UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Bachelor Biophysics 2024

Version from 1. October 2025

mathematics

life sciences

medical engineering science

physics

biophysics

computer science

bioinformatics

Elective Chemistry/Biology

Elective Computer Science

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:

- Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 3rd semester
- Bachelor CLS 2023 (compulsory), mathematics, 1st semester
- Bachelor Biophysics 2024 (compulsory), mathematics, 1st semester
- Bachelor Biophysics 2024 (compulsory), mathematics, 1st semester
- 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:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments during the semester
- Successful completion of e-tests during the semester
- Presentation of homework assignment

Module exam:
- MA1000-L1: Linear Algebra and Discrete Structures 1, written exam, 90 min, 100 % of module grade

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:

- Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 4th semester
- Bachelor CLS 2023 (compulsory), mathematics, 2nd semester
- Bachelor Biophysics 2024 (compulsory), mathematics, 2nd semester
- 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:

- written exam

Is requisite for:

- Image Registration (MA5030-KP05)
- Image Registration (MA5030-KP04, MA5030)
- Mathematical Methods of Image Processing (MA4500-KP05)
- Mathematical Methods in Image Processing (MA4500-KP04, MA4500)
- Optimization (Advanced Mathematics) (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:

Prerequisites for attending the module:
- None (The competencies of the modules listed under 'Requires' are needed for this module, but are not a formal prerequisite)

Prerequisites for the exam:
- Successful completion of homework assignments during the semester
- Successful completion of e-tests during the semester
- Presentation of homework assignment

Module exam:
-MA1500-L1: Linear Algebra and Discrete Structures 2, written exam, 90 min, 100 % of module grade

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 CLS 2023 (compulsory), mathematics, 1st semester
- Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 5th semester
- Bachelor Biophysics 2024 (compulsory: aptitude test), mathematics, 1st semester
- 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
- Metric and normalized spaces, basic topological concepts
- Multivariate differential calculus

Qualification-goals/Competencies:

- Students understand the basic terms of analysis, especially the concept of convergence.
- Students understand the basic thoughts and proof techniques and are able to use them for the analytical treatment of scientifially or technically motivated problems.
- Students can explain basic relationships in real analysis.
- Students can apply the basic concepts and proof techniques of differential calculus.
- 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.

Grading through:

- written exam

Is requisite for:

- Analysis 2 (MA2500-KP09)
- Analysis 2 (MA2500-KP08)

- Analysis 2 (MA2500-KP05, MA2500-MLS)
- 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
- PD Dr. rer. nat. Jörn Schnieder

Literature:

- K. Fritzsche: Grundkurs Analysis 1 + 2
- H. Heuser: Lehrbuch der Analysis 1 + 2
- K. Burg, H. Haf, F. Wille, A. Meister: Höhere Mathematik für Ingenieure
- R. Lasser, F. Hofmaier: Analysis 1 + 2

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of homework assignments during the semester
- Successful completion of e-tests

Modul exam:
- MA2000-L1: Analysis 1, written exam, 90 min, 100 % of module grade

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 Biophysics 2024 (compulsory), mathematics, 2nd semester
- Bachelor IT-Security 2016 (optional subject), specific, Arbitrary semester
- 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 private studies
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Advanced multivariate differential calculus
- Integral calculus for functions of one real variable (indefinite integrals, antiderivatives, substitution, partial fractions, definite integrals, fundamental theorem of calculus)
- Curvilinear integrals, bounded variation
- Function series, power series
- Fourier series (trigonometric polynomials, convergence)
- Linear operators in Hilbert spaces

Qualification-goals/Competencies:

- Students understand the advanced terms of analysis, such as even convergence.
- Students understand the advanced thoughts and proof techniques.
- Students can apply the advanced concepts and proof techniques.
- Students can explain advanced relationships in analysis.
- Interdisciplinary qualifications:
- Students can transfer advanced theoretical concepts to similar applications.
- Students have an advanced competence in modeling.
- Students can work as a group on complex mathematical problems.

Grading through:

- written exam

Requires:

- Analysis 1 (MA2000-KP09)
- Analysis 1 (MA2000-KP08, MA2000)

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
- K. Burg, H. Haf, F. Wille, A. Meister: Höhere Mathematik für Ingenieure
- R. Lasser, F. Hofmaier: Analysis 1 + 2

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments during the semester.
- Successful completion of e-tests

Modul exam:
-MA2500-L1: Analysis 2, written exam, 90 min, 100 % module grade

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:

- Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 8th semester
- Bachelor CLS 2023 (compulsory), mathematics, 2nd semester
- Bachelor MES 2020 (optional subject), mathematics / natural sciences, 3rd semester at the earliest
- Bachelor Biophysics 2024 (optional subject), mathematics, 6th semester
- 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)

Responsible for this module:

- Nachfolge von Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics
- Nachfolge von 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:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of homework assignments during the semester

Module exam(s):
- MA2510-L1: Stochastics 1, written exam, 90 min, 100 % of module grade

MA3400-KP05 - Biomathematics (BioMaKP05)

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

Course of study, specific field and term:

- Bachelor CLS 2023 (compulsory), mathematics, 3rd semester
- Bachelor Biophysics 2024 (compulsory), mathematics, 3rd semester
- 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), mathematics / computer science, 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:

- Examples and elementary solution methods for ordinary differential equations
- Existence and uniqueness theorems
- Dependence of solutions on initial conditions
- Linear systems (in particular with constant coefficients)
- Higher-Order linear differential equations
- Qualitative theory of nonlinear systems

Qualification-goals/Competencies:

- Students are able to explain basic notions from the theory of ordinarydifferential equations.
- Students can explain bad phenomena of solutions of differential equations using examples.
- Students can specify conditions under which good phenomena of solutions are guaranteed by applying theorems from the theory of ordinary differential equations.
- Students are able to find explicit solutions of simple differential equations.
- Students are able to explain how solutions of differential equations can beanalysed qualitatively.
- Students are able to present important models of the natural sciences which canbe analysed by differential equations.

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-KP04, MA2500)
- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- PD Dr. rer. nat. Christian Bey

Teacher:

- Institute for Mathematics
- PD Dr. rer. nat. Christian Bey

Literature:

- G. Birkhoff, G.-C. Rota: Ordinary Differential Equations

- H. Heuser: Gewöhnliche Differentialgleichungen - Teubner Verlag 2009 (6. Auflage)
- M.W. Hirsch, S. Smale: Differential Equations, Dynamical Systems, and Linear Algebra
- J. D. Murray: Mathematical Biology - Springer
- J. Scheurle: Gewöhnliche Differentialgleichungen
- R. Schuster: Biomathematik - Vieweg + Teubner Studienbücher 2009
- W. Walter: Gewöhnliche Differentialgleichungen

Language:

- offered only in German

Notes:

Admission requirememnts for taking the module:
- None (The competencies of the modules listed under 'Requires' are needed for this module, but are not a formal prerequisite)

Admission requirements for participation in module examination(s):
- Successful completion of homework assignments during the semester

Module exam(s):
- MA3400-L1: Biomathematics, written exam, 90 min, 100 % of module grade

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 2024 (compulsory), life sciences, 3rd semester
- 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:

- Campbell: Biology

Language:

- offered only in German

Notes:

Prerequisites for the modul:
- nothing

Prerequisites for admission to the written examination:
- nothing

Modul exam:
- LS1000-L1: Biology, written exam, 90 min, 100% modul grade

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 CLS 2023 (compulsory), life sciences, 3rd semester
- Bachelor Biophysics 2024 (compulsory), life sciences, 1st semester
- 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, 3rd semester at the earliest
- 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 in-classroom work
- 60 Hours private studies

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
- Roles of Environmental and occupational health and safety in the handling of hazardous materials (Globally Harmonized System of Classification and Labeling of Chemicals (GHS)) and of GSP of the University of Lübeck and of the DFG-guidelines
- 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 know the roles for GSP of the University of Lübeck.
- 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

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of homework assignments as specified at the beginning of the semester

Modul exam(s):
- LS1100-L1: General Chemistry, written exam, 90 min, 100% of module grade

LS1600-KP04 - Organic Chemistry (OCKP04)

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

Course of study, specific field and term:

- Bachelor CLS 2023 (compulsory), life sciences, 4th semester
- Bachelor Biophysics 2024 (compulsory), life sciences, 2nd semester
- 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 private studies
- 60 Hours in-classroom work

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

Notes:

Knowledge of basic chemistry (such as from LS1100-INF) is required.

Prerequisites for attending the module:
- None (The competencies of the modules listed under 'Requires' are needed for this module, but are not a formal prerequisite)

Prerequisites for the exam:
- Examination prerequisites can be defined at the beginning of the semester. If preliminary work is defined, it must have been completed and positively evaluated before the first examination.

Module exam:
LS1600-L1: Organic Chemistry, written exam, 90 min, 100 of % module grade

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 2023 (compulsory), life sciences, 4th semester
- Bachelor Biophysics 2024 (compulsory), life sciences, 1st and 2nd semester
- 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 with regards to the role of GSP of the University of Lübeck
- 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 within the roles of Good Scientific Praxis of the University of Lübeck. 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) with regards to the role of GSP of the University of Lübeck and the DFG-guidelines.

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

Literature:

- Thomas Weimar: Script of the practical course

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- Passing of LS1100-L1 and participation in the general health and safety briefing

Prerequisites for admission to the examination:
- Successful participation in the practical course with all tests

Module exam:
- 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. Not graded, 100%.

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 2024 (compulsory), life sciences, 3rd semester
- Bachelor Biophysics 2016 (compulsory), life sciences, 3rd semester

Classes and lectures:

- Biochemistry 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
- DNA Replication, transcription, translation

Qualification-goals/Competencies:

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

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. Thomas Krey

Teacher:

- Institute of Biochemistry

- Prof. Dr. Thomas Krey
- Prof. Dr. Lars Redecke
- PD Dr. rer. nat. Guido Hansen
- Dr. rer. nat. Janna Bigalke
- Dr. Mariana Grieben

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:

Prerequisites for the module:
- nothing

Prerequisites for admission to the written examination:
- nothing

Module exam:
- LS2001-L1: Biochemistry, written exam, 120 min, 100 % module grade

LS2801-KP04 - Selected methods of nucleic acid biology (MethNuklS)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each summer semester	4	9

Course of study, specific field and term:

- Bachelor Biophysics 2024 (optional subject), life sciences, 6th semester
- Bachelor Molecular Life Science 2024 (optional subject), life sciences, 4th or 6th semester
- Bachelor MLS 2018 (optional subject), life sciences, 4th semester
- Bachelor MLS 2016 (optional subject), life sciences, 4th semester

Classes and lectures:

- Selected methods of nucleic acid biology (practical course as compact course, 3 SWS)

Workload:

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

Contents of teaching:

- Studying nucleic acid/protein interactions
- Isolation and analysis of total RNA from eukaryotic cells
- Automated Sanger-Sequencing

Qualification-goals/Competencies:

- Students learn basic molecular methods for handling nucleic acids and proteins
- Students are able to translate theoretical contexts into independent and autonomous experimental work

Grading through:

- continuous, successful participation in practical course

Responsible for this module:

- Dr. rer. nat. Rosel Kretschmer-Kazemi Far

Teacher:

- Institute of Molecular Medicine

- Dr. rer. nat. Ralf Werner
- Dr. rer. nat. Rosel Kretschmer-Kazemi Far

Literature:

- : - Work instructions, scientific publications

Language:

- offered only in German

Notes:

Maximal group size: 9

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of protocols during the semester.

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 Biophysics 2024 (optional subject), life sciences, 6th semester
- Bachelor Molecular Life Science 2024 (optional subject), life sciences, 4th or 6th semester
- 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 II Danio rerio
- Vertebrates II 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:

- Active participation in all course days

Requires:

- Biology 1 (LS1000-KP06)

Responsible for this module:

- Dr. rer. nat. Alexandra Schatt

Teacher:

- Institute for Biology

- Prof. Dr. rer. nat. Enno Hartmann
- Dr. rer. nat. Nicole Sommer
- Prof. Dr. rer. nat. Christian Schmidt
- Dr. rer. nat. Carla Schulz
- Dr. rer. nat. Alexandra Schatt
- Priv.-Doz. Dr. rer. nat. Aleksander Rakovic

Literature:

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

Language:

- offered only in German

LS2804-KP04 - Experimentel Physiology (ExpPhysio)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each summer semester	4	12

Course of study, specific field and term:

- Bachelor Biophysics 2024 (optional subject), life sciences, 6th semester
- Bachelor Molecular Life Science 2024 (optional subject), life sciences, 4th or 6th semester
- Bachelor MLS 2018 (optional subject), life sciences, 4th semester
- Bachelor MLS 2016 (optional subject), life sciences, 4th semester

Classes and lectures:

- Experimentel Physiology (lecture, 2 SWS)
- Experimentel Physiology (seminar, 1 SWS)

Workload:

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

Contents of teaching:

- Experiments on isolated organs and physiological studies in humans:
- Practical course for the isolation of organs from frog, mouse and rat
- Study of isolated nerves and skeletal muscle to characterize organ physiology
- Determination of blood groups, hemolysis, and coagulation in human blood
- Study of isolated gut, blood vessels, and uterus to characterize the function of smooth muscle
- Practical course on sensory physiology exemplified on the eye
- Study on the circulatory regulation in humans

Qualification-goals/Competencies:

- Acquiring knowledge on experimental procedures in physiology and pharmacology

Grading through:

- presentation and experiments

Requires:

- Physiology (MZ2200-KP06)

Responsible for this module:

- Prof. Dr. med. Cor de Wit

Teacher:

- Institut of Physiology
- Prof. Dr. med. Cor de Wit

Literature:

- : - Lehrbücher der Physiologie

Language:

- offered only in German

LS2808-KP04 - Developmental biology in vivo and in vitro (EntwBio)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each summer semester	4	5

Course of study, specific field and term:

- Bachelor Biophysics 2024 (optional subject), life sciences, 6th semester
- Bachelor Molecular Life Science 2024 (optional subject), life sciences, 4th or 6th semester
- Bachelor MLS 2018 (optional subject), life sciences, 4th semester
- Bachelor MLS 2016 (optional subject), life sciences, 4th semester

Classes and lectures:

- Entwicklungsbiologie in vitro und in vivo (seminar / exercises, 3 SWS)

Workload:

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

Contents of teaching:

- Cultivation of adult stem cells from various vertebrates (subject to availability)
- Differentiation of adult stem cells by cultivation modification and their analysis
- Characterization of differentiated cell types by expression analysis of marker genes
- Comparison of in vitro cell differentiation with differentiated cells in adult tissue

Qualification-goals/Competencies:

- Students are able to list basic priciples of cell differentiation and to explain how to characterize differentiated cells
- Students are able to explain what stem cells are and which differences exist between somatic and embryonic stem cells

Grading through:

- protocols

Responsible for this module:

- Prof. Dr. rer. nat. Charli Kruse

Teacher:

- Institute of Medical and Marine Biotechnology
- Prof. Dr. rer. nat. Charli Kruse
- Dr. rer. nat. Anna Emilia Matthießen

Literature:

- Wolpert: Principles of Development

Language:

- offered only in German

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 Molecular Life Science 2024 (optional subject), life sciences, 5th semester
- Bachelor Biophysics 2024 (optional subject), life sciences, 5th semester
- 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:

- Medical Clinic I
- Institute of Neurobiology
- Institute for Experimental Endocrinology

- Prof. Dr. rer. nat. Henrik Oster
- Dr. rer. nat. Violetta Pilorz
- Dr. rer. nat. Isabel Heyde
- Dr. rer. nat. Carla Schulz
- Prof. Dr. rer. nat. Jens Mittag
- PD Dr. Britta Wilms

Literature:

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

Language:

- German and English skills required

Notes:

Admission requirements for enrolling in the module:
- LS2000-L1 Biochemistry 1 or LS2510-L1 Biochemistry 2
- Basic knowledge of physiology and biochemistry is required

Admission requirements for participating in module exam(s):
- Successful participation in the LS3250-S Tissue Engineering seminar

Module exam(s):
- LS3252-L1: Metabolic Medicine, written exam, 90 min, 100% of the module grade

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 Biophysics 2024 (compulsory), life sciences, 6th semester
- Bachelor Molecular Life Science 2024 (compulsory), life sciences, 6th semester
- 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:

- Dr. Alvaro Mallagaray

Teacher:

- Research Center Borstel, Leibniz Lung Center
- Institute of Biochemistry
- Institute of Chemistry and Metabolomics

- Prof. Dr. Thomas Krey
- Dr. math. et dis. nat. Jeroen Mesters
- Dr. Alvaro Mallagaray
- Dr. Dominik Schwudke

Literature:

- actual papers:
- 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

Notes:

Prerequisites for the module:
- nothing

Prerequisites for admission to the written examination:
- nothing

Module exam:
- LS3500-L1: Introduction into Structural Analysis, written exam, 90 min, 100 % module grade

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

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

Course of study, specific field and term:

- Bachelor Biophysics 2024 (compulsory), life sciences, 5th semester
- Master Molecular Life Science 2023 (optional subject), interdisciplinary competence, 2nd semester
- 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:

- Fundamentals of German radiation protection law and its practical application
- 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
- Applications of open radioactive substances

Qualification-goals/Competencies:

- The students have acquired the specialist knowledge required under the Radiation Protection Ordinance. After completing their academic training and the legally stipulated period of practical experience in handling radionuclides, they are thus able to plan, set up, and manage a radionuclide laboratory and perform the function of a radiation protection officer in Germany.
- 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 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

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
- Prof. Dr. rer. nat. Magdalena Rafecas

- Dr. math. et dis. nat. Jeroen Mesters
- Prof. Dr. Lars Redecke
- Dr.-Ing. Steven Seeger

Literature:

- Skript of the practical course:
- German rules for radiation saftey:
- Bundesamt für Strahlenschutz (BfS) (2007): Die Empfehlungen der Internationalen Strahlenschutzkommission (ICRP) von 2007 - ICRP-Veröffentlichung 103 (BfS-SCHR-47/09)
- G. Major.: Strahlenschutz - Im Buch: W. Schlegel, C.P. Karger, O. Jäkel (Hrsg.), Medizinische Physik. Springer-Verlag, 2018.
- H. Krieger: Grundlagen der Strahlungsphysik und des Strahlenschutzes - Springer, 2017
- H. Krieger: Strahlungsmessung und Dosimetrie - Springer, 2013
- Veröffentlichungen der Strahlenschutzkommission - Band 43: Berechnungsgrundlage für die Ermittlung von Körper-Äquivalentdosen bei äußerer Strahlenexposition - 2017

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- Participation in the radiation protection instruction
- Sufficient knowledge of German to be able to follow lectures and understand and apply legal texts.

Admission requirements for participation in module examination(s):
- Successful participation in 90 % of the radiation protection internship

Module examination(s):
- ME5050-L1: Biophysics of ionizing radiation and radiation protection, written exam, 120 min, 100% of the module grade (ungraded for MLS)

Admission requirements for participation in the internship:
- Successful completion of learning progress assessments

Each winter semester preferential for students of Biophysics, every summer semester preferential for MLS students.

Only by passing the German examination is it possible to obtain the certificate of professional competence!
Prerequisite for the award of the certificate of proficiency: Attendance during the entire course (In justified exceptional cases, a maximum absence of 10% of the lecture time is permitted) and at least 70% of the points in the written examination.
If less than 70% but more than 50% of the points are achieved, a written or oral re-examination will be offered promptly at the discretion of the module coordinator. If the re-examination is passed, the certificate of specialist knowledge will be awarded. In this case, only the result of the first examination is decisive for the grade on the certificate of achievement.
The Guideline on the technical knowledge required in radiation protection (technical knowledge guideline according to the Radiation Protection Ordinance) in the currently valid version is decisive for the implementation of the course and the issuing of the certificates of technical knowledge.

MZ2200-KP06 - Physiology (PhysioKP06)

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

Course of study, specific field and term:

- Bachelor Biophysics 2024 (compulsory), life sciences, 5th semester
- Bachelor Nutritional Medicine 2024 (compulsory), life sciences, 3rd semester
- Bachelor Molecular Life Science 2024 (compulsory), life sciences, 3rd semester
- 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:

- The students understand the cellular and molecular processes in living organisms.
- They understand the integrative processes in healthy humans.
- They are capable to interprete the physiological functions in a scientific way.

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. Isabel Heyde

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:

Prerequisites for the modul:
- nothing

Prerequisites for admission to the written examination:
- succesful participation in the seminar

Modul exam:
- MZ2200-L1: Physiologie, written exam, 60 min, 100 % module grade

ME3220-KP04, ME3220 - Therapeutische Laseranwendungen (TLA)

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

Course of study, specific field and term:

- Bachelor Biophysics 2024 (optional subject), medical engineering science, 5th semester
- Bachelor MES 2020 (optional subject), medical engineering science, 3rd semester at the earliest
- Master MES 2014 (optional subject), medical engineering science, Arbitrary semester
- Bachelor MES 2014 (optional subject), medical engineering science, 5th semester

Classes and lectures:

- Therapeutische Laseranwendungen (lecture, 3 SWS)

Workload:

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

Contents of teaching:

- The aim of the course is to learn about the effect of laser radiation on tissue with very different irradiance levels, i.e. to learn about it theoretically and to validate it experimentally in the laboratory using specific setups. The necessary lasers, laser parameters and various application techniques are discussed and applied for the corresponding effect classes, with the learning objectives listed below: - thermal tissue effects: light distribution, heating, thermal diffusion, coagulation, contractive forces due to phase transition. Examples: Laser thermokeratoplasty (thermal deformation of the cornea), skin tightening, hemostasis - Selective tissue effects: selective cell effects, thermo-mechanical transition, microvaporization, blistering, pressure transients. Examples: Selective cell effects on the retinal pigment epithelium of the eye without affecting the adjacent retina, selective laser trabeculoplasty for glaucoma treatment, removal of tattoos and port-wine stains - vaporizing tissue effect: thermal-vaporizing effects, various thermal edge zones (carbonization, coagulation, subnecrotic inflammation). Example: cutting of tissue - ablative tissue effect: photoablation, cavitation bubbles, pressure effects, ablation products. Example: laser lithotripsy (disintegration of ureteral stones) - disruptive tissue effect: laser-induced plasma, pressure waves, cavitation bubbles. Examples: Disruption of the post-sternal membrane on the lens capsule of the eye, refractive laser surgery

Qualification-goals/Competencies:

- Students learn laser light distribution in tissue as a function of absorption and scattering.
- The students learn the different mechanisms of action of laser light on tissue as a function of pulse duration and irradiance.
- The students learn the therapeutic possibilities in the different efficacy classes.
- The students learn the photocoagulation of the retina of the eye and the thermal coagulation of tissue as examples of thermal modes of action.
- The students learn selective retina therapy and tissue dissection as examples of vaporization effects.
- The students learn the laser-induced disintegration of hard concrements (ureter stones) as an example of photoablative mechanisms.
- The students learn refractive surgery and presbyopia prophylaxis as examples of plasma-mediated effects.
- The students learn different methods for real-time measurement of the laser effect on tissue, e.g. photoacoustics, spectroscopy, light reflection.
- Based on this, the students learn the real-time feedback to the treatment laser for intelligent, feedback laser therapy (Theragnostics).
- The students learn the application of all procedures in the wet lab in the laboratory on models.
- The students learn how to create an experimental protocol with a description of the method and presentation of the results.

Grading through:

- protocols

Responsible for this module:

- Prof. Dr. rer. nat. Robert Huber

Teacher:

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

Literature:

- Brinkmann R, Knipper A, Dröge G, Schroer F, Gromoll B, Birngruber R.: Fundamental Studies of Fiber-Guided Soft Tissue Cutting by

Means of Pulsed Midinfrared IR lasers and their Application in Ureterotomy - J Biomed Optics 1998; 3(1):85-95
- Theisen-Kunde D, Ott V, Brinkmann R, Keller R.: Potential of a new cw 2µm laser scalpel for laparoscopic surgery - Medical laser application 2007; 22:139-145
- Brinkmann R, Birngruber R.: Selektive Retina-Therapie (SRT) - Z Med Phys 2007; 17:6-22
- Brinkmann R, Koinzer S, Schlott K, Ptaszynski L, Bever M, Baade A, Luft S, Miura Y, Roider J, Birngruber R.: Real-time temperature determination during retinal photocoagulation on patients - J Biomed Opt 2012; 17(6): 061219
- Lange B, Cordes J, Brinkmann R.: Stone/Tissue Differentiation for Holmium Laser Lithotripsy using Autofluorescence - Las Surg Med 2015; 47(9):737-744
- König, K.: Handbook of Biological Confocal Microscopy - Third Edition, edited by James B. Pawley, Springer Science+Business Media, LLC, New York, 2006

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Preliminary examinations can be determined at the beginning of the semester. If preliminary work has been defined, it must have been completed and positively assessed before the initial examination.

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 2024 (compulsory), physics, 3rd semester
- 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:

- Die Studierenden bearbeiten Übungsaufgaben selbständig unter Berücksichtigung der Richtlinie der GWP der Universität zu Lübeck und gemäß den DFG-Leitlinien.
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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

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 2024 (compulsory), physics, 4th semester
- 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 in-classroom work
- 60 Hours private studies and exercises
- 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
- Guideline for GSP of the University at Lübeck and corresponding DFG guidelines

Qualification-goals/Competencies:

- Students can name the components of atoms and explain their structure
- They can explain the formation and shape of atomic and molecular spectra.
- They can apply their knowledge of the structure of atoms and molecules in the biophysical context.
- They can explain the structure of molecules
- You know the rules of good scientific practice

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

Notes:

Admission requirements for the module:
- Successful completion of the modules Physics 1 and Physics 2 (ME1010 and ME1020).

Admission requirements for the examination:
- Successful participation in the exercises

Module Exam:
- BP2600-L1: Atomic and Molecular Physics, written exam, 90 min, 100% module grade.

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 2024 (Module part of a compulsory module), physics, 6th semester
- Bachelor Biophysics 2016 (Module part of a compulsory module), biophysics, 6th semester

Classes and lectures:

- Advanced Practical Course Biophysics (practical course, 3 SWS)

Workload:

- 120 Hours work on project

Contents of teaching:

- Familiarization with a scientific topic
- Collaboration in current research projects of the supervising institute
- Evaluation and analysis of measurement data
- Documentation and presentation of research results, according to the guidelines of good scientific practice of the UZL.

Qualification-goals/Competencies:

- The students master the handling of laboratory equipment
- They are able to correctly assess work allocation and requirements
- They can correctly evaluate, analyze, and interpret research results/data.
- They can document and present research results
- They know the rules of good scientific practice

Grading through:

- continuous, successful participation in practical course

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institute of Physics
- MitarbeiterInnen des Instituts

Literature:

- : Scientific publications - Scientific publications

Language:

- offered only in German

ME1010-KP08, ME1010 - Physics 1 (Physik1)

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

Course of study, specific field and term:

- Bachelor Biophysics 2024 (compulsory: aptitude test), physics, 1st semester
- 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. Martin Koch
- Prof. Dr. rer. nat. Christian Hübner
- PD Dr. rer. nat. Hauke Paulsen
- Prof. Dr.-Ing. Maik Rahlves
- Prof. Dr. rer. nat. Robert Huber

Literature:

- Giancoli: Physics

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for admission to the written examination:
- Preliminary examinations can be determined at the beginning of the semester. If preliminary work has been defined, it must have been completed and positively assessed before the initial examination.

Module exam:
- ME1010-L1: written exam, 90 min, 100 % module grade

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 Biophysics 2024 (compulsory), physics, 2nd semester
- 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

Teacher:

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

- Prof. Dr. rer. nat. Martin Koch
- Prof. Dr. rer. nat. Christian Hübner
- Prof. Dr. rer. nat. Robert Huber
- Prof. Dr.-Ing. Maik Rahlves

Literature:

- Giancoli: Physics

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None (The competences of the required modules are required for this module, but the modules are not a prerequisite for admission.)

Prerequisites for the exam:
- Preliminary examinations can be determined at the beginning of the semester. If preliminary work has been defined, it must have been completed and positively assessed before the initial examination.

Modul exam:
- ME1020-L1: Physics 2, written exam, 90 min, 100 % module grade

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 Biophysics 2024 (compulsory), physics, 3rd semester
- Bachelor Molecular Life Science 2024 (compulsory), physics, 3rd semester
- 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:

- The students can practically work out the physical connections to the mentioned contents of the practical course with regard to the roles of GSP of the University of Lübeck and of the DFG-guidelines..
- They can use measuring instruments correctly.
- They can display measurement results graphically.
- They can analyze collected data quantitatively.
- They can estimate and evaluate the accuracy of the measurement data and the results of the analysis.
- They can document measurement results correctly.
- They can draw meaningful conclusions from measurement data.
- They can name the principles of occupational health and safety in physical laboratories and comply with them at work.

Grading through:

- certificates and protocols

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
- Dr. rer. nat. Norbert Linz
- MitarbeiterInnen des Instituts

- Prof. Dr. rer. nat. Robert Huber
- Dr. rer. nat. Verena Hirschfeld

Literature:

- Giancoli: Physik

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- Prerequisite for participation in the internship is physics 1 or 2.

Prerequisites for the exam:
- Certificates and protocols

Modul exam:
- ME2053-L1: Practical Course Physics, course, ungraded practical course, 0 % module grade, has to be passed

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 2024 (compulsory), physics, 4th semester
- 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:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments and presentation of own solutions in the course.

Format of the module exam:
- ME2060-L1: Fields and Quanta, Written exam, 90 min, 100 % of Module note

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 Biophysics 2024 (Module part of a compulsory module), physics, 4th semester
- Bachelor MES 2020 (Module part of a compulsory module), medical engineering science, 4th semester
- Bachelor Biophysics 2016 (Module part of a compulsory module), physics, 4th semester
- Bachelor MES 2014 (Module part of a compulsory module), 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

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Preliminary examinations can be determined at the beginning of the semester. If preliminary work has been defined, it must have been completed and positively assessed before the initial examination.

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 of a compulsory module), medical engineering science, 4th semester
- Bachelor Biophysics 2016 (Module part of a compulsory module), physics, 4th semester
- Bachelor MES 2014 (Module part of a compulsory module), medical engineering science, 4th semester
- Bachelor Biophysics 2024 (Module part of a compulsory module), physics, 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:

- Historical introduction
- Light as EM wave, physical parameters of the light wave field
- Detection and detection of light
- Geometric optics, raytracing
- Optical Instruments
- Optics of the eye
- Polarization
- Diffraction
- Optical fibres
- Integrated optics
- Optoelectronics
- Laser
- Nonlinear Optics

Qualification-goals/Competencies:

- The students can name the essential concepts of optics (geometric optics, wave optics, quantum optics) and distinguish them from each other.
- The students can name and explain the essential optical phenomena.
- The students can explain the function and application of the most important photonic components.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- E. Hecht: Optics - Addison-Wesley, (dt: Optik, Oldenbourg)
- Frank L. Pedrotti, Leno S. Pedrotti: Introduction to optics - Prentice-Hall
- Frank Pedrotti: Optik eine Einführung - Prentice Hall
- 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:

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

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Preliminary examinations can be determined at the beginning of the semester. If preliminary work has been defined, it must have been completed and positively assessed before the initial examination.

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 Biophysics 2024 (compulsory), physics, 4th semester
- 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. Gereon Hüttmann

Teacher:

- Institute of Biomedical Optics

- Dr. rer. nat. Norbert Linz
- Prof. Dr. rer. nat. Gereon Hüttmann

Literature:

- Haferkorn, H.: Optik - Wiley-VCH
- 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 - 5th Edition, 2016, Pearson
- Frank L. Pedrotti, Leno S. Pedrotti: Introduction to optics - Prentice Hall
- Paul A. Tipler, Gene Mosca: Physik: für Wissenschaftler und Ingenieure (Teil 5: Optik) - Springer 2000

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Format of the module exam:
- ME2600-L1: Introduction to Biomedical Optics and Photonics, Written exam, 90 min, 100 % Module note

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 2024 (compulsory), biophysics, 5th and 6th semester
- 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 2024 (Module part of a compulsory module), biophysics, 5th semester
- Bachelor Biophysics 2016 (Module part of a compulsory module), biophysics, 5th semester

Classes and lectures:

- Bachelor Seminar (seminar, 2 SWS)

Workload:

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

Contents of teaching:

-
-
-

Qualification-goals/Competencies:

- Students can apply for a scientific degree. Thoroughly work through the topic.
- They can present the results in a written elaboration and in an oral presentation in an understandable way.
- They can present and discuss a scientific question in English.

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:

- German and English skills required

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 2024 (compulsory), biophysics, 6th semester
- 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:

- Ability to solve a preformulated simpel scientific problem mostly independent in a defined period of time and to present and defendethe experimental results with regardto the roles of Good Scientific Practice (GSP) of the University of Lübeck and of the DFG-guidelines.
- They can answer expert questions on their subject understand.
- They can present complex content in written and oral presentations.

Grading through:

- Written report

Responsible for this module:

- Studiengangsleitung

Teacher:

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

Literature:

- Topical literature about the subject:

Language:

- thesis can be written in German or English

Notes:

Prerequisites for the module:
- Minimum of 120 ECTS

Prerequisites for admission to the written examination:
- succesful work on a topic of MLS

Module exam:
- BP3990-L1: Bachelor Thesis MLS, written documentation of a practical work of an MLS topic and colloquium, 60 min, 100 % module grade

If the Bachelor thesis is done externally (outside our university) the student has to choose a licensed lecturer (see PO) of our university as a second instructor who will be First Examiner in the examination.

Thesis must be written in German. Except: if the examinator is an English nativ speaker

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 CLS 2023 (optional subject), life sciences, 5th semester
- Bachelor Biophysics 2024 (compulsory), biophysics, 3rd semester
- Bachelor Molecular Life Science 2024 (compulsory), life sciences, 3rd semester
- Bachelor MES 2020 (optional subject), mathematics / natural sciences, 3rd semester at the earliest
- Bachelor MLS 2018 (compulsory), life sciences, 3rd 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:

- Introduction into Biophysics (lecture, 2 SWS)
- Biophysics (Excercise or 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:

- Dr. Young-Hwa Song

Teacher:

- Institute of Physics
- Dr. Young-Hwa Song
- Prof. Dr. rer. nat. Christian Hübner

Literature:

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

Language:

- offered only in German

Notes:

Prerequisites for the module:
- None

Prerequisites for admission to the written examination:
- Successful participation in the exercises as specified at the beginning of the semester

Module exam:
- LS2200-L1: Introduction into Biophysics, written exam, 120 min, 100 % of module grade

The lecture and exercises take place in the winter semester, the practical course in the summer semester.
Whether exercises or a practical course take place is specified in the SGO of the respective study program.
Prerequisite for the understanding of the lecture is the knowledge of the basics of inorganic and organic chemistry.

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:

- Master CLS 2023 (compulsory), MML with specialization in Life Science, 2nd semester
- Bachelor Biophysics 2024 (compulsory), biophysics, 4th semester
- Bachelor Molecular Life Science 2024 (compulsory), Chemistry, 4th semester
- Bachelor MLS 2018 (compulsory), Chemistry, 4th semester
- Bachelor MLS 2016 (compulsory), Chemistry, 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
- Molecular Mechanics
- Practical works:
- 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 with regard to the roles of GSP of the University of Lübeck and of the DFG-guidelines.
-

Grading through:

- written exam

Requires:

- Organic Chemistry (LS1600-KP10, LS1600-MLS)

Responsible for this module:

- Prof. Dr. rer. nat. Ulrich Günther

Teacher:

- Institute of Chemistry and Metabolomics
- Prof. Dr. rer. nat. Ulrich Günther

- 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
- James Keeler and Peter Wothers: Chemical Structure and Reactivity: An integrated approach - Oxford University Press, 2008; second ed. 2013

Language:

- offered only in German

Notes:

Prerequisites for the modul:
- None

Prerequisites for admission to the written examination:
- Successful completion of the excercises as specified at the beginning of the semester

Modul exam(s):
- LS2300-L1: Biophysical Chemistry, written exam, 90 min, 100 % of module grade
- LS2300-L2: Practical course Biophysical Chemistry, ungraded practical course, 0 % of module grade, has to be passed

MML: Optional course in the 2nd semester master program with specialisation in Life Science

Biophysics: some specific practicals

The practical course takes place in September as compact course. Prerequisite LS1600 and LS2600

The module is better understandable if the modules Physics 1 or 2 have been attended before.

(Share of Institute of Physics in practical course is 25%.)

CS1002-KP04, CS1002 - Introduction to Logics (Logik)

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

Course of study, specific field and term:

- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- 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 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 2nd semester
- Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 2nd semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 3rd semester
- Bachelor Medical Informatics 2011 (compulsory), computer science, 1st semester
- Bachelor MES 2011 (optional subject), computer science, 3rd semester
- Bachelor CLS 2010 (optional subject), computer science, 6th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 1st semester
- Bachelor Biophysics 2024 (optional subject), computer science, 6th semester

Classes and lectures:

- Introduction to Logic (lecture, 2 SWS)
- Introduction to Logic (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Key concepts of syntax: alphabet, string, term, formula
- Key concepts of semantics: assignment, structure, model
- Key concepts of proof calculus: axioms, proofs
- Formlization and coding of problems
- Validating correctness and satisfiability of formalizations
- Syntax and semantics of propositional logic
- Syntax and semantics of predicate logig
- Proof caculi

Qualification-goals/Competencies:

- Students are abel to explain the concepts of syntax and semantics for the examples of prepositional and predicate logic
- They are able to apply formal systems and proof systems
- They are able to transfer methods of mathematical logic to simple practical problems
- They are abel to formalize discrete problems
- They are able to modify proof templates in order to create simple proofs

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
- Prof. Dr. Rüdiger Reischuk

Literature:

- Uwe Schöning: Logik für Informatiker - Spektrum Verlag, 1995

- Kreuzer, Kühlig: Logik für Informatiker - Pearson Studium, 2006

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise slips as specified at the beginning of the semester.

Module Exam(s):
- CS1002-L1: Introduction to Logic, portfolio exam: a total of 70 points for written exercises down during the course of the semester, 30 points for the written exam at the end. The grade is calculated as follows: 50 to 54 points for a 4.0, then 55 to 59 points for a 3.7 and so on until the end 95 to 100 points for a 1.0.

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
- Bachelor Biophysics 2024 (optional subject), computer science, 6th 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.
- 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
- Dr.-Ing. Kristian Ehlers

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

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of practical exercises as specified at the beginning of the semester.

Module examination(s):
- CS1200-L1: Technical Foundations of Computer Science 1, written exam 120min, 100% of module grade.

CS1400-KP04, CS1400 - Introduction to Bioinformatics (EinBioinfo)

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

Course of study, specific field and term:

- Bachelor IT-Security 2016 (optional subject), interdisciplinary, Arbitrary semester
- Bachelor Nutritional Medicine 2024 (compulsory), mathematics / computer science, 5th semester
- Bachelor Molecular Life Science 2024 (compulsory), mathematics / computer science, 5th semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, 1st semester
- Bachelor Computer Science 2019 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor MLS 2018 (compulsory), life sciences, 5th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Computer Science 2016 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 1st semester
- Bachelor MLS 2016 (compulsory), life sciences, 5th semester
- Bachelor Medical Informatics 2014 (compulsory), medical computer science, 3rd semester
- Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 1st semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 3rd semester
- Bachelor MLS 2009 (compulsory), life sciences, 5th semester
- Bachelor CLS 2010 (compulsory), specialization field bioinformatics, 5th semester
- Bachelor MES 2011 (optional subject), medical engineering science, 3rd or 5th semester
- Bachelor Computer Science 2012 (compulsory), specialization field bioinformatics, 1st semester
- Bachelor Biophysics 2024 (optional subject), computer science, 5th semester

Classes and lectures:

- Introduction to Bioinformatics (lecture, 2 SWS)
- Introduction to Bioinformatics (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Life, Evolution & the Genome
- Sequence assembly - Industrial reading of genetic information
- DNA sequence models & hidden markov models
- Viterbi-Algoritm
- Sequence alignment & dynamic programming
- Unsupervised data analysis (k-means, PCA, ICA)
- DNA microarrays & GeneChip technologies

Qualification-goals/Competencies:

- Students are able to explain the basic concepts of coding, transcription and translation of information in living beings.
- They are able to explain how a solution of the shortest common superstring problem can be estimated with a simple greedy algorithm.
- They are able to create a Markov chain or a Hidden Markov Model (HMM) for a given modelling problem.
- They are able to give examples on how to solve a problem using dynamic programming.
- They are able to implement the introduced algorithms (in Matlab)
- They are able to use unsupervised learning methods and they are able to interpret the results.
- They are able to explain basic Microarray-and DNA-Chip-Technologies.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. rer. nat. Amir Madany Mamlouk

Teacher:

- Institute for Neuro- and Bioinformatics
- Prof. Dr. rer. nat. Amir Madany Mamlouk

Literature:

- H. Lodish, A. Berk, S. L. Zipursky and J. Darnell: Molekulare Zellbiologie - Spektrum Akademischer Verlag, 4. Auflage, 2001, ISBN-13: 978-3827410771
- A. M. Lesk: Introduction to Bioinformatics - Oxford University Press, 3. Auflage, 2008, ISBN-13: 978-0199208043
- R. Merkl and S. Waack: Bioinformatik Interaktiv: Grundlagen, Algorithmen, Anwendungen - Wiley-VCH Verlag, 2. Auflage, 2009, ISBN-13: 978-3527325948
- M. S. Waterman: Introduction to Computational Biology - Chapman and Hall, 1995

Language:

- offered only in German

Notes:

For students of the master programme Infection Biology, this is not a stand-alone module, but rather part of the module CS4011.

Prerequisites for attending the module:
- None

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
- Bachelor Biophysics 2024 (optional subject), computer science, 5th 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
- Media storage (compression / formats)
- 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 or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr.-Ing. Andreas Schrader

Teacher:

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

Literature:

- Thomas Görne: Tontechnik - 4. Auflage, Hanser 2014
- Ulrich Schmidt: Professionelle Videotechnik - 6. Auflage, Springer 2013

Language:

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

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise slips as specified at the beginning of the semester.

Module Exam(s):
- CS1601-L1 Fundamentals of Multimedia Technology, as determined by the instructor: Written exam, 90min, 100% of module grade OR oral exam, 100% of module grade.

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 Robotics and Autonomous Systems 2020 (optional subject), Additionally recognized elective module, Arbitrary semester
- 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, 3rd semester at the earliest
- 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
- Bachelor Biophysics 2024 (optional subject), computer 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 and real-time operating systems
- Specification languages
- Transformation from specification to implementation
- Development tools
- Programming of embedded systems using C

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.
- They can independently implement the specifications of the embedded system through C programming
- They can use real-time operating systems to implement embedded systems with real-time capability and deterministic time behavior

Grading through:

- written exam

Requires:

- Introduction to Programming (CS1000-KP10, CS1000SJ14)
- 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

Notes:

Admission requirements for taking the module:
- None (the competencies of the modules listed under

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 Biophysics 2024 (optional subject), computer science, 5th semester
- 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
- System 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 or oral exam as announced by the examiner

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
- Prof. Dr. Diedrich Wolter

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:

Admission requirements for taking the module:
- None (the competences of the modules mentioned under Requires are needed for this module, but are not a formal prerequisite).

Admission requirements for participation in module examination(s):
- Successful completion of exercises as specified at the beginning of the semester.

Module exam(s):
- CS2300-L1: Software Engineering, written exam, 90min, 100% of the module grade.

Passing this module is a formal requirement for participation in the module CS2301-KP06 Lab Course Software Engineering. It is recommended to do the internship directly in the following semester.

CS2700-KP04, CS2700 - Databases (DB)

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

Course of study, specific field and term:

- Bachelor Biophysics 2024 (optional subject), computer science, 6th semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- 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, 3rd 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
- Datalog* Syntax, semantics, treatment of negation (stratification)* Evaluation strategies (naive, semi naive, magic set transformation)
- 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:

- For all subjects mentioned in the course contents under the indents students should name the central ideas, which can define relevant terms and explain the functioning of algorithms by means of application examples.

Grading through:

- written exam

Is requisite for:

- Nonstandard Databases and Data Mining (CS3130-KP08)

- Nonstandard Database Systems (CS3202-KP04, CS3202)

Requires:

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

Responsible for this module:

- Prof. Dr. Sven Groppe

Teacher:

- Institute of Information Systems
- Prof. Dr. Sven Groppe

Literature:

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

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competences of the modules mentioned under "requires" are needed for this module, but are not a formal prerequisite).

Admission requirements for participation in module examination(s):
- Successful completion of exercise sheets as specified at the beginning of the semester.

Module Exam(s):
- CS2700-L1: Databases, written exam, 90min, 100% of the module grade.

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:

- Master CLS 2023 (compulsory), mathematics, 1st semester
- Bachelor Biophysics 2024 (compulsory), computer science, 5th semester
- 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
- 2D Sampling
- Image enhancement
- Edge detection
- Multiresolution concepts: Gaussian and Laplacian Pyramid, wavelets
- Principles of image compression
- Segmentation
- Morphological image processing

- Students work self-actingly and independently with regard to the roles of GSP of the University of Lübeck.

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

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

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments during the semester (at least 50% of max. points).

Module exam:
- CS3100-L1: Signal Processing, written exam, 90 min, 100% of module grade

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 Biophysics 2024 (optional subject), computer science, 6th semester
- 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, 3rd semester at the earliest
- 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, 3rd semester at the earliest
- 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:

- portfolio exam

Requires:

- Analysis 2 (MA2500-KP04, MA2500)
- Algorithms and Data Structures (CS1001-KP08, CS1001)

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:

Admission requirements for taking the module
- None (the competences of the modules mentioned under Requires are needed for this module, but are not a formal prerequisite).

Admission requirements for participation in module examination(s):
- Successful completion of exercises as specified at the beginning of the semester.

Moduel Exam(s):
- CS3204-L1: Artificial Intelligence, Portfolio examination, 100% of the module grade

Note: The portfolio examination consists of: 70 points in the form of a written examination at the end of the semester, 15 points in the form of semester-accompanying programming tasks (group and individual performance), 15 points in the form of semester-accompanying e-tests (individual performance)

CS1020-KP05 - Introduction Into Databases and Systems Biology (EinfDBSB)

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

Course of study, specific field and term:

- Bachelor Biophysics 2024 (compulsory), bioinformatics, 6th semester
- Bachelor Nutritional Medicine 2024 (compulsory), life sciences, 6th semester
- Bachelor Molecular Life Science 2024 (compulsory), life sciences, 6th semester
- 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:

- LIED | Lübecker Institut für experimentelle Dermatologie (Lübeck Institute of Experimental Dermatology)
- Institute for Theoretical Computer Science

- Prof. Dr. rer. nat. Till Tantau
- Prof. Dr. Hauke Busch

Literature:

- Edda Klipp et al.: Systems Biology - A Textbook - Weinheim Wiley-VCH Verlag GmbH & Co. KGaA [2016]
- Sarah E Hunt et al.: Ensembl variation resources , Database Volume 2018 - doi.org/10.1093/database/bay119 T. Hubbard et al. The Ensembl genome database project., Nucleic Acids Research 2002 30(1):38-41.
- Gumm, Sommer: Einführung in die Informatik - 2012, De Gruyter Studium Kemper
- Kemper, Eickler: Datenbanksysteme: Eine Einführung - 2015, De Gruyter Studium

Language:

- offered only in German

Notes:

Prerequisites for the module:
- nothing

Prerequisites for admission to the written examination:
- succesful work on the exercises

Module exam:
- CS1020-L1: Introduction into databases and system biology, written exam, 90 min, 100 % module grade

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 2024 (compulsory), Elective Chemistry/Biology, 4th semester
- 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 Medical and Marine Biotechnology
- Institute for Biology

- Prof. Dr. rer. nat. Enno Hartmann
- PD Dr. rer. nat. Kai-Uwe Kalies
- Prof. Dr. rer. nat. Charli Kruse

Literature:

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

Language:

- offered only in German

Notes:

Prerequisites for the modul:
- nothing

Prerequisites for admission to the written examination:
- nothing

Modul exam:
- LS2700-L1: Cellbiology, written exam, 90 min, 100 % module grade

LS3150-KP04 - Molecular Biology (MolBioKP04)

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

Course of study, specific field and term:

- Bachelor Biophysics 2024 (compulsory), Elective Chemistry/Biology, 5th semester
- Bachelor Biophysics 2016 (compulsory), Elective Chemistry/Biology, 5th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Lectures:Typically, 5 coherent blocks will be lectured.
- Basics: genetic engineering and gene regulation
- Growth and aging: molecular processes during ontogenetic differentiation, maintenance and loss of function during aging of cells and organisms
- Nucleic-acids: molecular basis, polymorphism, RNA-regulation. Diagnostic and possible therapeutic aspects
- Molecular biology of plants: molecular basis as well as economic and ecological aspects of transgenic plants and herbicide resistance
- Gene-therapeutic approaches and recombinant vaccines
- Conceptual design of publications
- English as lingua franca in science

Qualification-goals/Competencies:

- Students are able to present basic steps of genetic engineering
- They can explain basic mechanisms of gene expression
- They are able to formulate basic mechanisms of RNA-regulated biological systems
- They can present examples for the relationship between pathophysiological processes and their molecular basis
- They are able to explain principles of gene therapy
- 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. Norbert Tautz

Teacher:

- Institute of Virology and Cell Biology
- Department of Neurosurgery
- Institute of Medical and Marine Biotechnology

- Dr. rer. nat. Olaf Isken
- Prof. Dr. rer. nat. Norbert Tautz
- PD Dr. rer. nat. Christina Zechel

Literature:

- Alberts et al.: Molecular Biology of Cells - Garland Science
- Lodish et al.: Molecular Cell Biology - Freeman
- Buchanan et al.: Biochemistry and Molecular Biology of Plants - Wiley Verlag
- : Versuchsanleitungen
- : Course script

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Module exam:
- LS3150-L1: Molekular Biology, written exam, 90 min, 100 % module grade

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 IT-Security 2016 (optional subject), interdisciplinary, Arbitrary semester
- Bachelor Biophysics 2024 (compulsory), Elective Computer Science, 5th semester
- 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
- According to the rules of GSP of the UzL

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

- Dr.-Ing. Kristian Ehlers

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 are issued a B certificate, after having finished entire assignments including the tests and having passed the written exam at the end of the term.
Students of other majors are issued an A-certificate after having passed the written exam.

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments during the semester.

Written exam:
-CS1500-L1: Introduction to Robotics and Automation, written exam, 60 - 120 min, 100% modul grade.

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 CLS 2023 (compulsory), mathematics, 2nd semester
- Bachelor Biophysics 2024 (compulsory), Elective Computer Science, 4th semester
- Bachelor Nutritional Medicine 2024 (compulsory), mathematics / natural sciences, 4th semester
- Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd semester at the earliest
- 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 Molecular Life Science 2024 (compulsory), mathematics / computer science, 4th 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:

- With regard to the roles of GSP of the University of Lübeck and of the DFG-guidelines the student were able to work with the following statistical methods: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

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

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Active and regular participation in the exercise groups as specified at the beginning of the semester.

Module exam:
-MA1600-L1: Biostatistics 1, written exam, 90 min, 100 % of module grade