UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Bachelor Biophysics 2016

Version from 1. October 2019

1st and 2nd semester

1st semester

2nd semester

3rd semester

4th semester

5th and 6th semester

5th semester

6th semester

LS1610-KP04 - Practical course chemistry (ACPKP04)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor CLS 2016 (compulsory), life sciences, 4th semester
- Bachelor Biophysics 2016 (compulsory), life sciences, 1st and 2nd semester

Classes and lectures:

- Practical course chemistry (practical course, 4 SWS)

Workload:

- 80 Hours private studies
- 40 Hours in-classroom work

Contents of teaching:

- Practical course:
- The students work independently under supervision
- Selected experiments related to topics of the lectures general and organic chemistry

Qualification-goals/Competencies:

- From their independent work in the lab course students have fundamental practical skills to perform simple experiments and analyzes in the chemical laboratory. They are competent in basic techniques of the handling of hazardous materials according to GHS (Globally Harmonized System of Classification and Labeling of Chemicals).
- Students are capable to document, interpret and present the results of conducted experiments (laboratory journal and concluding discussion).

Grading through:

- Continuous, successful participation in practical course. All experiments have to be conducted.

Requires:

- General Chemistry (LS1100-KP04)

Responsible for this module:

- PD Dr. phil. nat. Thomas Weimar

Teacher:

- Institute of Medical Engineering
- Dr. rer. nat. Kerstin Lüdtke-Buzug
- Dr. rer. nat. Thorsten Biet

Literature:

- Thomas Weimar: Script of the practical course

Language:

- offered only in German

Notes:

Course ist not graded. In order to pass the course students have to conduct experiments within defined error margins and present an experiment of the course in a talk.

LS1100-KP04 - General Chemistry (ACKP04)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, arbitrary semester
- Bachelor Computer Science 2019 (optional subject), Canonical Specialization Bioinformatics and Systems Biology, 3rd semester
- Bachelor MES 2020 (optional subject), mathematics / natural sciences
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), advanced curriculum, arbitrary semester
- Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester
- Bachelor Computer Science 2016 (optional subject), Canonical Specialization Bioinformatics, 3rd semester
- Bachelor CLS 2016 (compulsory), life sciences, 3rd semester
- Bachelor Biophysics 2016 (compulsory), life sciences, 1st semester

Classes and lectures:

- General Chemistry (lecture, 3 SWS)
- General Chemistry (exercise, 1 SWS)

Workload:

- 60 Hours private studies
- 60 Hours in-classroom work

Contents of teaching:

- Lectures:
- The structure of atoms and the periodic table of the elements
- Chemical bonds, molecules and Ions
- Reaction equations and stoichiometry
- The threedimensional structure of molecules: From the VSEPR model to molecular orbitals
- Special properties of water
- Chemical equilibrium
- Acids and bases
- Redox reactions and electrochemistry
- Complexes and metal-ligand bonds
- Interactions between mater and radiation - Molecular spectroscopy
- Thermodynamics
- Chemical kinetics
- Exercises:
- Students discuss problems covering all topics of the lectures on the black board

Qualification-goals/Competencies:

- Students have fundamental knowledge of general and inorganic chemistry.
- Students understand the fundamental concepts of general and inorganic chemistry and can apply them to reactions and general scientific topics.
- Students are able to perform chemical calculations from all subareas of the course.
- They can transfer the acquired knowledge to problems of other branches in chemistry and related sciences and are thus able to participate in continuative courses.

Grading through:

- written exam

Is requisite for:

- Practical course chemistry (LS1610-KP04)
- Organic Chemistry (LS1600-KP04)

Responsible for this module:

- PD Dr. phil. nat. Thomas Weimar

Teacher:

- Institute of Chemistry and Metabolomics
- PD Dr. phil. nat. Thomas Weimar

Literature:

- Schmuck et al.: Chemie für Mediziner - Pearson Studium
- Binnewies et al.: Allgemeine und Anorganische Chemie - Spektrum Verlag

Language:

- offered only in German

MA1000-KP08, MA1000 - Linear Algebra and Discrete Structures 1 (LADS1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Media Informatics 2020 (compulsory), mathematics, 3rd semester
- Bachelor Computer Science 2019 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2019 (compulsory: aptitude test), mathematics, 1st semester
- Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 3rd semester
- Bachelor Computer Science 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor CLS 2016 (compulsory), mathematics, 1st semester
- Bachelor IT-Security 2016 (compulsory), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Biophysics 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor MES 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Media Informatics 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Computer Science 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2011 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Computer Science 2012 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor MES 2011 (compulsory), mathematics, 1st semester
- Bachelor CLS 2010 (compulsory), mathematics, 1st semester

Classes and lectures:

- Linear Algebra and Discrete Structures 1 (lecture, 4 SWS)
- Linear Algebra and Discrete Structures 1 (exercise, 2 SWS)

Workload:

- 125 Hours private studies and exercises
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Fundamentals: logic, sets, mappings
- Relations, equivalence relations, orderings
- Proof by induction
- Groups: fundamentals, finite groups, permutations, matrices
- Rings, fields, congruencies
- Complex numbers: calculus, representation, roots of unity
- Vector spaces: bases, dimension, scalar product, norms

Qualification-goals/Competencies:

- Students understand the fundamental concepts of linear algebra.
- They understand basic thought processes and methods of proof.
- They can explain fundamental relationships in linear algebra.
- They can apply fundamental concepts and methods of proof to algebraic problems.
- They have an understanding of abstract thought processes.
- Interdisciplinary qualifications:
- Students have basic competency in modelling.
- They can transfer fundamental theoretical concepts to similar applications.
- They can work on elementary mathematics problems within a team.
- They can present elementary solutions to their problems to a group.

Grading through:

- written exam

Is requisite for:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)

Responsible for this module:

- Prof. Dr. rer. nat. Jan Modersitzki

Teacher:

- Institute of Mathematics and Image Computing
- Prof. Dr. rer. nat. Jan Modersitzki
- Prof. Dr. rer. nat. Jan Lellmann

Literature:

- G. Fischer: Lineare Algebra: Eine Einführung für Studienanfänger - Vieweg+Teubner
- G. Strang: Lineare Algebra - Springer
- K. Jänich: Lineare Algebra - Springer
- D. Lau: Algebra und diskrete Mathematik I + II - Springer
- G. Strang: Introduction to Linear Algebra - Cambridge Press
- K. Rosen: Discrete Mathematics and Its Applications - McGraw-Hill

Language:

- offered only in German

Notes:

Prerequisite tasks for taking the exam can be announced at the beginning of the semester. If any prerequisite tasks are defined, they must be completed and passed before taking the exam for the first time.

MA2000-KP08, MA2000 - Analysis 1 (Ana1KP08)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Media Informatics 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Computer Science 2019 (compulsory), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2019 (compulsory), mathematics, 1st semester
- Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 5th semester
- Bachelor Computer Science 2016 (compulsory), mathematics, 1st semester
- Bachelor CLS 2016 (compulsory), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor IT-Security 2016 (compulsory), mathematics, 1st semester
- Bachelor Biophysics 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2014 (compulsory), mathematics, 1st semester
- Bachelor Media Informatics 2014 (compulsory), mathematics, 1st semester
- Bachelor MES 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Computer Science 2014 (compulsory), mathematics, 1st semester
- Bachelor Medical Informatics 2011 (compulsory), mathematics, 3rd semester
- Bachelor CLS 2010 (compulsory), mathematics, 1st semester
- Bachelor MES 2011 (compulsory), mathematics, 1st semester
- Bachelor Computer Science 2012 (compulsory), mathematics, 3rd semester

Classes and lectures:

- Analysis 1 (lecture, 4 SWS)
- Analysis 1 (exercise, 2 SWS)

Workload:

- 125 Hours private studies
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Sequences and series
- Functions and continuity
- Differentiability, Taylor series
- Multivariate differential calculus

Qualification-goals/Competencies:

- Students understand the basic concepts of analysis.
- Students understand the basic thoughts and proof techniques.
- Students can explain basic relationships in analysis.
- Students can apply the basic concepts and proof techniques.
- Students have an understanding for abstract structures.
- Interdisciplinary qualifications:
- Students have a basic competence in modeling.
- Students can transfer theoretical concepts to similar applications.
- Students can work as a group on elementary mathematical problems.
- Students can present elementary solutions to their problems in front of a group.

Grading through:

- e-tests

Is requisite for:

- Analysis 2 (MA2500-MML)
- Analysis 2 (MA2502-MIW)
- Analysis 2 (UngenutztMA2500-MIWSJ14)
- Analysis 2 (MA2500-KP08)
- Analysis 2 (MA2500-KP09)
- Analysis 2 (MA2500-KP04, MA2500)

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics
- Prof. Dr. rer. nat. Jürgen Prestin

Literature:

- K. Fritzsche: Grundkurs Analysis 1 +2
- H. Heuser: Lehrbuch der Analysis 1+2

Language:

- offered only in German

Notes:

Prerequisites for admission to the examination can be determined at the beginning of the semester. If such prerequisites are defined, they must have been fulfilled prior to the first attempt at the examination and must have been rated as positive.

ME1010-KP08, ME1010 - Physics 1 (Phy1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory: aptitude test), physics, 1st semester
- Bachelor Biophysics 2016 (compulsory: aptitude test), physics, 1st semester
- Bachelor MES 2014 (compulsory: aptitude test), physics, 1st semester
- Bachelor MES 2011 (compulsory), physics, 1st semester

Classes and lectures:

- Physics 1 (lecture, 4 SWS)
- Physics 1 (exercise, 2 SWS)

Workload:

- 110 Hours private studies
- 90 Hours in-classroom work
- 40 Hours exam preparation

Contents of teaching:

- Physical values, units, accuracy, measurement errors
- Mathematical methods and notations
- Kinematics of point mass, Newton s Axioms, contact forces, modulus, virtual forces, Newton s equation of motion, differential equations
- Work and energy, power and efficiency, momentum, inertia, physical pendulum, momentum of rotation
- Conservation laws and symmetries
- Gravitation, oscillation, waves, acoustics, Doppler effect
- Resting and flowing gases and liquids, effects of surfaces and interfaces
- Temperature, thermometer, therm. expansion, state equations, kinetic gas theory
- Van-der-Waals state equation, heat capacity, heat conduction, 1st law of thermodynamics, volume work, p-V diagram
- Adiabatic processes, 2nd law of thermodynamics, thermal engines and Carnot cycle, efficiency, heat pump
- Entropy, disorder and probability, 3rd law of thermodynamics

Qualification-goals/Competencies:

- You can name the basic laws of physics
- You can measure according to physics rules
- You can explain physical laws based on observations
- You can formally analyze physical problems
- You can judge which concept is best suited to solve a certain problem
- You can design novel physical experiments on your own

Grading through:

- written exam

Is requisite for:

- Physics 2 (ME1020-KP08, ME1020)

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institute of Biomedical Optics
- Institute of Physics
- Institute of Medical Engineering

- Prof. Dr. rer. nat. Thorsten Buzug
- Prof. Dr. rer. nat. Christian Hübner
- PD Dr. rer. nat. Hauke Paulsen
- Prof. Dr. rer. nat. Alfred Vogel
- Prof. Dr. rer. nat. Robert Huber

Literature:

- Giancoli: Physics

Language:

- offered only in German

LS1600-KP04 - Organic Chemistry (OCKP04)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master Medical Informatics 2019 (optional subject), bioinformatics, 1st or 2nd semester
- Master Medical Informatics 2014 (optional subject), bioinformatics, 1st or 2nd semester
- Bachelor CLS 2016 (compulsory), life sciences, 4th semester
- Bachelor Biophysics 2016 (compulsory), life sciences, 2nd semester

Classes and lectures:

- Organic Chemistry (lecture, 3 SWS)
- Organic Chemistry (exercise, 1 SWS)

Workload:

- 60 Hours in-classroom work
- 60 Hours private studies

Contents of teaching:

- Lectures:
- Alkanes, cycloalkanes
- Alkenes and Alkynes
- Aromatics
- Stereochemistry
- Substitution and elimination reactions
- Alcohols, phenols and thiols
- Ether and epoxides
- Aldehydes and ketones
- Carboxylic acids and derivativs
- Amines and derivativs
- Heterocycles
- Lipids
- Carbohydrates
- Amino acids and peptides
- Nucleotides and nucleic acids
- Exercises:
- Students discuss problems covering all topics of the lectures on the black board

Qualification-goals/Competencies:

- After successful completion of the course, students have a fundamental knowledge of organic chemistry. They are confident using structural formulas of substance classes and functional groups presented in the course. They are confident in the nomenclature and can correctly describe relative and absolute configurations of molecules.
- Students know the most important reactions, reaction types and reaction principles of organic chemistry. They understand the structural properties of functional groups and are able to formulate organic chemical reaction mechanisms of these groups.
- Students can transfer and apply the acquired skills to problems of other branches of chemistry and related sciences and are thus able to participate in continuative courses.

Grading through:

- written exam

Requires:

- General Chemistry (LS1100-KP04)

Responsible for this module:

- PD Dr. phil. nat. Thomas Weimar

Teacher:

- Institute of Chemistry and Metabolomics
- PD Dr. phil. nat. Thomas Weimar

Literature:

- Hart, H., L. E. Craine, D. J. Hart: Organische Chemie - Wiley-VCH
- Buddrus, J.: Organische Chemie - De Gruyter Verlag

Language:

- offered only in German

MA1500-KP08, MA1500 - Linear Algebra and Discrete Structures 2 (LADS2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2019 (compulsory: aptitude test), mathematics, 2nd semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 2nd semester
- Bachelor Medical Informatics 2019 (compulsory), mathematics, 2nd semester
- Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 4th semester
- Bachelor Computer Science 2016 (compulsory: aptitude test), mathematics, 2nd semester
- Bachelor CLS 2016 (compulsory), mathematics, 2nd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester
- Bachelor IT-Security 2016 (compulsory), mathematics, 2nd semester
- Bachelor Biophysics 2016 (compulsory), mathematics, 2nd semester
- Bachelor Medical Informatics 2014 (compulsory), mathematics, 2nd semester
- Bachelor MES 2014 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2014 (compulsory: aptitude test), mathematics, 2nd semester
- Bachelor Medical Informatics 2011 (compulsory), mathematics, 2nd semester
- Bachelor CLS 2010 (compulsory), mathematics, 2nd semester
- Bachelor MES 2011 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2012 (compulsory: aptitude test), mathematics, 2nd semester

Classes and lectures:

- Linear Algebra and Discrete Structures 2 (lecture, 4 SWS)
- Linear Algebra and Discrete Structures 2 (exercise, 2 SWS)

Workload:

- 125 Hours private studies and exercises
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Systems of linear equations, matrices
- Determinants
- Linear mappings
- Orthogonality
- Eigenvalues

Qualification-goals/Competencies:

- The students understand advanced concepts of linear algebra.
- They understand advanced thought processes and methods of proof.
- They can apply advanced concepts and methods of proof to algebraic problems.
- They can explain advanced relationships in linear algebra.
- Interdisciplinary qualifications:
- Students can transfer advanced theoretical concepts to similar applications.
- They have an advanced competency in modeling.
- They can solve complex problems within a group.
- They can present the solution to complex problems to a group.

Grading through:

- e-tests

Is requisite for:

- Image Registration (MA5030-KP05)
- Image Registration (MA5030-KP04, MA5030)
- Mathematical Methods in Image Processing (MA4500-KP05)
- Mathematical Methods in Image Processing (MA4500-KP04, MA4500)
- Optimization (MA4031-KP08)
- Module part: Optimization (MA4030 T)
- Optimization (MA4030-KP08, MA4030)

Requires:

- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

- Prof. Dr. rer. nat. Jan Modersitzki

Teacher:

- Institute of Mathematics and Image Computing
- Prof. Dr. rer. nat. Jan Modersitzki
- Prof. Dr. rer. nat. Jan Lellmann

Literature:

- G. Fischer: Lineare Algebra: Eine Einführung für Studienanfänger - Vieweg+Teubner
- G. Strang: Lineare Algebra - Springer
- K. Jänich: Lineare Algebra - Springer
- D. Lau: Algebra und diskrete Mathematik I + II - Springer
- G. Strang: Introduction to Linear Algebra - Cambridge Press
- K. Rosen: Discrete Mathematics and Its Applications - McGraw-Hill

Language:

- offered only in German

Notes:

Prerequisite tasks for taking the exam can be announced at the beginning of the semester. If any prerequisite tasks are defined, they must be completed and passed before taking the exam for the first time.

MA2500-KP08 - Analysis 2 (Ana2KP08)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Bachelor MES 2014 (compulsory), mathematics, 2nd semester
- Bachelor MES 2020 (compulsory), mathematics, 2nd semester
- Bachelor Biophysics 2016 (compulsory), mathematics, 2nd semester

Classes and lectures:

- Analysis 2 (lecture, 4 SWS)
- Analysis 2 (exercise, 2 SWS)

Workload:

- 125 Hours exam preparation
- 90 Hours in-classroom work
- 25 Hours private studies

Contents of teaching:

- Advanced multivariate differential calculus
- Indefinite and definite integrals, fundamental theorem of calculus
- Curvilinear integrals, bounded variation
- Function series, power series
- Trigonometric polynomials, Fourier series, Fourier coefficients
- Linear operators in Hilbert spaces

Qualification-goals/Competencies:

- Deeper insight into some selected aspects of analysis
- Deepening the basic knowledge in theory formation and model building competence

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics
- Prof. Dr. rer. nat. Jürgen Prestin

Literature:

- H. Heuser: Lehrbuch der Analysis 1+2
- K. Fritzsche: Grundkurs Analysis 1+2

Language:

- offered only in German

ME1020-KP08, ME1020 - Physics 2 (Physik2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory), physics, 2nd semester
- Bachelor Biophysics 2016 (compulsory), physics, 2nd semester
- Bachelor MES 2014 (compulsory), physics, 2nd semester
- Bachelor MES 2011 (compulsory), physics, 2nd semester

Classes and lectures:

- Physics 2 (lecture, 4 SWS)
- Physics 2 (exercise, 2 SWS)

Workload:

- 130 Hours private studies
- 90 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Electric charge, Coulomb force, electric field, electric potential, capacity
- Stationary electric current, resistor, Kirchhoff s laws
- Magnetic field, magnetic dipole, electric current and magnetic field
- Electromagnetic induction, resonant circuit
- Nonstationary electric and magnetic fields, displacement current, Maxwell s equations
- Refraction, reflexion
- Geometrical optics, image generation, lenses, aberrations, optical instruments
- Interference, diffraction, resolution power
- Polarization, birefringence, Brewster s angle
- Relativity theory
- Bohr s atomic model, spectral lines, quantum mechanical atomic model
- Molecules and solid bodies

Qualification-goals/Competencies:

- You can name the basic laws of physics
- You can measure according to physics rules
- You can explain physical laws based on observations
- You can formally analyze physical problems
- You can judge which concept is best suited to solve a certain problem
- You can design novel physical experiments on your own

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Physics 1 (ME1010-KP08, ME1010)

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner
- Prof. Dr. rer. nat. Thorsten Buzug
- Prof. Dr. rer. nat. Alfred Vogel

Teacher:

- Institute of Biomedical Optics
- Institute of Physics
- Institute of Medical Engineering

- Prof. Dr. rer. nat. Thorsten Buzug
- Prof. Dr. rer. nat. Christian Hübner
- Prof. Dr. rer. nat. Alfred Vogel

Literature:

- Giancoli: Physics

Language:

- offered only in German

BP2040-KP05 - Classical and statistical mechanics (KSM)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	5

Course of study, specific field and term:

- Bachelor Biophysics 2016 (compulsory), physics, 3rd semester

Classes and lectures:

- Classical and statistical mechanics (lecture, 2 SWS)
- Classical and statistical mechanics (exercise, 2 SWS)

Workload:

- 70 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- written exam

Requires:

- Analysis 2 (UngenutztMA2500-MIWSJ14)

Responsible for this module:

- PD Dr. rer. nat. Hauke Paulsen

Teacher:

- Institute of Physics

Literature:

- Randy Harris: Moderne Physik - Pearson Studium
- :

Language:

- offered only in German

LS1000-KP06 - Biology 1 (Bio1_BP)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	6

Course of study, specific field and term:

- Bachelor Biophysics 2016 (compulsory), life sciences, 3rd semester

Classes and lectures:

- Biology (lecture, 4 SWS)

Workload:

- 100 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Enno Hartmann

Teacher:

- Institute for Biology

- Prof. Dr. rer. nat. Enno Hartmann
- Prof. Dr. rer nat. Rainer Duden
- PD Dr. rer. nat. Kai-Uwe Kalies
- PD Dr. rer. nat. Bärbel Kunze

Literature:

- :

Language:

- offered only in German

LS2000-KP06 - Biochemistry 1 (Bioche1_06)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	6

Course of study, specific field and term:

- Bachelor Biophysics 2016 (compulsory), life sciences, 3rd semester

Classes and lectures:

- Biochemistry 1 for Biophysics (lecture, 4 SWS)

Workload:

- 90 Hours private studies
- 60 Hours in-classroom work
- 30 Hours exam preparation

Contents of teaching:

- Characteristics of biosystems, biomolecules
- Proteins: structure and dynamics
- Enzymes: structure, function and regulation
- Intermediary metabolism
- Biomembranes and cell respiration

Qualification-goals/Competencies:

- Understanding structures and functions of biochemical important biomolecules
- Understanding biochemical interrelations and their importance for cellular metabolism
- Knowledge of biochemical separation and analysis procedures

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Rolf Hilgenfeld

Teacher:

- Institute of Biochemistry

- Prof. Dr. rer. nat. Rolf Hilgenfeld
- Prof. Dr. rer. nat. Stefan Anemüller
- Dr. math. et dis. nat. Jeroen Mesters

Literature:

- Berg/Tymoczko/Stryer: Biochemistry 7th ed.
- Voet/Voet: Biochemistry 4th ed.
- Lehninger: Principles of Biochemistry 5th ed.
- Alberts et al.: Molecular Biology of the Cell 5th ed.

Language:

- offered only in English

Notes:

Compulsory elective subject for students specializing in life science

LS2200-KP04, LS2200 - Introduction into Biophysics (EinBiophy)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor MES 2020 (optional subject), mathematics / natural sciences
- Bachelor MLS 2018 (compulsory), life sciences, 3rd and 4th semester
- Bachelor MLS 2016 (compulsory), life sciences, 3rd and 4th semester
- Bachelor CLS 2016 (optional subject), life sciences, 5th semester
- Bachelor Nutritional Medicine 2016 (compulsory), biophysics, 3rd semester
- Bachelor Biophysics 2016 (compulsory), biophysics, 3rd semester
- Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd or 5th semester
- Bachelor MLS 2009 (compulsory), life sciences, 3rd and 4th semester
- Bachelor CLS 2010 (optional subject), life sciences, 5th semester
- Bachelor MES 2011 (compulsory), medical engineering science, 5th semester

Classes and lectures:

- Biophysics (lecture, 2 SWS)
- Biophysics (practical course, 1 SWS)

Workload:

- 50 Hours private studies
- 45 Hours in-classroom work
- 15 Hours written report
- 10 Hours exam preparation

Contents of teaching:

- Biological macro molecules, structure, forces
- Proteins, structure, properties
- Biomembranes, structure, properties
- Mechanical properties of cells
- Thermo dynamics of biological processes

Qualification-goals/Competencies:

- You can assign forces in biological systems
- You become familiar with the basic aspects of living matter
- You gain the expertise to simplify complex living systems
- You can choose and apply appropriate experimental methods for the study of living matter

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institute of Physics

- Prof. Dr. rer. nat. Christian Hübner
- Dr. Young-Hwa Song

Literature:

- Volker Schünemann: Biophysik: Eine Einführung
- Werner Mäntele: Biophysik

Language:

- offered only in German

Notes:

The lecture occurs every winter semester. The practical course occurs every summer semester.

MA3400-KP05 - Biomathematics (BioMaKP05)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	5

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, arbitrary semester
- Bachelor Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, 5th semester
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Master MLS 2018 (optional subject), interdisciplinary competence, 1st semester
- Bachelor Computer Science 2016 (optional subject), advanced curriculum, arbitrary semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 5th semester
- Master MLS 2016 (optional subject), interdisciplinary competence, 1st semester
- Bachelor CLS 2016 (compulsory), mathematics, 3rd semester
- Bachelor Biophysics 2016 (compulsory), mathematics, 3rd semester

Classes and lectures:

- Biomathematics (lecture, 2 SWS)
- Biomathematics (exercise, 2 SWS)

Workload:

- 70 Hours private studies and exercises
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Basics of differential equations
- Differential equations of first order
- Linear differential equations of n-th order
- Systems of linear differential equations with constant coefficients
- Notes on numerics and qualitative analysis; the prey-predator model

Qualification-goals/Competencies:

- Learning the basics of ordinary differential equations
- Ability to apply differential equations
- Learning by means of examples how to use differential equations for models in biology, chemistry and medicine
- Basic understanding of simple numerical methods

Grading through:

- written exam

Responsible for this module:

- PD Dr. rer. nat. Hanns-Martin Teichert

Teacher:

- Institute for Mathematics
- PD Dr. rer. nat. Hanns-Martin Teichert

Literature:

- J. D. Murray: Mathematical Biology - Springer
- H. Heuser: Gewöhnliche Differentialgleichungen - Teubner Verlag 2009 (6th edition)
- R. Schuster: Biomathematik - Teubner Studienbücher 1995
- S. Handrock-Meyer: Differenzialgleichungen für Einsteiger - Hanser 2007

Language:

- offered only in German

Notes:

Prerequisites for admission to the examination can be determined at the beginning of the semester. If such prerequisites are defined, they must have been fulfilled prior to the first attempt at the examination and must have been rated as positive.

ME2053-KP04, ME2053 - Physics Lab Course (PhysPrakt)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory), physics, 3rd semester
- Bachelor MLS 2018 (compulsory), life sciences, 3rd semester
- Bachelor Biophysics 2016 (compulsory), physics, 3rd semester
- Bachelor MES 2014 (compulsory), physics, 3rd semester
- Bachelor MLS 2009 (compulsory), life sciences, 3rd semester
- Bachelor MES 2011 (compulsory), physics, 3rd semester

Classes and lectures:

- Physics Lab Course (practical course, 3 SWS)

Workload:

- 55 Hours written report
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Experiment 1: fluid dynamics
- Experiment 2: heat
- Experiment 3: non stationary current
- Experiment 4: stationary current
- Experiment 5: spectrometer
- Experiment 6: diffusion
- Experiment 7: wave optics
- Experiment 8: geometrical optics
- Experiment 9: radio activity
- Experiment 10: sound and ultrasound

Qualification-goals/Competencies:

- Hands-on access to physical relations
- Graphical representation of experimental data
- Excellence in interpreting data
- Excellence in documating data and teamwork
- Basic knowledge in safety measures in the lab

Grading through:

- certificates and protocols

Requires:

- Physics 2 (ME1020-KP08, ME1020)
- Physics 1 (ME1010-KP08, ME1010)
- Physics 2 (ME1020-MLS)
- Physics 1 (ME1010-KP06, ME1010-MLS)

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institute of Biomedical Optics
- Institute of Medical Engineering
- Institute of Physics

- Prof. Dr. rer. nat. Christian Hübner
- Prof. Dr. rer. nat. Thorsten Buzug
- PD Dr. rer. nat. Hauke Paulsen
- Prof. Dr. rer. nat. Alfred Vogel
- MitarbeiterInnen des Instituts

Literature:

- Giancoli: Physik

Language:

- offered only in German

BP2600-KP05 - Atom and Molecule Physics (AtomMolPhy)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	5

Course of study, specific field and term:

- Bachelor Biophysics 2016 (compulsory), physics, 4th semester

Classes and lectures:

- Atom and Molecule Physics (lecture, 2 SWS)
- Atom and Molecule Physics (exercise, 2 SWS)

Workload:

- 60 Hours private studies and exercises
- 60 Hours in-classroom work
- 30 Hours exam preparation

Contents of teaching:

- Mass, size, and structure of atoms and the electron
- Bohr's hydrogen model
- Orbital and spin magnetism, fine structure
- The atom in electric and magnetic field
- Many-electron atoms
- X-ray spectra, nuclear spin, hyperfine structure
- Mass, size, and structure of molecules
- Theory of the chemical bond
- Molecular spectroscopy (IR, Raman, etc)
- Nuclear and electron spin resonance

Qualification-goals/Competencies:

- You can explain the structure of the atom
- You understand the physical basics of atom/molecule spectra
- You are able to apply your knowledge of the structure of atoms and molecules in the context of biophysics

Grading through:

- written exam

Requires:

- Physics 2 (ME1020-KP08, ME1020)
- Physics 1 (ME1010-KP08, ME1010)

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institute of Physics
- Prof. Dr. rer. nat. Christian Hübner
- MitarbeiterInnen des Instituts

Literature:

- Wolfgang Demtröder: Atoms, Molecules and Photons: An Introduction to Atomic-, Molecular- and Quantum Physics - Springer
- :

Language:

- offered only in German

LS2300-KP08, LS2301 - Biophysical Chemistry (BPCKP08)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Bachelor MLS 2018 (compulsory), life sciences, 4th semester
- Bachelor MLS 2016 (compulsory), life sciences, 4th semester
- Master CLS 2016 (compulsory), MML with specialization in Life Science, 2nd semester
- Bachelor Biophysics 2016 (compulsory), biophysics, 4th semester
- Master CLS 2010 (optional subject), computational life science / life sciences, 2nd semester
- Bachelor MLS 2009 (compulsory), life sciences, 4th semester

Classes and lectures:

- Biophysical Chemistry (lecture, 3 SWS)
- Biophysical Chemistry (exercise, 1 SWS)
- Biophysical Chemistry (practical course, 3 SWS)

Workload:

- 160 Hours private studies
- 80 Hours in-classroom work

Contents of teaching:

- Lecture topics:
- What is Biophysical Chemistry?
- Basics of NMR spectroscopy
- Basics of mass spectrometry
- Theoretical calculation of molecules - Quantum mechanics or molecular mechanics?
- Basics of chemical thermodynamics
- Thermodynamics of ligand binding
- Basics of chemical kinetics
- Basics of enzyme kinetics
- Practical:
- NMR, Molecular Modeling, experiments with a focus on thermodynamics and kinetics

Qualification-goals/Competencies:

- Acquire basic knowledge on spectroscopic techniques to analyze (bio)molecules. Focus is on NMR and mass spectrometry techniques
- Insight into properties (e.g. structure, dynamics, spectroscopic properties) of molecules employing theoretical models. Acquisition of basic knowledge to compute molecules
- Application of laws of thermodynamics to describe chemical reactions and biological processes with a focus on binding and recognition reactions in biological systems
- Acquire basic knowledge to analyze time courses of chemical reactions and biological processes
- Acquisition of skills to work independently and self-determined in the laboratory

Grading through:

- written exam

Requires:

- Introduction into Biophysics (LS2200-KP04, LS2200)
- Biological Chemistry (LS2600-KP06, LS2601)
- General Chemistry (LS1100-KP04)
- Organic Chemistry (LS1600-KP10, LS1600-MLS)

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Chemistry and Metabolomics
- Prof. Dr. rer. nat. Thomas Peters
- PD Dr. phil. nat. Thomas Weimar

Literature:

- Peter Atkins and Julio de Paula: Physical Chemistry for the Life Sciences - Oxford, University Press, Freeman and Company, 2006, ISBN 0-1992-8095-9
- Thomas Engel und Philip Reid: Physikalische Chemie - Pearson Studium, 2006, ISBN 13: 978-3-8273-7200-0
- van Holde, Johnson & HoPrentice Hall: Principles of Physical Biochemistry - New Jersey, 1998, 2006, ISBN 0-13-720459-0
- Atkins: Physical Chemistry - Oxford University Press, Oxford Mel-bourne Tokyo, 1998, ISBN 0-19-850101-3 Paperback, Deutsche Ausgabe (dritte Auflage) bei Wiley VCH, 2002: ISBN 3-527-30236-0 Wiley-VCH, Weinheim
- Fersht, W. H.: Structure and Mechanism in Protein Science - New York, 1999, ISBN 0-7167-3268-8
- Cantor & Schimmel: Biophysical Chemistry, Parts I-III - Freeman and Company, New York, 1980, ISBN 0-71671188-5 Paperback
- H. Friebolin: Ein- und zweidimensionale NMR-Spektroskopie - Wiley-VCH

Language:

- offered only in German

Notes:

Prerequisite for examination is the successful participation in the excercises and oral presentation.
The practical course takes place in September as compact course. Prerequisite LS1600 and LS2600.

LS2700-KP04 - Cell Biology (ZellbioKP4)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Biophysics 2016 (compulsory), Elective Chemistry/Biology, 4th semester

Classes and lectures:

- Cell Biology (lecture, 3 SWS)

Workload:

- 75 Hours private studies
- 45 Hours in-classroom work

Contents of teaching:

- Special structure of cells
- Cell cycle and apoptosis
- Introduction into developmental biology

Qualification-goals/Competencies:

- Principle of the basic function of the eukaryotic cells
- Detailed knowledge in all areas of cell biology covered by the lecture (see

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Enno Hartmann

Teacher:

- Institute of Virology and Cell Biology
- Institute for Biology

- Prof. Dr. rer. nat. Enno Hartmann
- PD Dr. rer. nat. Kai-Uwe Kalies
- Prof. Dr. rer. nat. Jürgen Rohwedel

Literature:

- Lodish: Molecular Cell Biology
- Pollard: Cell Biology
- Wolpert: Principles of Development
- Alberts: Molecular Biology of the Cell

Language:

- offered only in German

MA1600-KP04, MA1600, MA1600-MML - Biostatistics 1 (BioStat1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, arbitrary semester
- Bachelor Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, 6th semester
- Bachelor Medical Informatics 2019 (compulsory), medical computer science, 6th semester
- Bachelor MLS 2018 (compulsory), life sciences, 6th semester
- Bachelor Nutritional Medicine 2018 (compulsory), mathematics / computer science, 6th semester
- Bachelor CLS 2016 (compulsory), mathematics, 2nd semester
- Bachelor CLS 2010 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2016 (optional subject), advanced curriculum, arbitrary semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 4th semester
- Bachelor MLS 2016 (compulsory), life sciences, 6th semester
- Bachelor Biophysics 2016 (compulsory), Elective Computer Science, 4th semester
- Bachelor Nutritional Medicine 2016 (compulsory), mathematics / computer science, 6th semester
- Bachelor Medical Informatics 2014 (compulsory), medical computer science, 4th semester
- Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 6th semester
- Master MES 2011 (advanced curriculum), biophysics and biomedical optics, 2nd semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 4th semester
- Master Computer Science 2012 (optional subject), specialization field bioinformatics, 2nd or 3rd semester
- Master Computer Science 2012 (compulsory), advanced curriculum stochastics, 2nd semester
- Bachelor Computer Science 2012 (optional subject), specialization field bioinformatics, 6th semester
- Bachelor MLS 2009 (compulsory), life sciences, 6th semester
- Bachelor MES 2011 (optional subject), medical engineering science, 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field medical informatics, 6th semester

Classes and lectures:

- Biostatistics 1 (lecture, 2 SWS)
- Biostatistics 1 (exercise, 1 SWS)

Workload:

- 66 Hours private studies
- 39 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Descriptive statistics
- Probability theory, including random variables, density, and cumulative distribution function
- Normal distribution, other distributions
- Diagnostic tests, reference range, normal range, coefficient of variation
- Statistical testing
- Sample size calculations
- Confidence intervals
- Selected statistical tests I
- Selected statistical tests II
- Linear simple regression
- Analysis of variance (one-way-classification)
- Clinical trials
- Multiple Testing: Bonferroni, Bonferroni-Holm, Bonferroni-Holm-Shaffer, Wiens, hierarchical Testing

Qualification-goals/Competencies:

- The students are able to calculate descriptive statistics.
- They are able to calculate quantiles and surfaces of the normal distribution.
- They are able to explain terms of diagnostic testing, such as sensitivity or specificity.
- They are able to list the basic principles of statistical testing, sample size calculation and confidence interval construction.
- They are able to carry out a set of elementary statistical tests, such as t-test, test of proportions, X2 independence test, and to interpret the results.
- They are able to explain the basic principles of linear regression.
- They are able to apply the linear simple regression.
- They are able to explain the basic idea for the one-way analysis of variance (ANOVA).

- They are able to explain the results table for the one-way and two-way ANOVA.
- They are able to interpret the results of the ANOVA.
- They know the basic principles of clinical therapeutic studies.
- They know the assumptions that need to be fulfilled for the application of specific statistical tests.
- They are able to calculate simple adjustments for multiple comparisons.

Grading through:

- written exam

Is requisite for:

- Module part: Biostatistics 2 (MA2600 T)
- Biostatistics 2 (MA2600-KP07)
- Biostatistics 2 (MA2600-KP04, MA2600)

Responsible for this module:

- Prof. Dr. rer. biol. hum. Inke König

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. biol. hum. Inke König
- MitarbeiterInnen des Instituts
- Dr. Reinhard Vonthein

Literature:

- Matthias Rudolf, Wiltrud Kuhlisch: Biostatistik: Eine Einführung für Biowissenschaftler - 1. Auflage, Pearson: Deutschland
- Lothar Sachs, Jürgen Hedderich: Angewandte Statistik: Methodensammlung mit R - 15. Auflage, Springer: Heidelberg

Language:

- offered only in German

ME2060-KP05 - Fields and Quanta (FQ_BioPhy)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	5

Course of study, specific field and term:

- Bachelor Biophysics 2016 (compulsory), physics, 4th semester

Classes and lectures:

- Fields and Quanta (lecture, 2 SWS)
- Fields and Quanta (exercise, 2 SWS)

Workload:

- 60 Hours in-classroom work
- 60 Hours private studies
- 30 Hours exam preparation

Contents of teaching:

- Scalar and vector fields
- electric charge, electr. Potential, electr. field
- Current density, continuity equation
- magnetic field
- electromagnetic induction
- Maxwell equations
- Wave-particle duality
- Uncertainty
- Wave functions, operators and measurement
- Schrödinger equation

Qualification-goals/Competencies:

- Students are able to calculate the propagation of electromagnetic waves in homogeneous media.
- They can enumerate the main axioms of quantum mechanics.
- They can explain the terms operator, wave function, quantum numbers and measurements, and the relationships between them.
- They can calculate the eigenstates of simple quantum mechanical systems.
- They can describe the stationary states of the hydrogen atom and calculate the associated energy values.
- They are using the terms and concepts of theoretical physics such an extent that you can acquire further representations on their own.

Grading through:

- written exam

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)
- Analysis 2 (MA2500-KP08)
- Analysis 1 (MA2000-KP08, MA2000)
- Physics 2 (ME1020-KP08, ME1020)
- Physics 1 (ME1010-KP08, ME1010)

Responsible for this module:

- Prof. Dr. rer. nat. Magdalena Rafecas

Teacher:

- Institute of Medical Engineering
- Prof. Dr. rer. nat. Magdalena Rafecas
- Prof. Dr. rer. nat. Martin Koch

Literature:

- D. J. Griffiths: Elektrodynamik: Eine Einführung - Pearson, Hallbergmoos 2011
- D. J. Griffiths: Quantenmechanik: Lehr- und Übungsbuch - Pearson, Hallbergmoos 2012

Language:

- offered only in German

Notes:

Examination prerequisites can be determined at the beginning of the semester. If intermediate consumption is defined, it must have been provided before the initial assessment and evaluated positively.

ME2100 T - Module part: Introduction into Biomedical Optics (EinBMO)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor MES 2020 (module part), medical engineering science, 4th semester
- Bachelor Biophysics 2016 (module part), physics, 4th semester
- Bachelor MES 2014 (module part), medical engineering science, 4th semester

Classes and lectures:

- Introduction into Biomedical Optics (lecture, 2 SWS)
- Biomedical Optics/Excercises (exercise, 1 SWS)

Workload:

- 55 Hours private studies and exercises
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Absorption and light scattering in biological tissues (Mie, Rayleigh)
- Measurement of optical tissue parameters,Mathematical description of light propagation
- Fundamentals of photophysics
- Spectroscopy, fluorescent markers, and flow cytometryof photophysics
- Lasers for biomedicine
- Fundamentals of photochemistry and photobiology
- Thermal effects on biomolecules and tissue, photocoagulation
- Pulsed laser tissue ablation
- Nonlinear absorption and plasma-mediated dissection of transparent tissues
- Intraocular photodisruption, laser lithotripsy, refractive surgery, and cell surgery
- Fundamentals of light, fluorescence, and laser scanning microscopy

Qualification-goals/Competencies:

- The students are able to name and describe the fundamental physical phenomena and laws regarding light propagation and absorption in tissue.
- They can explain the interaction of light and tissue and describe it mathematically.
- They attain an overview of diagnostic and therapeutic techniques in the field of biomedical optics and can list, describe and compare them.
- They acquire an overview of optical instruments for biomedical applications and are able to explain their function.
- They are able to assess the capabilities and limits of microscopic imaging.
- They are able to transfer their knowledge to practical applications.
- The students have the professional, social and communication skills to discuss and solve Biomedical Optics exercises in tutorial groups.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Biomedical Optics
- Dr. rer. nat. Norbert Linz

Literature:

- H.P. Berlien, G. Müller (eds): Applied Laser Medicine - Springer 2003
- M. Niemz: Laser-Tissue Interactions - 3rd Edition, Springer 2007

Language:

- offered only in German

ME2102 T - Module part: Photonics (Photonik)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor MES 2020 (module part), medical engineering science, 4th semester
- Bachelor Biophysics 2016 (module part), physics, 4th semester
- Bachelor MES 2014 (module part), medical engineering science, 4th semester

Classes and lectures:

- Photonics (lecture, 2 SWS)
- Photonics (exercise, 1 SWS)

Workload:

- 45 Hours in-classroom work
- 35 Hours private studies and exercises
- 20 Hours exam preparation

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Biomedical Optics
- PD Dr. rer. nat. Gereon Hüttmann

Literature:

- :
- :
- :
- :
- :

Language:

- English, except in case of only German-speaking participants

ME2600-KP08, ME2600 - Introduction to Biomedical Optics and Photonics (EinfBMOPho)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory), medical engineering science, 4th semester
- Bachelor Biophysics 2016 (compulsory), physics, 4th semester
- Bachelor MES 2014 (compulsory), medical engineering science, 4th semester

Classes and lectures:

- ME2100 T: Module part: Introduction to Biomedical Optics (4 ECTS) (course, 3 SWS)
- ME2102 T: Module part: Photonics (4 ECTS) (course, 3 SWS)

Workload:

- 110 Hours private studies
- 90 Hours in-classroom work
- 40 Hours exam preparation

Contents of teaching:

- as described for the module parts

Qualification-goals/Competencies:

- as described for the module parts

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Alfred Vogel

Teacher:

- Institute of Biomedical Optics
- Dr. rer. nat. Norbert Linz
- PD Dr. rer. nat. Gereon Hüttmann

Literature:

- H.P. Berlien, G. Müller: Applied Laser Medicine - Springer 2003
- P.N. Prasad: Introduction to Biophotonics - Wiley 2003
- M. Niemz: Laser-Tissue Interactions - 3rd Edition, Springer 2007
- D. B. Murphy: Fundamentals of Light Microscopy and Electronic Imaging - Wiley-Liss 2001
- E. Hecht: Optics - Addison-Wesley, (dt: Optik, Oldenbourg)
- B.E.A. Saleh, M.C. Teich: Fundamentals of Photonics - Wiley 2007 (dt.: Grundlagen der Photonik, Wiley-VCH)
- Matt Young: Optics and Lasers : Including Fibers and Optical Waveguides - Springer 2000

Language:

- German and English skills required

BP3100-KP07 - Seminar and Practical Course Biophysics (SemBiophys)

Duration:	Turnus of offer:	Credit points:
2 Semester	each winter semester	7 (Typ B)

Course of study, specific field and term:

- Bachelor Biophysics 2016 (compulsory), biophysics, 5th and 6th semester

Classes and lectures:

- Bachelor Seminar Biophysics (seminar, 2 SWS)
- Advanced Practical Course Biophysics (practical course, 3 SWS)

Workload:

- 200 Hours (see module parts)

Contents of teaching:

-

Qualification-goals/Competencies:

-

Grading through:

- continuous, successful participation in practical course

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institutes of the Department of Computer Science/ Engineering
- Institutes of natural science
- Institute of Physics

Language:

- German and English skills required

BP3102 T - Bachelor Seminar Biophysics (SemBP)

Duration:	Turnus of offer:
1 Semester	each winter semester

Course of study, specific field and term:

- Bachelor Biophysics 2016 (module part), biophysics, 5th semester

Classes and lectures:

- Bachelor Seminar (seminar, 2 SWS)

Workload:

- 30 Hours in-classroom work
- 20 Hours written report
- 20 Hours private studies
- 10 Hours oral presentation (including preparation)

Contents of teaching:

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-
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Qualification-goals/Competencies:

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-
-

Grading through:

- Oral presentation and written report

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institutes of natural science
- Institutes of the Department of Computer Science/ Engineering

Language:

- offered only in English

CS1500-KP04, CS1500 - Introduction to Robotics and Automation (ERA)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 1st semester
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor Biophysics 2016 (compulsory), Elective Computer Science, 5th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 1st semester
- Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 1st semester
- Bachelor CLS 2010 (optional subject), computer science, 5th or 6th semester
- Bachelor MES 2011 (optional subject), medical engineering science, 5th semester
- Bachelor Computer Science 2012 (compulsory), specialization field robotics and automation, 1st semester

Classes and lectures:

- Introduction to Robotics and Automation (lecture, 2 SWS)
- Introduction to Robotics and Automation (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction
- Control systems
- Programmable Logic Controller (PLC)
- Combinatorial control
- Sequential control
- Feedback control systems
- Plants
- PID controller
- Controller parameterization
- Autonomous mobile robots
- AI-paradigms
- Elementary and emergent behaviors
- Signal acquisition and processing
- Actuators

Qualification-goals/Competencies:

- The students are able to explain the principles of control systems.
- The students are able to design combinatorial and sequential control systems.
- The students are able to program simple application problems as PLC-program in the IEC-languages.
- The students are able to analyze closed-loop controlled systems (plants) and to select and parameterize a suitable feedback PID controller.
- The students are able to present the principal structure and functionality of autonomous wheel-driven robots.
- The students are able to program simple autonomous robots in a behavior-based way..

Grading through:

- written exam

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- Prof. Dr.-Ing. Mladen Berekovic

Literature:

- J. L. Jones, D. Roth: Robot Programming - A Practical Guide to Behavior-Based Robotics - New York: Mc Graw Hill 2004
- J. Knespl: Automatisierungstechnik 1 - Regelungstechnik - Köln: Stam-Verlag 1999
- R. R. Murphy: Introduction to AI Robotics - Cambridge, MA: The MIT Press 2000
- G. Wellenreuther, D. Zastrow: Automatisieren mit SPS - Theorie und Praxis - Braunschweig: Vieweg 2008

Language:

- offered only in German

Notes:

Computer Science students get a B certificate.

CS1601-KP04, CS1601 - Basics of Multimedia Systems (MMTechnik)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Biophysics 2016 (optional subject), computer science, 5th semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, arbitrary semester
- Bachelor Media Informatics 2020 (compulsory), media informatics, 3rd semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), media informatics, 5th or 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 4th or 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, arbitrary semester
- Bachelor Media Informatics 2014 (compulsory), media informatics, 3rd semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 6th semester
- Bachelor CLS 2010 (optional subject), computer science, 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field media informatics, 2nd semester

Classes and lectures:

- Basics of Multimedia Systems (lecture, 2 SWS)
- Basics of Multimedia Systems (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Sensation and Perception
- Analog Media Technology
- Digitalisation
- Digital Audio, Image and Video Technology
- Haptical Technologies
- Foundations of Data Compression
- Storage Media
- Media Transmission (Broadcast / Streaming)

Qualification-goals/Competencies:

- Students are able to present to essential functions and principles of multimedia systems.
- They are able to judge possibilities and limitations of human perception.
- They are able to classify the conditions and technologies for capturing, processing, storing, transmitting and perception of multimedia.
- They can balance the specific advantages and disadvantages of analog and digital media technology.
- They are able to apply appropriate technical components and processes for the design of multimedia systems.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr.-Ing. Andreas Schrader

Teacher:

- Institute of Telematics
- Prof. Dr.-Ing. Andreas Schrader

Literature:

- Thomas Görne: Tontechnik - Hanser 2011
- Ulrich Schmidt: Professionelle Videotechnik - Springer 2009

Language:

- English, except in case of only German-speaking participants

CS2300-KP06, CS2300SJ14 - Software Engineering (SWEng14)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each winter semester	6	12

Course of study, specific field and term:

- Bachelor Media Informatics 2020 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), computer science, 3rd semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 3rd semester
- Bachelor IT-Security 2016 (compulsory), computer science, 3rd semester
- Bachelor Biophysics 2016 (optional subject), computer science, 5th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 3rd semester
- Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 3rd semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 3rd semester

Classes and lectures:

- Software Engineering (lecture, 3 SWS)
- Software Engineering (exercise, 1 SWS)

Workload:

- 100 Hours private studies and exercises
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- overview on major fields of software engineering
- Software development, software process models
- Project plan and workload estimation
- Software management and quality assurance
- Syste,m Analysis and requirements analysis
- Basics of UML
- Software architectures and design patterns
- Validation and verification
- Legal aspects: copyright, standards, liability, licenses

Qualification-goals/Competencies:

- The students understand software design as an engineering process.
- They can argue about major software process models.
- They can explain important techniques and factors of software management.
- They can describe and evaluate measures for quality ensurance.
- They are able to model software systemson different levels of abtraction.
- They can apply the basic concepts of object-oriented modelling and design.
- They are able to apply design patterns in a useful way.
- They can discuss about legal aspects of software development.

Grading through:

- written exam

Is requisite for:

- Safe Software (CS3250-KP08)
- Lab Course Software Engineering (CS2301-KP06, CS2301)

Requires:

- Algorithms and Data Structures (CS1001-KP08, CS1001)
- Introduction to Programming (CS1000-KP10, CS1000SJ14)

Responsible for this module:

- Prof. Dr. Martin Leucker

Teacher:

- Institute of Software Technology and Programming Languages
- Prof. Dr. Martin Leucker

Literature:

- H. Balzert: Lehrbuch der Software-Technik: Software-Entwicklung - Spektrum Akademischer Verlag 2001
- B. Brügge, A. H. Dutoit: Objektorientierte Softwaretechnik mit UML, Entwurfsmustern und Java - Pearson Studium 2004
- I. Sommerville: Software Engineering - Addison-Wesley 2006
- B. Oestereich: Analyse und Design mit der UML 2.1 - Objektorientierte Softwareentwicklung - Oldenbourg 2006
- D. Bjorner: Software Engineering 1-3 - Springer 2006

Language:

- offered only in German

Notes:

For participating in CS2301-KP06 Lab Course Software Engineering it is necessary to pass the exam for CS2300-KP06 Software Engineering before. Please take the lab course immediately in the following term.

CS3100-KP08, CS3100SJ14 - Signal Processing (SignalV14)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 5th semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, arbitrary semester
- Bachelor Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, 5th semester
- Bachelor MES 2020 (compulsory), computer science, 5th semester
- Bachelor Media Informatics 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 5th semester
- Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 5th semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 5th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, arbitrary semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Web and Data Science, 5th semester
- Master CLS 2016 (compulsory), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 5th semester
- Bachelor IT-Security 2016 (optional subject), computer science, arbitrary semester
- Bachelor Biophysics 2016 (compulsory), computer science, 5th semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 5th semester
- Bachelor MES 2014 (compulsory), computer science, 5th semester
- Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester

Classes and lectures:

- Signal Processing (lecture, 2 SWS)
- Signal Processing (exercise, 1 SWS)
- Image Processing (lecture, 2 SWS)
- Image Processing (exercise, 1 SWS)

Workload:

- 110 Hours private studies
- 90 Hours in-classroom work
- 40 Hours exam preparation

Contents of teaching:

- Linear time-invariant systems
- Impulse response
- Convolution
- Fourier transform
- Transfer function
- Correlation and energy density of deterministic signals
- Sampling
- Discrete-time signals and systems
- Discrete-time Fourier transform
- z-Transform
- FIR and IIR filters
- Block diagrams
- FIR filter design
- Discrete Fourier transform (DFT)
- Fast Fourier transform (FFT)
- Characterization and processing of random signals
- Introduction, interest of visual information
- Fourier transformatio
- 2D Sampling
- Image enhancement
- Edge detection
- Multiresolution concepts: Gaussian and Laplacian Pyramid, wavelets
- Principles of image compression
- Segmentation
- Morphological image processing

Qualification-goals/Competencies:

- Students are able to explain the fundamentals of linear system theory.
- They are able to define and competently explain the essential elements of signal processing mathematically.
- They will have a command of mathematical methods for the description and analysis of continuous-time and discrete-time signals and systems.
- They are able to design digital filters and know various structures for their implementation.
- They are able to explain the basic techniques for describing and processing of random signals.
- They will have basic knowledge of two-dimensional system theory.
- They are able to describe the main techniques for image analysis and image enhancement.
- They are able to apply the learned principles in practice.

Grading through:

- written exam

Requires:

- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing
- Prof. Dr.-Ing. Alfred Mertins

Literature:

- A. Mertins: Signaltheorie: Grundlagen der Signalbeschreibung, Filterbänke, Wavelets, Zeit-Frequenz-Analyse, Parameter- und Signalschätzung - Springer-Vieweg, 3. Auflage, 2013
- A. K. Jain: Fundamentals of Digital Image Processing - Prentice Hall, 1989
- Rafael C. Gonzalez, Richard E. Woods: Digital Image Processing - Prentice Hall 2003

Language:

- offered only in German

LS3150-KP04, LS3151 - Molecular Biology (MolBioINF)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, arbitrary semester
- Master Computer Science 2019 (optional subject), Elective, arbitrary semester
- Master Medical Informatics 2019 (optional subject), bioinformatics, 1st or 2nd semester
- Bachelor Biophysics 2016 (compulsory), Elective Chemistry/Biology, 5th semester
- Master Computer Science 2014 (compulsory), specialization field bioinformatics, 1st, 2nd, or 3rd semester
- Master Medical Informatics 2014 (optional subject), bioinformatics, 1st or 2nd semester
- Master Computer Science 2012 (compulsory), specialization field bioinformatics, 2nd semester

Classes and lectures:

- Molecular Biology (lecture, 2 SWS)
- Molecular Biology (seminar, 2 SWS)

Workload:

- 60 Hours in-classroom work
- 60 Hours private studies

Contents of teaching:

- Lecture: Molecular basis for processing and analysis of biological data (nucleic acids, genome sequencing, DNA polymorphism, infection biology, host genome and virus infection, stem cell biology)
- Seminar: Scientific article reading and oral presentation
- understanding scientific context
- training in reading and speaking English in science

Qualification-goals/Competencies:

- Students are able to present basic molecular biological requirements for processing and analysis of biological data.
- They are able to explain the molecular biological terms genome, transcriptome and proteome.
- They acquire the competence to handle English literature and to present it in a scientific oral presentation.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Rohwedel

Teacher:

- Institute of Virology and Cell Biology

- Prof. Dr. rer. nat. Jürgen Rohwedel
- Prof. Dr. rer. nat. Norbert Tautz
- Dr. rer. nat. Olaf Isken

Literature:

- Alberts et al.: Molecular Biology of Cells - Garland Science
- Lodish et al.: Molecular Cell Biology - Freeman

Language:

- offered only in German

Notes:

Seminar-dates by appointment, prior registration is mandatory

LS3251-KP05 - Tissue Engineering (TissueEng)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	5

Course of study, specific field and term:

- Bachelor Biophysics 2016 (optional subject), life sciences, 5th semester

Classes and lectures:

- Tissue Engineering (seminar with practical exercises, 2 SWS)
- Tissue Engineering (lecture, 2 SWS)

Workload:

- 90 Hours private studies
- 60 Hours in-classroom work

Contents of teaching:

- Lectures:Mamalia cells in their natural environment and under in vitro culture as an example of industrial application.
- Aging of cells in vitro
- Established cell lines
- Diverse in vitro culturing conditions
- Proliferation and differentiation under in vitro conditions
- Stem cell biology
- Materials for medical applications
- Fermentors, bioreactors and protein purification
- Home work e. g. Tissue transplantation and rejection
- Practical course (in groups of 2):Principles of aseptic manipulations, working in sterile containments, object and selfprotection, use of autoclaves
- Preparation of sterile media, additives and other reagents
- Slicing of tissue samples, transfer into tissue culture flasks for explant cultures
- Microscopy and documentation of growing cells
- Cell count, passaging by trypsinisation
- Viability test, freezing of cells and reseeding after thawing
- Adherence of cells to various matrices
- Immunohistochemistry of intracellular and extracellular proteins
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Qualification-goals/Competencies:

- Students are able to explain principles of cell- and tissue culture to generate biocomposites from differentiated and pluripotent cells
- They are able to explain basic principles of pro- and eukaryotic gene expression systems
- They are able to explain basic principles of matrix biology
- They can reproduce the aspects of stem cell biology
- They acquire the ability to assess ethical aspects of tissue engineering
- They improve their competence for correct documentation and team working skills

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Rohwedel

Teacher:

- Fraunhofer Research Institution for Marine Biotechnology
- Lübeck University of Applied Sciences
- Department of Dermatology, Allergology and Venerology
- Institute of Virology and Cell Biology

- Prof. Dr. rer. nat. Holger Notbohm
- Prof. Dr. med. Jürgen Brinckmann
- Prof. Dr. Uwe Englisch
- Dr. rer. nat. Heyke Diddens-Tschoeke
- Prof. Dr. rer. nat. Jürgen Rohwedel

- Dr. C. Probst
- Dr. rer. nat. Daniel Hans Rapoport
- Dr. med. vet. Jennifer Kloepper
- Prof. Dr. med. Ralf Ludwig

Literature:

- Lanza, Langer, Vacanti: Principles of Tissue Engineering

Language:

- offered only in German

Notes:

Knowledge in Cell biology is a prerequisite for this course. Entrance requirement for the practical course: certificate of the course Biochemistry 1 or 2.

LS3252-KP05 - Metabolic Medicine (MetabolMed)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	5

Course of study, specific field and term:

- Bachelor Biophysics 2016 (optional subject), life sciences, 5th semester

Classes and lectures:

- Metabolic Medicine (lecture, 2 SWS)
- Tissue Engineering (seminar with practical exercises, 2 SWS)

Workload:

- 90 Hours private studies
- 60 Hours in-classroom work

Contents of teaching:

- Metabolic physiology
- glucose metabolism & diabetes
- lipid metabolism & obesity, adipokines
- gastroenterology
- thyroid
- central appetite regulation
- circadian clocks & metabolism
- sleep & metabolism

Qualification-goals/Competencies:

- Understanding the principles of energy homeostasis
- Understanding physiological interactions of different compartments in the context of energy metabolism
- Students know the symptoms of major metabolic disorders and their pathophysiological causes

Grading through:

- written exam

Requires:

- Biochemistry 1 (LS2000-KP06)
- Physiology (MZ2200-KP06)

Responsible for this module:

- Prof. Dr. rer. nat. Henrik Oster

Teacher:

- Department of Dermatology, Allergology and Venerology
- Medical Clinic I

- Prof. Dr. rer. nat. Henrik Oster
- Prof. Dr. med. Sebastian Schmid
- Prof. Dr. med. Christian Sina
- Dr. med. Volker Ott
- Dr. rer. nat. Carla Schulz
- Prof. Dr. rer. nat. Jens Mittag

Literature:

- Keith N. Frayn: Metabolic Regulation: A Human Perspective - Wiley & Blackwell, 2010

Language:

- German and English skills required

Notes:

Principle knowldege in physiology and biochemistry required.
To this module belongs the seminar Tissue Engineering.
Entrance requirement for the seminar: certificate of the course Biochemistry 1 or 2.

ME5050-KP05 - Biophysics of Ionizing Radiation and Radiation Safety (StrahlenSk)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	5

Course of study, specific field and term:

- Master MLS 2018 (optional subject), interdisciplinary competence, 2nd semester
- Bachelor Biophysics 2016 (compulsory), life sciences, 5th semester
- Master MLS 2016 (optional subject), interdisciplinary competence, 1st or 2nd semester

Classes and lectures:

- Biophysics of Ionizing Radiation and Radiation Safety (lecture, 2 SWS)
- Biophysics of Ionizing Radiation and Radiation Safety (practical course, 2 SWS)

Workload:

- 60 Hours in-classroom work
- 60 Hours private studies
- 30 Hours exam preparation

Contents of teaching:

- Physics of ionizing radiation
- Basic principles of dosimetry
- Introduction to methods of radiation measurement
- Radiation biology: principles of radiation damage, deterministic and stochastic effects, health risks caused by ionizing radiation
- Radiation chemistry, handling of open and enclosed radioactive materials
- Safety requirements in radionuclide laboratories
- Application of radionuclides in research and medicine
- German and international laws and regulations dealing with radiation safety
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Qualification-goals/Competencies:

- The students will have acquired in depth knowledge of the legal regulations concerning the work with radioactive materials and are able to implement these regulations in all relevant situations: Purchase, transport, storage, experimental use, disposal and decontamination
- They are able to safely handle open and enclosed radioactive compounds
- They are able to work in radiation protection areas in compliance with legal regulations
- They are able to measure radioactivity, calculate radiation doses and evaluate the results with respect to legal thresholds and biological impact
- They are able design experiments using radioactive materials, identify and meet the necessary safety precautions and establish a suitable workplace
- The students will acquire the requisite qualification (Fachkunde) according to German law (RöV and StrlSchV). This will qualify them (upon fulfillment of other regulatory requirements) to perform as a radiation safety officer according to German law.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Christian Schmidt

Teacher:

- Institute of Medical Engineering
- Institute of Biochemistry
- Institute for Biology
- Institute of Physics
- Isotopes laboratory

- Prof. Dr. rer. nat. Christian Schmidt
- Prof. Dr. rer. nat. Christian Hübner
- Dipl.-Ing. Henning Schönwald
- Prof. Dr. rer. nat. Magdalena Rafecas
- Dr. math. et dis. nat. Jeroen Mesters

- Dr. Lars Redecke

Language:

- offered only in German

Notes:

Each winter semester preferential for students of Biophysics and MIW, every summer semester preferential for MLS students.
The module certificate will be graded for Biophysics students and non-graded for MLS students.
The attendance of the radiation protection briefing is a prerequisite for the participation in the course.
The module certificate will be issued if a student has attended at least 90% of the practical training and achieved at least a score of 50% of the points in the written exam.
If the minimum score of 50% is not reached, a written or oral examination will be offered at the discretion of the module administrator.
The Fachkundebescheinigungen according to the German radiation safety regulations will be issued if a student has attended the entire course (a maximum absence during 10% of the lectures is permissible in exceptional cases) and has achieved a score of at least 70% in the written exam.
If a student has achieved less than 70% but more than 50% of the points in the written exam, a written or oral examination will be offered at the discretion of the module administrator.
Upon passing this examination the Fachkundebescheinigungen will be issued.
In this case, the decisive factor for the grade in the module certificate remains the result of the first examination.
Decisive for the realization of this course and the issuance of the Fachkundebescheinigungen are the Richtlinie über die im Strahlenschutz erforderliche Fachkunde (Fachkunde-Richtlinie Technik nach Strahlenschutzverordnung) in the currently valid version.

MZ2200-KP06 - Physiology (PhysioKP06)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	6

Course of study, specific field and term:

- Bachelor MLS 2018 (compulsory), life sciences, 3rd semester
- Bachelor Nutritional Medicine 2018 (compulsory), life sciences, 3rd semester
- Bachelor MLS 2016 (compulsory), life sciences, 3rd semester
- Bachelor Nutritional Medicine 2016 (compulsory), life sciences, 3rd semester
- Bachelor Biophysics 2016 (compulsory), life sciences, 5th semester

Classes and lectures:

- Physiology (lecture, 4 SWS)
- Physiology (seminar, 1 SWS)

Workload:

- 120 Hours private studies
- 60 Hours in-classroom work

Contents of teaching:

- Cell physiology & cell-to-cell communication
- Sensory & neuronal physiology
- Motor systems and respiration
- Cardiovascular and immune system
- Kidney physiology, electrolyte homeostasis and pH regulation
- Energy metabolism and homeostasis
- Endocrine system
- Circadian rhythms and sleep

Qualification-goals/Competencies:

- Understanding cellular and molecular processes in living organisms
- Understanding integrative processes in healthy humans
- Are capable of scientific intepretation of physiological functions

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Henrik Oster

Teacher:

- Institute of Neurobiology

- Prof. Dr. rer. nat. Henrik Oster
- Dr. rer. nat. Violetta Pilorz

Literature:

- Schmidt et al.: Physiolologie des Menschen - Springer, Heidelberg
- Rhoades et al.: Medical Physiology - Lippincott Raven, Philadelphia
- Speckmann et al.: Physiologie - Elsevier, Amsterdam

Language:

- offered only in German

Notes:

A Participation in the exam is only possible if the seminar has been passed.

PY1200-KP04, PY1200-MIW - Basic Psychology 1 (APKP04)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor MES 2014 (optional subject), no specific field, arbitrary semester
- Master MES 2014 (optional subject), no specific field, 1st or 2nd semester
- Master MES 2020 (optional subject), interdisciplinary, arbitrary semester
- Bachelor MES 2020 (optional subject), interdisciplinary, arbitrary semester
- Master Robotics and Autonomous Systems 2019 (optional suject), interdisciplinary competence, 1st or 2nd semester
- Bachelor Biophysics 2016 (optional subject), no specific field, 5th semester

Classes and lectures:

- Basic Psychologie 1 (lecture, 2 SWS)

Workload:

- 90 Hours private studies and exercises
- 30 Hours in-classroom work

Contents of teaching:

- Acquisition of basic knowledge in the topics perception, action, cognition and language
- Teaching of basic ideas, concepts and theories of perception and cognitive psychology
- Learning basic principles of experimental psychology work for planning and conducting experiments
- Understanding and judgment of basic ideas, theories and methods of perception, cognition and language

Qualification-goals/Competencies:

- Understanding and ability to apply psychological concepts
- Basic understanding of translating psychological research questions into empirical questions
- Developing scientific reasoning, thinking and discussing based on basic psychological research
- Social competency in discussing and application of knowledge
- Self competency in terms of critical reflection and work with scientific literature
- Ability to structure newly acquired knowledge

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Ulrike Krämer

Teacher:

- Department of Neurology

- Prof. Dr. rer. nat. Ulrike Krämer
- Dr. rer. nat. Dipl.-Psych. Frederike Beyer

Literature:

- Goldstein: Wahrnehmungspsychologie - Spektrum, 2007
- Müsseler (Hrsg.): Allgemeine Psychologie - Spektrum, 2007
- Anderson: Kognitive Psychologie (7. Auflage) - Springer, 2013

Language:

- offered only in German

BP3900 T - Advanced Practical Course Biophysics (FortPrakBP)

Duration:	Turnus of offer:
1 Semester	each summer semester

Course of study, specific field and term:

- Bachelor Biophysics 2016 (module part), biophysics, 6th semester

Classes and lectures:	Workload:
• Advanced Practical Course Biophysics (practical course, 3 SWS)	• 120 Hours work on project

Contents of teaching:

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-
-
-

Qualification-goals/Competencies:

-
-
-
-

Grading through:

- continuous, successful participation in practical course

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institute of Physics

Language:

- offered only in German

BP3990-KP12 - Bachelorarbeit Biophysik (BABP)

Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	12

Course of study, specific field and term:

- Bachelor Biophysics 2016 (compulsory), biophysics, 6th semester

Classes and lectures:

- Bachelor Thesis (supervised self studies, 1 SWS)
- Colloquium (presentation (incl. preparation), 1 SWS)

Workload:

- 360 Hours private studies

Contents of teaching:

-

Qualification-goals/Competencies:

-
-
-

Grading through:

- Written report

Responsible for this module:

- Studiengangsleitung

Teacher:

- Institutes of natural science
- Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges

Language:

- thesis can be written in German or English

CS1020-KP05 - Introduction into databases and system biology (EinfDBSB)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	5

Course of study, specific field and term:

- Bachelor MLS 2018 (compulsory), computer science, 6th semester
- Bachelor Nutritional Medicine 2018 (compulsory), computer science, 6th semester
- Bachelor MLS 2016 (compulsory), computer science, 6th semester
- Bachelor Biophysics 2016 (compulsory), bioinformatics, 6th semester
- Bachelor Nutritional Medicine 2016 (compulsory), computer science, 6th semester

Classes and lectures:

- Introduction into databases and system biology (lecture, 2 SWS)
- Introduction into databases and system biology (exercise, 1 SWS)
- Introduction into databases and system biology (practical course, 1 SWS)

Workload:

- 75 Hours private studies
- 45 Hours in-classroom work
- 30 Hours exam preparation

Contents of teaching:

- Entity-Relationship-Models
- Relation algebras
- Database systems
- Structured query language
- bio-databases
- Basic terms of system biology
- Cellular networks

Qualification-goals/Competencies:

- Students can create databases, manage them and create complex database queries.
- They can explain the basic terms of system biology and classify them correctly.
- Students know different bio-databases and can use and access them to solve problems from bioinformatics and system biology.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Till Tantau

Teacher:

- Institute for Theoretical Computer Science
- Prof. Dr. rer. nat. Till Tantau

Language:

- offered only in German

CS1200-KP06, CS1200SJ14 - Fundamentals of Computer Engineering 1 (TGI1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	6

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory), computer science, 4th semester
- Bachelor Media Informatics 2020 (compulsory), computer science, 2nd semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 2nd semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory: aptitude test), computer science, 2nd semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 2nd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), computer science, 2nd semester
- Bachelor IT-Security 2016 (compulsory), computer science, 2nd semester
- Bachelor Biophysics 2016 (optional subject), computer science, 6th semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 2nd semester
- Bachelor Media Informatics 2014 (compulsory), computer science, 2nd semester
- Bachelor MES 2014 (compulsory), foundations of computer science, 4th semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 2nd semester

Classes and lectures:

- Fundamentals of Computer Engineering 1 (lecture, 2 SWS)
- Fundamentals of Computer Engineering 1 (exercise, 2 SWS)

Workload:

- 100 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Von-Neumann computer
- Switching algebra and switching functions
- Technological realization
- Combinatorial and sequential circuits
- Memories
- Microprocessors
- Assembler programming
- Microcontrollers
- Input/Output programming
- Basic processor architectures

Qualification-goals/Competencies:

- The students can explain the principal organization of a computer and the execution of a program according to the Von-Neumann principle.
- They can elucidate the principal functioning of combinatorial and sequential circuits and describe them formally using switching algebra.
- They can demonstrate the basic circuits for the technological realization of logic gates with bipolar and MOS transistors.
- They can explain the structure and operation of registers and memories.
- They can elucidate the instruction set of a microprocessor exemplarily and to be able to use it for assembly programming.
- Sie können die Ein/Ausgabe-Schnittstellen eines Mikrocontrollers beschreiben und in Assemblersprache programmieren (mit Polling bzw. Interrupt).
- They can program microcontrollers for simple applications in assembly language and in C.
- They can discuss and compare basic processor architectures and their instruction sets.

Grading through:

- written exam

Is requisite for:

- Embedded Systems (CS2101-KP04, CS2101)
- Computer Architecture (CS2100-KP04, CS2100SJ14)
- Fundamentals of Computer Engineering 2 (CS1202-KP06, CS1202)

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- Prof. Dr.-Ing. Mladen Berekovic

Literature:

- C. Hamacher, Z. Vranesic, S. Zaky, N. Manjikian: Computer Organisation and Embedded Systems - McGraw-Hill 2012
- M. M. Mano, C. R. Kime: Logic and Computer Design Fundamentals - Pearson 2007
- D. A. Patterson, J. L. Hennessy: Computer Organisation & Design - The Hardware/Software Interface - Morgan Kaufmann 2011
- T. Ungerer, U. Brinkschulte: Mikrocontroller und Mikroprozessoren - Springer 2010

Language:

- offered only in German

CS2101-KP04, CS2101 - Embedded Systems (ES)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), major subject informatics, arbitrary semester
- Bachelor Computer Science 2019 (optional subject), Canonical Specialization SSE, 6th semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, arbitrary semester
- Bachelor Computer Science 2016 (optional subject), Canonical Specialization SSE, 6th semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, arbitrary semester
- Bachelor Biophysics 2016 (optional subject), computer science, 6th semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 4th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 6th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 4th semester
- Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester
- Bachelor MES 2011 (compulsory), computer system science, 6th semester

Classes and lectures:

- Embedded Systems (lecture, 2 SWS)
- Embedded Systems (exercise, 1 SWS)

Workload:

- 60 Hours private studies and exercises
- 45 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Target architectures (microcontrollers, FPGAs etc.)
- Conceptional models
- Peripheral buses
- Scheduling algorithms
- Specification languages
- Transformation from specification to implementation
- Development tools

Qualification-goals/Competencies:

- Students are able to explain the differences between desktop systems and embedded systems.
- They are able to select an appropriate hardware architecture for an embedded system.
- They are able to select appropriate communication protocols for interfacing peripheral components.
- They are able to control peripheral components with a microcontroller.
- They are able to model embedded systems conceptually and to specify them formally.
- They are well acquainted with the model-based design and tool-based implementation and of simple embedded systems.

Grading through:

- written exam

Requires:

- Fundamentals of Computer Engineering 1 (CS1200-KP06, CS1200SJ14)

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- Prof. Dr.-Ing. Mladen Berekovic

Literature:

- P. Marwedel: Eingebettete Systeme - Berlin: Springer 2007
- W. Wolf: Computers as Components - Principles of Embedded Computing System Design - San Francisco: Morgan Kaufmann 2012
- D.D. Gajski, F. Vahid, S. Narayan, J. Gong: Specification and Design of Embedded Systems - Englewood Cliffs: Prentice Hall 1994
- U. Brinkschulte, T. Ungerer: Mikrocontroller und Mikroprozessoren - Berlin: Springer 2010
- H. Woern, U. Brinkschulte: Echtzeitsysteme - Berlin: Springer 2005

Language:

- offered only in German

CS2700-KP04, CS2700 - Databases (DB)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor MES 2020 (optional subject), computer science / electrical engineering
- Bachelor Media Informatics 2020 (compulsory), computer science, 5th semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 4th semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 4th semester
- Bachelor Biophysics 2016 (optional subject), computer science, 6th semester
- Bachelor MES 2011 (optional subject), computer science, 4th or 6th semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 4th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 4th or 6th semester
- Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 4th semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 4th semester
- Bachelor Medical Informatics 2011 (compulsory), computer science, 2nd semester
- Master CLS 2010 (optional subject), computer science, 2nd semester
- Bachelor CLS 2010 (optional subject), computer science, 6th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 4th semester

Classes and lectures:

- Databases (lecture, 2 SWS)
- Databases (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction, conceptual view of database systems, conceptual data modeling with the Entity-Relationship (ER) modeling language
- The relational data model* Referential integrity, keys, foreign keys, functional dependencies (FDs)* Canonical mapping of entity types and relationships into the relational data model* Update, insertions, and deletion anomalies* Relational algebra as a query language* Database normalization, closure w.r.t. FD set, canonical cover of FD sets, normal forms, correct and dependency preserving decomposition of relation schemata, multi-value dependencies, inclusion dependencies
- Practical query language: SQL* Selection, projection, join, aggregation, grouping, sorting, difference, relational algebra in SQL* Data management* Integrity constraints
- Storage structures and database architecture* Characteristics of storage media, I/O complexity* DBMS architecture: disk space manager, buffer manager, files and access methods, record allocation strategies (row-wise, column-wise, mixed)
- Query processing* Indexing techniques, ISAM index, B+-tree index, hash index* Sorting: Two-way merge sort, blockwise processing, selection trees, query execution plans, join operator: nested loops join, blockwise nested loops join, index-based joins, sort-merge join, partition-based join with hashing* Addition operators: grouping and duplicate elimination, selection, projection, pipeline principle
- Query optimization* Cost metrics, Estimating sizes of intermediate tables, selectivity* Join optimization, physical plan properties, interesting orders, query transformation* Index cuts, bitmap indexes
- Transactions and recovery* ACID, anomalies, serializability, locks, 2-phase commit protocol, concurrent access to index structures, isolation levels* Implementation of transaction w.r.t. ACID, shadow pages, write ahead log, snapshots

Qualification-goals/Competencies:

- Basic understanding of database principles
- Knowledge about relational database design
- Knowledge of database query languages such as relational algebra and SQL
- Knowledge about principles of concurrent data access
- Introduction of database implementation techniques to allow for estimating resources required for answering queries

Grading through:

- written exam

Is requisite for:

- Nonstandard Databases and Data Mining (CS3130-KP08)
- Nonstandard Database Systems (CS3202-KP04, CS3202)

Requires:

- Introduction to Programming (CS1000-KP08, CS1000SJ14-MML/MI, CS1000SJ14-MIW)
- Introduction to Programming (CS1000-KP10, CS1000SJ14)

Responsible for this module:

- Prof. Dr. rer. nat. habil. Ralf Möller

Teacher:

- Institute of Information Systems
- Prof. Dr. rer. nat. habil. Ralf Möller

Literature:

- A. Kemper, A, Eickler: Datenbanksysteme - Eine Einführung - Oldenbourg-Verlag

Language:

- offered only in German

CS3204-KP04, CS3204 - Artificial Intelligence 1 (KI1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 6th semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, arbitrary semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering
- Bachelor Media Informatics 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering
- Bachelor Computer Science 2016 (optional subject), major subject informatics, arbitrary semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Web and Data Science, 6th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, arbitrary semester
- Bachelor Biophysics 2016 (optional subject), computer science, 6th semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 6th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 6th semester
- Bachelor Medical Informatics 2011 (optional subject), applied computer science, 4th to 6th semester
- Bachelor CLS 2010 (optional subject), computer science, 6th semester
- Bachelor MES 2011 (optional subject), medical engineering science, 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field robotics and automation, 4th semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

- Artificial Intelligence (lecture, 2 SWS)
- Artificial Intelligence (exercise, 2 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Part 1: Search strategiesAs an introduction and a prerequisite for most of the principles of artificial intelligence search strategies are introduced and explained. We will introduce uninformed, informed, local search, adversial search as well as heuristic search. The concept of agents will be presented.
- Part 2: Learning and reasoningRevision of the foundations of mathematical logic and probability. Principles of machine learning (supervised and unsupervised) are introduced. An introduction to fuzzy logic is also included.
- Part 3: Applications of artificial intelligenceTypical applications in the fields or robotics, machine vision, and industrial image and data processing are identified. Ethical issues and risks of the development of artificial intelligence are discussed.

Qualification-goals/Competencies:

- The students are able to handle scope-oriented tutorials with a mathematical background in a team, and timely.
- They have developed an understanding for the benefits and disadvantages of the different search and problem solving techniques.
- The students are in a position to choose and apply independently appropriate algorithms for search and learning issues.
- They have gained an insight into the complex development of systems with artificial intelligence and the distinction of its various forms.
- The students have an understanding of the risks and possible technological consequences of the development of systems with strong AI.

Grading through:

- written exam

Is requisite for:

- Artificial Intelligence 2 (CS5204-KP04, CS5204)

Responsible for this module:

- Prof. Dr. rer. nat. Floris Ernst

Teacher:

- Institute for Robotics and Cognitive Systems
- MitarbeiterInnen des Instituts
- Prof. Dr. rer. nat. Floris Ernst

Literature:

- G. Görz (Hrsg.): Handbuch der Künstlichen Intelligenz - München: Oldenbourg Wissenschaftsverlag, 2003
- C-M. Bishop: Pattern Recognition and Machine Learning - Springer Verlag, 2007
- Russell/Norvig: Artificial Intelligence: a modern approach - (3rd Ed.), Prentice Hall, 2009
- Mitchell: Machine Learning - McGraw-Hill, 1997
- Luger: Artificial Intelligence: Structures and Strategies for Complex Problem Solving - (6th Ed.), Addison-Wesley, 2008

Language:

- offered only in German

Notes:

It is recommended to attend the modules CS1001-KP08 Algorithms and Data Structures as well as MA2500 Analysis 2 beforehand.

Desirable pre-condition for a CS3701 Project in the field of Artificial Intelligence

CS4340-KP04, CS4340SJ14 - Health Economy (GOEK14)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor MES 2020 (optional subject), medical engineering science
- Master Medical Informatics 2019 (advanced module), medical computer science, 1st or 2nd semester
- Bachelor Biophysics 2016 (optional subject), no specific field, 6th semester
- Bachelor MES 2014 (optional subject), medical engineering science, 4th or 6th semester
- Master Medical Informatics 2014 (compulsory), medical computer science, 1st or 2nd semester

Classes and lectures:

- Health Economy (lecture, 2 SWS)
- Health Economy (exercise, 1 SWS)

Workload:

- 55 Hours private studies and exercises
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Healthcare systems (international comparison)
- PART 1: MACRO-ECONOMICS ASPECTS
- Health Technology Assessment (HTA) as an instrument of evidence-based decision support
- Medical cost-benefit assessment
- Health economic evaluations
- Resource allocation and priority setting
- PART 2: BUSINESS ECONOMICS ASPECTS
- Players in the health care system, social legislation and health care reforms
- Hospital organization and service provision
- Payment modalities in the outpatient and inpatient sector, especially the G-DRG system
- Internal and external accounting: cost & service allocation
- DRG-related cost unit accounting and analysis tools
- Innovation financing for medical technology products and processes

Qualification-goals/Competencies:

- Students can assess the necessity of doing business from the perspective of single actors in the health care market as well as from the perspective of solidarity communities of all insured persons - in the statutory health insurance (GKV).
- They can name and discuss variants of national health systems with alternative control principles and financing models.
- PART 1: MACRO-ECONOMIC PERSPECTIVE
- They can explain the relevance and working methods of the Federal Joint Committee (G-BA) for the approval of procedures and products, including their eligibility for reimbursement in health care in the context of statutory health insurances (GKV).
- They can explain HTA as an instrument to support health-related decisions at system level.
- They can explain clinically relevant endpoints and surrogate parameters, as well as appropriate measures of morbidity.
- They can discuss suitable study forms, their validity (evidence levels) and applications as well as variants and quality criteria of meta-analyses for the demonstration of benefits.
- They can explain cost types and measurement approaches for their determination in health economic studies.
- In addition to the benefit (efficacy), they can also include clinical safety (undesired efficacy).
- They can assess the suitability of data sources for health economic studies and perform sensitivity analysis by changing assumptions and data sources.
- They can apply the acquired knowledge to analyze and critically evaluate concrete HTA reports on the efficacy and cost-effectiveness of medical products and procedures.
- They can identify ethical requirements for approval and reimbursability issues, including the tension between the health care of a population and that of an individual.
- PART 2: BUSINESS ECONOMIC PERSPECTIVE
- They can name variants and conditions for the reimbursement of investment costs and operating costs in outpatient and inpatient care in standard care, including new selective forms of care.
- They can explain the functions and effects of G-DRGs for case-mix-based reimbursement of inpatient treatment cases and calculate and discuss the case mix (index) for specific case constellations.
- They can explain the role of internal accounting (including the delimitation of operational costs and services from expenses and income from financial accounting in accordance with KHBV) for the economic assessment of operational events.
- They can explain the terms fixed/variable and direct/indirect costs, as well as cost type, cost center and cost unit accounting, incl. the

relevance of contribution margin analysis.
- They can outline the analysis of costs and activities in the hospital on the basis of DRG-related cost unit accounting according to the national calculation handbook (InEK Institute).
- In particular, they can carry out internal cost allocation of indirect costs.
- They can interpret the national G-DRG cost modules published annually by the InEK and define their role for benchmarking economical projects of individual hospitals.
- They can perform case mix (profit) optimization with respect to resource constraints using the Simplex algorithm.
- They can explain the mechanisms and conditions of NUBs for innovation financing and the delay of several years for introducing them into the reimbursement catalogues of the statutory health insurance (GKV).

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. habil. Josef Ingenerf

Teacher:

- Institute for Social Medicine and Epidemiology
- Institute of Medical Informatics

- Prof. Dr. phil. Sascha Köpke
- Prof. Dr. Katrin Balzer
- Prof. Dr. rer. nat. habil. Josef Ingenerf

Literature:

- Roeder N., Hensen P., Franz D. (Hrsg): Gesundheitsökonomie, Gesundheitssystem und öffentliche Gesundheitspflege Ein praxisorientiertes Kurzlehrbuch - 2. aktualisierte Auflage. Köln: Deutscher Ärzte-Verlag 2013 (ISBN 978-3-769-13514-5)
- Fleßa S., Greiner W.: Grundlagen der Gesundheitsökonomie Eine Einführung in das wirtschaftliche Denken im Gesundheitswesen - 3. aktualisierte Auflage. Berlin: Springer Gabler 2013 (ISBN 978-3-642-30918-2)
- Graumann M., Schmidt-Graumann A.: Rechnungslegung und Finanzierung der Krankenhäuser - 2. aktualisierte Auflage. Herne/Berlin: NWB 2011 (ISBN: 978-3-482-57572-3)
- Perleth M., Busse R., Gerhardus A., Gibis B., Lühmann D. (Hrsg): Health Technology Assessment : Konzepte, Methoden, Praxis für Wissenschaft und Entscheidungsfindung - Berlin: MWV, 1. Aufl. 2007 (ISBN: 978-3-939069-22-5)

Language:

- offered only in German

Notes:

Examination prerequisites can be determined at the beginning of the semester. If pre-exam prerequisites have been defined, they must have been completed before the initial examination and evaluated positively.

LS2803-KP04 - Model organisms in molecular biology research (BioModOrg)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each summer semester	4	16

Course of study, specific field and term:

- Bachelor MLS 2018 (optional subject), life sciences, 4th semester
- Bachelor MLS 2016 (optional subject), life sciences, 4th semester
- Bachelor Biophysics 2016 (optional subject), life sciences, 6th semester

Classes and lectures:

- Model organisms in molecular biology research (lecture, 1 SWS)
- Model organisms in molecular biology research (exercise, 2 SWS)

Workload:

- 70 Hours private studies
- 45 Hours in-classroom work

Contents of teaching:

- Microorganisms Saccharomyces cerevisae
- Green plants Arabidopsis thaliana
- Invertebrates I Caenorhabditis elegans
- Invertebrates II Drosophila melanogaster
- Vertebrates Mus musculus
- Phylogeny of model organisms

Qualification-goals/Competencies:

- basic understanding of the biology of the organisms presented
- basic understanding of the advantages and disadvantages of the different model organisms for biological research
- basic practical abilities in self-acting handling these organisms

Grading through:

- continuous, successful participation in course

Requires:

- Biology 1 (LS1000-KP06)

Responsible for this module:

- Prof. Dr. rer. nat. Enno Hartmann

Teacher:

- Institute for Biology

- Prof. Dr. rer. nat. Enno Hartmann
- Prof. Dr. rer nat. Rainer Duden
- Prof. Dr. rer. nat. Christian Schmidt
- Prof. Dr. rer. nat. Walther Traut

Literature:

- : - zur Einführung: Campbell Allgemeine Biologie die entsprechenden Kapitel

Language:

- offered only in German

LS3500-KP05, LS3500 - Introduction into Structural Analysis (EinStruA05)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	5

Course of study, specific field and term:

- Bachelor MLS 2018 (compulsory), life sciences, 6th semester
- Bachelor Biophysics 2016 (compulsory), life sciences, 6th semester
- Bachelor MLS 2016 (compulsory), life sciences, 6th semester

Classes and lectures:

- Introduction into Structural Analysis (lecture, 2 SWS)
- Introduction into Structural Analysis (seminar / exercises, 2 SWS)

Workload:

- 90 Hours private studies
- 60 Hours in-classroom work

Contents of teaching:

- Part A: Protein structure analysis by crystal X-ray diffraction:
- Crystal growth: precipitant and phasediagram
- Crystal morphology: symmetry and space groups
- X-ray diffraction: Bragg's law, reciprocal lattice and the Ewald-sphere construction
- Phase determination: Patterson map and molecular replacement
- Part B: Basic NMR spectroscopy for the investigation of biomolecular structures: Basics of NMR spectroscopy: NMR experiments, Spin systems, the classical vector model
- The nuclear Overhauser effect
- Identification and characterisation of protein-ligand interactions: The transfer nOe, the STD-NMR-experiment, the HSQC experiment, the cross-saturation experiment
- Building blocks for NMR experiments
- Part C: Basics of mass spectrometry:Indroduction and basics
- Ion sources and their fields of application
- Mass analysers
- Structural analysis of biomolecules

Qualification-goals/Competencies:

- The students will acquire basic skills in selected biophysical techniques to analyze the structure and dynamics of biological macromolecules. The emphasis is on understanding the concepts behind these techniques.
- Furthermore, the students will learn how to elucidate the structure of small organic molecules
-

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Research Center Borstel
- Institute of Biochemistry
- Institute of Chemistry and Metabolomics

- Prof. Dr. rer. nat. Thomas Peters
- Prof. Dr. rer. nat. Rolf Hilgenfeld
- Dr. math. et dis. nat. Jeroen Mesters
- Dr. Alvaro Mallagaray de Benito
- Dr. Dominik Schwudke

Literature:

- Wird den aktuellen Gegebenheiten angepasst und in der Vorlesung angegeben. Siehe auch in den entsprechenden Skripten:
- Teil B: Horst Friebolin: Ein- und zweidimensionale NMR-Spektroskopie. Eine Einführung - Wiley-VCH
- Alexander Mc Pherson: Introduction to Macromolecular Crystallography - 1st edition, 2003, Wiley

Language:

- offered only in German

MA2510-KP04, MA2510 - Stochastics 1 (Stoch1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor MES 2020 (optional subject), mathematics / natural sciences
- Bachelor Computer Science 2019 (compulsory), mathematics, 4th semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 4th semester
- Bachelor Medical Informatics 2019 (optional subject), mathematics, 4th to 6th semester
- Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 8th semester
- Bachelor Computer Science 2016 (compulsory), mathematics, 4th semester
- Bachelor CLS 2016 (compulsory), mathematics, 2nd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 4th semester
- Bachelor IT-Security 2016 (compulsory), mathematics, 2nd semester
- Bachelor Biophysics 2016 (optional subject), mathematics, 6th semester
- Bachelor Medical Informatics 2014 (optional subject), mathematics, 5th or 6th semester
- Bachelor MES 2014 (optional subject), mathematics / natural sciences, 4th or 6th semester
- Bachelor Computer Science 2014 (compulsory), mathematics, 4th semester
- Bachelor Computer Science 2012 (compulsory), mathematics, 4th semester
- Bachelor MES 2011 (compulsory), mathematics, 4th semester
- Bachelor CLS 2010 (compulsory), mathematics, 2nd semester

Classes and lectures:

- Stochastics 1 (lecture, 2 SWS)
- Stochastic 1 (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- probability spaces
- basics of combinatorics
- conditional probability and stochastic independency
- random variables
- important discrete and continuous one-dimensional probability distributions
- characteristics of distributions
- law of large numbers, central limit theorem
- modeling examples from the life sciences

Qualification-goals/Competencies:

- Students are able to explain basic stochastic models formally correct and in the context of their application
- They are able to formalize stochastic problems
- They are able to identify basic combinatorial patterns and to use them for solving stochastic problems
- They understand central statements of elementary stochastics

Grading through:

- written exam

Is requisite for:

- Stochastic processes (MA4610-KP05)
- Stochastic processes and modeling (MA4610-KP04, MA4610)
- Modeling Biological Systems (MA4450-KP08, MA4450-MML)
- Modeling Biological Systems (MA4450-KP07)
- Module part: Modeling Biological Systems (MA4450 T-INF)
- Module part: Modeling Biological Systems (MA4450 T)
- Modeling Biological Systems (MA4450)
- Modeling (MA4449-KP07)
- Module part: Stochastics 2 (MA4020 T)
- Stochastics 2 (MA4020-KP05)
- Stochastics 2 (MA4020-MML)

- Stochastics 2 (MA4020-KP04, MA4020)

Requires:

- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics
- Prof. Dr. rer. nat. Karsten Keller

Literature:

- N. Henze: Stochastik für Einsteiger - Vieweg
- U. Krengel: Einführung in die Wahrscheinlichkeitstheorie - Vieweg

Language:

- offered only in German

Notes:

Only students who have passed the exercises are admitted to the examination.

PS1030-KP04, PS1030 - English for Bachelor and Master students MLS (Engl)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master MES 2020 (optional subject), interdisciplinary, arbitrary semester
- Bachelor MES 2020 (optional subject), interdisciplinary, arbitrary semester
- Bachelor MLS 2018 (optional subject), interdisciplinary competence, arbitrary semester
- Bachelor MLS 2016 (optional suject), interdisciplinary competence, arbitrary semester
- Bachelor Biophysics 2016 (optional subject), no specific field, 6th semester
- Master MES 2014 (optional subject), no specific field, 2nd semester
- Bachelor MES 2014 (optional subject), no specific field, 4th or 6th semester
- Master MLS 2009 (optional subject), interdisciplinary competence, arbitrary semester
- Bachelor Computer Science 2012 (optional subject), computer science, arbitrary semester
- Bachelor MES 2011 (optional subject), medical engineering science, arbitrary semester
- Master CLS 2010 (optional subject), interdisciplinary competence, arbitrary semester
- Bachelor MLS 2009 (optional subject), interdisciplinary competence, arbitrary semester

Classes and lectures:

- English for Bachelor and Master students MLS (exercise, 4 SWS)

Workload:

- 60 Hours in-classroom work
- 60 Hours private studies

Contents of teaching:

- Exercise:The content follows a curriculum, modified depending on the given skills and the thematic interests of the participants.
- Creating a CV in English

Qualification-goals/Competencies:

- Acquisition of basic skills in spoken and written English
- Improvement of communication in English
- Improvement of reading and writing of texts in English, including technical literature

Grading through:

- written exam

Responsible for this module:

- B. Sc. Sara Meitner

Teacher:

-

- B. Sc. Sara Meitner

Literature:

- : - Publications and articles

Language:

- offered only in English

PS4620-KP04, PS4620SJ14 - Ethics of Sciences (EthikKP04)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4 (Typ B)

Course of study, specific field and term:

- Master Medical Informatics 2019 (optional subject), interdisciplinary competence, 1st or 2nd semester
- Bachelor MES 2014 (optional subject), no specific field, arbitrary semester
- Master MES 2014 (optional subject), no specific field, 1st or 2nd semester
- Master Medical Informatics 2014 (optional subject), interdisciplinary competence, 1st or 2nd semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, arbitrary semester
- Bachelor Interdisciplinary Courses (optional subject), Interdisciplinary modules, arbitrary semester
- Master Robotics and Autonomous Systems 2019 (optional subject), interdisciplinary competence, 1st or 2nd semester
- Bachelor Biophysics 2016 (optional subject), no specific field, 6th semester

Classes and lectures:

- Ethics in Sciences (lecture, 2 SWS)

Workload:

- 65 Hours private studies
- 30 Hours in-classroom work
- 25 Hours work on an individual topic with written and oral presentation

Contents of teaching:

- Societal and ethical implications of research in biomedical sciences and technologies
- Basics of philosophy and sociology of science
- Good scientific practice
- Basics of bioethics: duties of investigators, obligations to colleagues,
- Ethics of human subjects research and animal experim. Environmental ethicsentation. Control and governance of technology. Risk assessement
- Use and implications of images in science

Qualification-goals/Competencies:

- Students can explain the methodology of the physical sciences and technology and their philosophical basis
- They can recognize ethical dimensions of practice and deciding
- They can recognize and evaluate ethical dimensions of practice and deciding in biotechnolgoy
- They can understand relevant laws in Germany
- They can participate in current discussions in bioethics and research ethics
- They can reflect on ethical dimensions of biomedical sciences

Grading through:

- Oral presentation and written report

Responsible for this module:

- Prof. Dr. phil. Christoph Rehmann-Sutter

Teacher:

- Institute for the History of Medicine and Science Studies
- Prof. Dr. med. Cornelius Borck
- Prof. Dr. phil. Christoph Rehmann-Sutter
- Prof. Dr. rer. nat. Burghard Weiss

Literature:

- Daniel A. Vallero: Biomedical Ethics for Engineers. Ethics and Decision Making in Biomedical and Biosystem Engineering - Amsterdam: Elsevier 2007
- Ben Mepham: Bioethics. An Introduction for the Biosciences - Oxford: Oxford University Press 2008
- Sergio Sismondo: An introduction to science and technology studies - Chichester: Wiley-Blackwell 2010

Language:

- offered only in English

PY2904-KP04, PY2904 - Media Psychology (MedienPsy)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Media Informatics 2020 (compulsory), psychology, 4th semester
- Bachelor Psychology 2013 (optional subject), psychology, arbitrary semester
- Bachelor Biophysics 2016 (optional subject), no specific field, 6th semester
- Bachelor Psychology 2016 (optional subject), psychology, arbitrary semester
- Bachelor Media Informatics 2014 (compulsory), psychology, 4th semester

Classes and lectures:

- Media Psychology (lecture, 2 SWS)
- Media Psychology (seminar, 1 SWS)

Workload:

- 75 Hours private studies and exercises
- 45 Hours in-classroom work

Contents of teaching:

- History of media psychology
- Media selection and media use
- Media reception
- Media effects
- Media socialisation and media competency
- Persuasive technology, advertisment, gamification
- Human-computer interaction, computer-mediated communication, social networks

Qualification-goals/Competencies:

- The students can explicate theories and findings of media psychology using digital media as examples.
- They are able to draw conclusions from media psychology s scientific contributions regarding multimedia and interactive media and to judge media use and media effects based on knowledge of media psychology.
- They are able to analyse and to evaluate digital media with methods from media psychology.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Franke

Teacher:

- Institute for Multimedia and Interactive Systems
- Prof. Dr. rer. nat. Thomas Franke
- MitarbeiterInnen des Instituts

Literature:

- B. Batinic & M. Appel (Hrsg.): Medienpsychologie - Heidelberg: Springer, 2008
- S. Trepte & L. Reinecke: Medienpsychologie - Stuttgart: Kohlhammer, 2013
- :

Language:

- offered only in German