic concepts in the areas modeling, specification, and semantics. They are able to use predicate logic and algebraic concepts to formalize given, informally described scenarios. They are able to develop formal models in a systematic fashion, to make necessary design decisions, and to employ informal notation and graphics to facilitate the construction of formal models. They know selected formal specfication languages and are able to apply at least one such language. They understand the distinction between the syntax and semantics of formal languages and are able to prove propositions about expressions as well as simple meta-properties about the languages themselves. They are able to formalize basic system requirements as predicates and can assess the faithfulness of such formalizations.

3 Recommended prerequisite for participation

Recommended:
Participation of lecture “Automaten, formale Sprachen und Entscheidbarkeit” and “Aussagen- und Prädikatenlogik”, respective according knowledge.

4 Form of examination

Module Eccompanying Examination:

- [20-00-0013-iv] (Technical Examination, Written/Oral Examination, Standard BWS)

5 Grading

Module Eccompanying Examination:

- [20-00-0013-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)

6 Usability of this module

B.Sc. Informatik
B.Sc. Wirtschaftsinformatik
B.Sc. Psychologie in IT
Joint B.A. Informatik
B.Sc. Sportwissenschaft und Informatik
May be used in other degree programs.

7 Grade bonus compliant to §25 (2)

In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.

8 References

U. Kastens, H. Kleine Büning: Modellierung - Grundlagen und formale Methoden, Hanser
G. Winskel: The Formal Semantics of Programming Languages, MIT Press
C. A. R. Hoare: Communicating Sequential Processes, Prentice-Hall
Literature recommendations will be updated regularly.

Courses

Course Nr.	**Course name**		
20-00-0013-iv	Modellierung, Spezifikation und Semantik		
Instructor		**Type**	**SWS**
		Integrated Course	3

Module name					
Software Engineering					
Module Nr.	**Credit Points**	**Workload**	**Self study**	**Duration**	**Cycle offered**
20-00-0017	5 CP	150 h	105 h	1	Every 2. Sem.
Language			**Module owner**		
German			Prof. Dr. phil. nat. Marc Fischlin		

1 Content

Providing an overview of the main areas of software engineering and the skills necessary for modeling and implementing small software systems.
The main topics are:
- Software Project Management
- Software Process Models
- Requirements Engineering
- Software Development Tools
- Software Quality; in particular:
- Test Processes (automated testing, test coverage metrics, debugging)
- Software Metrics
- Object-oriented Analysis and Design
- Modeling using UML
- Software Design Patterns

2 Learning objectives / Learning Outcomes

After successfully completing the lecture, the students are able to perform the following tasks:
- name and classify the areas of Software Engineering in the context of software development projects;
- effectively use standard software development tools;
- perform basic quality assurance using automated tests;
- design and implement object-oriented systems using UML and design patterns.

3 Recommended prerequisite for participation

Recommended:
Funktionale und Objektorientierte Programmierkonzepte
Algorithmen und Datenstrukturen

4 Form of examination

Module Eccompanying Examination:
- [20-00-0017-iv] (Technical Examination, Written/Oral Examination, Standard BWS)

5 Grading

Module Eccompanying Examination:
- [20-00-0017-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)

6 Usability of this module

B.Sc. Informatik
B.Sc. Wirtschaftsinformatik
B.Sc. Psychologie in IT
Joint B.A. Informatik
B.Sc. Sportwissenschaft und Informatik
M.Sc. Sportwissenschaft und Informatik
B.Sc. Computational Engineering
B.Sc. Informationssystemtechnik
May be used in other degree programs.

7 Grade bonus compliant to §25 (2)

In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.

8 References

- Lehrbuch der Softwaretechnik: Softwaremanagement; H. Balzert; Springer
- Design Patterns - Elements of Reusable Object-Oriented Software; E. Gamma, R. Helm, R. Johnson, J. Vlissides; Prentice Hall
- Software Qualität - Testen, Analysieren und Verifizieren von Software; P. Liggesmeyer; Springer
- WHY PROGRAMS FAIL: A Guide to Systematic Debugging; A. Zeller; Morgan Kaufmann
- Writing Effective Use Cases; A. Cockburn; Pearson

Courses

Course Nr.	**Course name**		
20-00-0017-iv	Software Engineering		
Instructor		**Type** Integrated Course	**SWS** 3

Module name Architecture and Design of Computer Systems					
Module Nr. 20-00-0012	**Credit Points** 5 CP	**Workload** 150 h	**Self study** 105 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. phil. nat. Marc Fischlin		

1	**Content** - Technological foundations and trends in micro electronics - Design flows for microelectronic systems - Description of hardware systems - Characteristics of computing systems - Architectural support for parallel execution - Memory systems - Heterogeneous systems-on-chip - On-chip and off-chip communication structures - Embedded systems, including in context of cyber-physical systems
2	**Learning objectives / Learning Outcomes** After successfully attending the course, students are familiar with functional and non-functional requirements for heterogeneous discrete and integrated computing systems. They understand the techniques for realizing such systems and can use design methods and tools to apply the techniques to independently implement computing systems (or components thereof) that fulfill the given requirements. They are able to evaluate computing systems in a number of quality metrics.
3	**Recommended prerequisite for participation** Recommended: Pass of lecture „Digitaltechnik“ and „Rechnerorganisation“, respectively according knowledge.
4	**Form of examination** Module Eccompanying Examination: • [20-00-0012-iv] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0012-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik B.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik B.Sc. Informationssystemtechnik May be used in other degree programs.
7	**Grade bonus compliant to §25 (2)**
8	**References** Literature recommendations will be updated regularly, an example might be: Nikhil/Czeck: Bluespec by Example Arvind/Nikhil/Emer/Vijayaraghavan: Computer Architecture: A Constructive Approach Hennessy/Patterson: Computer Architecture – A Quantitative Approach Crockett/Elliott/Enderwitz/Stewart: The Zynq Book Flynn/Luk: Computer System Design Sass/Schmidt: Embedded Systems Design
Courses	

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

Module name					
Image Processing					
Module Nr.	**Credit Points**	**Workload**	**Self study**	**Duration**	**Cycle offered**
20-00-0155	3 CP	90 h	60 h	1	Every 2. Sem.
Language			**Module owner**		
German			Prof. Dr. Bernt Schiele		

1 Content

Fundamentals of image processing:
- Image properties
- Image transformations
- Simple and complex filtering
- Image compression,
- Segmentation
- Classification

2 Learning objectives / Learning Outcomes

After successfully completing the course, students have an overview over the mechanisms used in and the abilities of modern image processing techniques. They are able to solve basic to medium level problems in image processing.

3 Recommended prerequisite for participation

4 Form of examination

Module Eccompanying Examination:
- [20-00-0155-iv] (Technical Examination, Written/Oral Examination, Standard BWS)

5 Grading

Module Eccompanying Examination:
- [20-00-0155-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)

6 Usability of this module

B.Sc. Informatik
M.Sc. Informatik
B.Sc. Computational Engineering
M.Sc. Computational Engineering
M.Sc. Wirtschaftsinformatik
B.Sc. Psychologie in IT
Joint B.A. Informatik
B.Sc. Sportwissenschaft und Informatik
M.Sc. Sportwissenschaft und Informatik
May be used in other degree programs.

7 Grade bonus compliant to §25 (2)

8 References

- Gonzalez, R.C., Woods, R.E., “”Digital Image Processing"", Addison- Wesley Publishing Company, 1992
- Haberaecker, P., ""Praxis der Digitalen Bildverarbeitung und Mustererkennung"", Carl Hanser Verlag, 1995
- Jaehne, B., ""Digitale Bildverarbeitung"", Springer Verlag, 1997

Courses

Course Nr.	Course name		
20-00-0155-iv	Image Processing		
Instructor		**Type**	**SWS**
		Integrated Course	2

Module name Medical Image Processing					
Module Nr. 20-00-0379	**Credit Points** 3 CP	**Workload** 90 h	**Self study** 60 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. Bernt Schiele		

1	**Content** The lecture consists of two parts. The first half of the lecture describes how devices that yield medical image data (CT, NMR, PET, SPECT, Ultrasound) work. The second half of the lecture covers various image processing techniques that are typically applied to medical images.
2	**Learning objectives / Learning Outcomes** After successfully completing the course, students have an overview over the mechanisms used in and the abilities of modern medical image processing techniques. They are able to solve basic to medium level problems in medical image processing.
3	**Recommended prerequisite for participation** Basics within Mathematics are highly recommended. Participation in lecture “Bildverarbeitung”.
4	**Form of examination** Module Eccompanying Examination: • [20-00-0379-vl] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0379-vl] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs.
7	**Grade bonus compliant to §25 (2)**
8	**References** 1) Heinz Handels: Medizinische Bildverarbeitung 2) 2) Gonzalez/Woods: Digital Image Processing (last edition) 3) 3) Bernd Jähne: Digitale Bildverarbeitung. 6. überarbeitete und erweiterte Auflage. Springer, Berlin u. a. 2005, ISBN 3-540-24999-0 4) Kristian Bredies, Dirk Lorenz: Mathematische Bildverarbeitung. Einführung in Grundlagen und moderne Theorie. Vieweg+Teubner, Wiesbaden 2011, ISBN 978-3-8348-1037-3

Courses

Course Nr. 20-00-0379-vl	**Course name** Medical Image Processing		
Instructor		**Type** Lecture	**SWS** 2

Module name Visualization in Medicine					
Module Nr. 20-00-0467	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 120 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. Bernt Schiele		

1	**Content** Medical Image Data; Image Processing; Medical Visualization with VTK; Indirect Volume Visualization; Direct Volume Visualization; Transfer Functions; Interactive Volume Visualization; Illustrative Rendering; Example: Visualization of Tensor Image Data; Example: Visualization of Tree Structures; Example: Virtual Endoscopy; Image-guided Surgery
2	**Learning objectives / Learning Outcomes** After successfully attending the course, students are familiar with volume visualization techniques. They understand the necessity of image enhancement for the visualization. They can use the "Visualization Toolkit" (VTK) to apply the techniques to implement computing systems for the visualization of medical image data for diagnosis, planning and therapy.
3	**Recommended prerequisite for participation** Useful but not mandatory: GDV I, (Medical) Image processing
4	**Form of examination** Module Eccompanying Examination: • [20-00-0467-iv] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0467-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs.
7	**Grade bonus compliant to §25 (2)** In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.
8	**References** Preim, Botha: Visual Computing for Medicine

Courses

	Course Nr. 20-00-0467-iv	**Course name** Medical Visualization	
	Instructor	**Type** Integrated Course	**SWS** 4

Module name Current Trends in Medical Computing					
Module Nr. 20-00-0468	**Credit Points** 3 CP	**Workload** 90 h	**Self study** 60 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German			**Module owner** Prof. Dr. Bernt Schiele		

1	**Content** - Participants independently familiarize themselves with a chosen seminar topic by working with the provided initial scientific papers (usually English-language texts) - Deeper and/or wider library research originating from the initially provided papers - Critical discussion of the provided topic - Preparation of a presentation (written text and slides) about the topic - Giving a talk in front of a heterogenous (mixed prior knowledge) audience - Interactive discussion after the presentation - Medical application areas include oncology, orthopedics and navigated surgery. Learning about methods related to medical image processing: segmentation, registration, visualization, simulation, navigation, tracking and others.
2	**Learning objectives / Learning Outcomes** Successful participation in the course enables students to become acquainted with an unfamilar topic by working with scientific papers. They recognize the essential aspects of the examined works and are able to concisely present them to an audience with mixed prior knowledge on the subject. They apply a number of presentation techniques in the process. The students are able to actively guide and participate in a scientific discussion on the presented topic.
3	**Recommended prerequisite for participation** Bachelor from 4. Semester or Master students.
4	**Form of examination** Module Eccompanying Examination: • [20-00-0468-se] (Study Achievement, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0468-se] (Study Achievement, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs.
7	**Grade bonus compliant to §25 (2)**
8	**References** Will be announced in seminar.
Courses	

	Course Nr. 20-00-0468-se	**Course name**		
	Instructor		**Type** Seminar	**SWS** 2

Module name Serious Games					
Module Nr. 20-00-0366	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 120 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German and English			**Module owner** Prof. Dr. Bernt Schiele		

1	**Content** Introduction to the topic of “”Serious Games"": scientific and technical foundations, application areas and trends. Individual lectures include: * Introduction to Serious Games * Game Development, Game Design * Game Technology, Tools and Engines * Personalization and Adaptation * Interactive Digital Storytelling * Authoring and Content Generation * Multiplayer Games * Game Interfaces and Sensor Technology * Effects, Affects and User Experience * Mobile Games * Serious Games Application Domains and Best Practice Examples The exercise consists of theoretical and practical parts. Students are taught how to use a Game Engine.
2	**Learning objectives / Learning Outcomes** After successfully completing this course the students are able to explain the concept of “Serious Games” and can transfer it to different application domains (like education or health). They can describe the general approach for developing computer games and can apply basic principles of game design, personalisation / adaptation and interactive digital storytelling. Aside from that students are able to sketch out other current research questions regarding Serious Games as well as their solutions.
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Eccompanying Examination: • [20-00-0366-iv] (Technical Examination, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0366-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs.
7	**Grade bonus compliant to §25 (2)** In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.
8	**References**

	Will be given in lecture.

Courses

Course Nr. 20-00-0366-iv	**Course name** Serious Games		
Instructor		**Type** Integrated Course	**SWS** 4

Module name					
Serious Games Seminar					
Module Nr.	**Credit Points**	**Workload**	**Self study**	**Duration**	**Cycle offered**
20-00-0328	4 CP	120 h	90 h	1	Every 2. Sem.
Language			**Module owner**		
German and English			Prof. Dr.-Ing. Michael Gösele		

1	**Content** In this seminar the students will analyze and discuss the current state of the art for serious games (e.g. in education, health and sports). The topics relate to current research questions in the field, partly in cooperation with partners from the games industry and/or Serious Games users.
2	**Learning objectives / Learning Outcomes** After successfully completing this course the students are able to become acquainted with an unfamiliar subject in the field of "Serious Games". They are familiar with library research techniques for scientific papers and industry sources. The techniques and results mentioned in these references can be summarized, assessed and compared to each other. Besides, the students are able to present their findings in front of an audience applying a number of different presentation techniques and to actively participate in a scientific discussion on their topic.
3	**Recommended prerequisite for participation**
4	**Form of examination** Module Eccompanying Examination: • [20-00-0328-se] (Study Achievement, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0328-se] (Study Achievement, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs.
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

Course Nr.	**Course name**		
20-00-0328-se	Serious Games Seminar		
Instructor		**Type**	**SWS**
Prof. Dr.-Ing. Michael Gösele		Seminar	2

Module name Serious Games Lab					
Module Nr. 20-00-0236	**Credit Points** 6 CP	**Workload** 180 h	**Self study** 120 h	**Duration** 1	**Cycle offered** Every 2. Sem.
Language German and English			**Module owner** Prof. Dr.-Ing. Michael Gösele		

1 Content

In this lab the students will design concepts and implement prototypes in the field of serious games (e.g. in education, health and sports).
The topics relate to current research questions in the field, partly in cooperation with partners from the games industry and/or Serious Games users.

2 Learning objectives / Learning Outcomes

After successfully attending the course, the students can conceptualize and prototypically implement practical tasks in the context of "Serious Games". Besides, the students are able to present their findings in front of an audience applying a number of different presentation techniques and to actively participate in a scientific discussion on their topic.

3 Recommended prerequisite for participation

Programming skills (depending on topic).

4 Form of examination

Module Eccompanying Examination:

- [20-00-0236-pr] (Study Achievement, Written/Oral Examination, Standard BWS)

5 Grading

Module Eccompanying Examination:

- [20-00-0236-pr] (Study Achievement, Written/Oral Examination, Weighting: 100 %)

6 Usability of this module

B.Sc. Informatik
M.Sc. Informatik
B.Sc. Computational Engineering
M.Sc. Computational Engineering
M.Sc. Wirtschaftsinformatik
B.Sc. Psychologie in IT
Joint B.A. Informatik
B.Sc. Sportwissenschaft und Informatik
M.Sc. Sportwissenschaft und Informatik
May be used in other degree programs.

7 Grade bonus compliant to §25 (2)

8 References

Courses

Course Nr. 20-00-0236-pr	**Course name** Serious Games Lab		
Instructor Prof. Dr.-Ing. Michael Gösele		**Type** Internship	**SWS** 4

Module name					
Serious Games Project					
Module Nr.	**Credit Points**	**Workload**	**Self study**	**Duration**	**Cycle offered**
20-00-0649	9 CP	270 h	180 h	1	Every 2. Sem.
Language			**Module owner**		
German and English			Prof. Dr.-Ing. Michael Gösele		

1	**Content** In this project the students will design concepts and implement prototypes in the field of serious games (e.g. in education, health and sports). The topics relate to current research questions in the field, partly in cooperation with partners from the games industry and/or Serious Games users.
2	**Learning objectives / Learning Outcomes** After successfully attending the course, the students can conceptualize and prototypically implement practical tasks in the context of "Serious Games". Additionally they acquire practical knowledge in the area of project management, which they can apply to their own topic as well as transfer it to future projects. Besides, the students are able to present their findings in front of an audience applying a number of different presentation techniques and to actively participate in a scientific discussion on their topic.
3	**Recommended prerequisite for participation** Programming skills (the language will depended on the topic and may be chosen at will for certain topics).
4	**Form of examination** Module Eccompanying Examination: • [20-00-0649-pp] (Study Achievement, Written/Oral Examination, Standard BWS)
5	**Grading** Module Eccompanying Examination: • [20-00-0649-pp] (Study Achievement, Written/Oral Examination, Weighting: 100 %)
6	**Usability of this module** B.Sc. Informatik M.Sc. Informatik B.Sc. Computational Engineering M.Sc. Computational Engineering M.Sc. Wirtschaftsinformatik B.Sc. Psychologie in IT Joint B.A. Informatik B.Sc. Sportwissenschaft und Informatik M.Sc. Sportwissenschaft und Informatik Can be used in other degree programs.
7	**Grade bonus compliant to §25 (2)**
8	**References**

Courses

	Course Nr.	**Course name**		
	20-00-0649-pp	Serious Games Project		
	Instructor		**Type**	**SWS**
	Prof. Dr.-Ing. Michael Gösele		Internship	6

7 Open Optional Subjects

Complete Catalogue of all modules FB 18 Electrical Engineering and Information Technology

8 Studium Generale

Modules for the Studium Generale can be found in a separate module handbook for the Studium Generale.