UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Master CLS

Version from 1. April 2019

mathematics

interdisciplinary competence

life sciences

imaging systems

computer science

computational life science / life sciences

computational life science / imaging

computational life science / biostatistics

neuroscience

CS3100 - Signal processing (SignalV)		
Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Medical Informatics before 2014 (compulsory), computer science, 5th semester
- Master CLS (compulsory), mathematics, 1st semester
- Bachelor Computer Science before 2014 (compulsory), foundations of computer science, 5th semester

Classes and lectures:

- Signal processing (lecture, 2 SWS)
- Signal processing (exercise, 1 SWS)

Workload:

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

Qualification-goals/Competencies:

- Students are able to explain the fundamentals of linear system theory.
- They are able to describe the basic elements of signal processing.
- They will have a command of 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.

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Is requisite for:

- Image processing (CS3203)

Requires:

- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing

- Prof. Dr.-Ing. Alfred Mertins

Literature:

- A. Mertins: Signaltheorie: Grundlagen der Signalbeschreibung, Filterbänke, Wavelets, Zeit-Frequenz-Analyse, Parameter- und Signalschätzung - Springer-Vieweg, 3. Auflage, 2013

Language:

- offered only in German

CS3203 - Image processing (Bildverarb)

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

Course of study, specific field and term:

- Bachelor Computer Science before 2014 (optional subject), specialization field bioinformatics, 6th semester
- Bachelor Medical Informatics before 2014 (compulsory), computer science, 6th semester
- Master CLS (compulsory), mathematics, 2nd semester
- Bachelor Computer Science before 2014 (compulsory), specialization field robotics and automation, 6th semester
- Bachelor Computer Science before 2014 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

- Image processing (lecture, 2 SWS)
- Image processing (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction, interest of visual information
- Fourier transformation
- Sampling and sampling theorem
- Filtering
- Image enhancement
- Edge detection
- Multiresolution concepts: Gaussian and Laplacian Pyramid, wavelets
- Principles of image compression
- Segmentation
- Morphological image processing

Qualification-goals/Competencies:

- Students 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:

- Exercises
- programming project
- Written or oral exam as announced by the examiner

Requires:

- Signal processing (CS3100)
- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing

- Prof. Dr.-Ing. Alfred Mertins

Literature:

- A. 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

CS3205-KP04, CS3205 - Computer Graphics (CompGrafik)

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

Course of study, specific field and term:

- Bachelor Medical Informatics since 2019 in planning (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science since 2016 (optional subject), major subject informatics, arbitrary semester
- Bachelor Robotics and Autonomous Systems (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security (optional subject), computer science, arbitrary semester
- Bachelor Medical Informatics since 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor MES since 2014 (optional subject), computer science and electrical engineering, 4th or 6th semester
- Bachelor Media Informatics (compulsory), media informatics, 6th semester
- Bachelor Computer Science 2014 and 2015 (optional subject), central topics of computer science, 5th or 6th semester
- Bachelor Medical Informatics before 2014 (optional subject), computer science, 4th to 6th semester
- Master Computer Science before 2014 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Bachelor CLS (optional subject), mathematics, 6th semester
- Bachelor Computer Science before 2014 (optional subject), central topics of computer science, 5th or 6th semester
- Master CLS (optional subject), mathematics, 2nd semester
- Bachelor Computer Science before 2014 (compulsory), specialization field media informatics, 5th or 6th semester

Classes and lectures:

- Computer Graphics (lecture, 2 SWS)
- Computer Graphics (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Homogeneous coordinates and geometrical transformations
- Planar and perspective projections
- Polygon meshes
- Bezier curves and surfaces
- B-spline curves and surfaces
- Culling and Clipping
- Hidden surface removal
- Raster graphics algorithms
- Illumination and shading

Qualification-goals/Competencies:

- Knowledge and understanding of the basic concepts, algorithms and methods
- Ability to implement the basic algorithms
- Ability to assess the possibilities and limitations of the learned techniques

Grading through:

- Exercises
- written exam

Requires:

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

Responsible for this module:

- Prof. Dr. rer. nat. habil. Heinz Handels

Teacher:

- Institute of Medical Informatics

- Dr. rer. nat. Jan Ehrhardt

Literature:

- Foley et. al: Grundlagen der Computergrafik - Addison-Wesley, 1994

Language:

- offered only in German

CS4220 - Statistical Pattern Recognition (SME)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Master MES before 2014 (optional subject), mathematics, 1st semester
- Master CLS (compulsory), mathematics, 1st or 3rd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 1st semester
- Master Computer Science before 2014 (compulsory), computer science mandatory courses, 1st semester

Classes and lectures:

- Pattern Recognition (lecture, 2 SWS)
- Pattern Recognition (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to probability theory
- Principles of feature extraction and pattern recognition
- Bayes decision theory
- Discriminance functions
- Neyman-Pearson test
- Receiver Operating Characteristic
- Parametric and nonparametric density estimation
- kNN classifiers
- Linear classifiers
- Support vector machines and kernel trick
- Random Forest
- Neural Nets
- Feature reduction and feature transforms
- Validation of classifiers
- Selected application scenarios: acoustic scene classification for the selection of hearing-aid algorithms, acoustic event recognition, attention classification based on EEG data, speaker and emotion recognition

Qualification-goals/Competencies:

- Students are able to describe the main elements of feature extraction and pattern recognition.
- They are able to explain the basic elements of statistical modeling.
- They are able to use feature extraction, feature reduction and pattern classification techniques in practice.

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing

- Prof. Dr.-Ing. Alfred Mertins

Literature:

- R. O. Duda, P. E. Hart, D. G. Storck: Pattern Classification - New York: Wiley

Language:

- offered only in German

Notes:

Preliminary examination results can be provided at the beginning of each Semester. If preliminary examination results are required, they have to be positively attested.

CS5159 - Ubiquitous Computing (UbiqComp)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, 2nd or 3rd semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester
- Master Computer Science before 2014 (optional subject), advanced curriculum organic computing, 2nd or 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field media informatics, 2nd or 3rd semester

Classes and lectures:

- Ubiquitous Computing (lecture with exercises, 3 SWS)

Workload:

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

Contents of teaching:

- The
- Technology trends: information technology, new materials
- Wireless communication and mobile computing
- Spontaneous networking
- Context awareness: location, context, and situation
- Smart labels (RFIDs) and wireless chipcards
- Embedded systems and sensors
- Energy aspects
- Wearable computing
- Interaction with invisible computers
- Software infrastructures
- Selected research projects
- Applications scenarios
- Social implications

Qualification-goals/Competencies:

- Understand fundamental challenges, concepts, approaches, and limitations of UC
- Follow and judge recent UC research papers
- Design, implementation, and analysis of exemplary UC systems

Grading through:

- Viva Voce or test

Responsible for this module:

- Prof. Dr.-Ing. Thilo Pionteck (Nachfolger NN)

Teacher:

- Institute of Computer Engineering

- Prof. Dr.-Ing. Thilo Pionteck (Nachfolger NN)

Literature:

- Friedemann Mattern (Ed.): Die Informatisierung des Alltags - Leben in smarten Umgebungen - Springer-Verlag, 2007
- Elgar Fleisch, Friedemann Mattern (Eds.): Das Internet der Dinge - Ubiquitous Computing und RFID in der Praxis - Springer-Verlag, 2005

Language:

- offered only in German

MA3445-KP04, MA3445 - Graph Theory (Graphen)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second year	4

Course of study, specific field and term:

- Bachelor Medical Informatics since 2019 in planning (optional subject), mathematics, 4th to 6th semester
- Bachelor IT-Security (optional subject), mathematics, arbitrary semester
- Bachelor Robotics and Autonomous Systems (optional subject), mathematics, 5th or 6th semester
- Bachelor Medical Informatics since 2014 (optional subject), mathematics, 5th or 6th semester
- Master MES since 2014 (optional subject), mathematics / natural sciences, 1st or 2nd semester
- Bachelor Computer Science 2014 and 2015 (optional subject), central topics of computer science, 5th or 6th semester
- Master CLS (optional subject), mathematics, arbitrary semester
- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester
- Bachelor Computer Science before 2014 (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Graph theory (lecture, 2 SWS)
- Graph theory (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Hamiltonian graphs and degree sequences
- Menger's theorem - new proofs
- Matchings and decompositions of graphs
- The theorems of Turan and Ramsey
- Vertex and edge colourings
- The four colour theorem

Qualification-goals/Competencies:

- Ability to solve discrete problems using graph theoretical methods
- Knowledge of proof techniques and ideas of discrete mathematics
- Knowledge of fundamental and selected recent research results

Grading through:

- Exercises
- Oral examination

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

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

Teacher:

- Institute for Mathematics

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

Literature:

- F. Harary: Graph Theory - Reading, MA:.Addison-Wesley 1969
- R. Diestel: Graphentheorie - Berlin: Springer 2000
- D. Jungnickel: Graphen, Netzwerke und Algorithmen - Mannheim: BI-Wissenschaftsverlag1994
- J. Bang-Jensen, G. Gutin: Digraphs: Theory, Algorithms and Applications - London: Springer 2001
- B. Bollobas: Modern Graph Theory - Berlin: Springer 1998

Language:

- offered only in German

MA4041 - Numerical Linear Algebra (NumLinAlg)

Duration:	Turnus of offer:	Credit points:
1 Semester	Currently not available	4

Course of study, specific field and term:

- Bachelor CLS (optional suject), mathematics, 6th semester
- Master CLS (optional subject), mathematics, 2nd or 3rd semester

Classes and lectures:

- Numerical Linear Algebra (lecture, 2 SWS)
- Numerical Linear Algebra (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Iterative solving of big linear equation systems
- Numerics of eigenvalue problems

Qualification-goals/Competencies:

- Students know the most important algorithms of scientific computing.
- They know how to handle high-dimensional problems.
- They are able to handle computer specific problems like Cache and BLAS.
- They are able to implement practical problems originating from life sciences.
- Interdisciplinary qualifications:
- Students can transfer theoretical concepts to practical problems.
- Students have experience in implementation.
- Students can abstract practical problems.

Grading through:

- Exercises
- Presentation of one´s own solution of an exercise
- programming project
- Written or oral exam as announced by the examiner

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Analysis 2 (MA2500-MML)

Responsible for this module:

- Prof. Dr. rer. nat. Jan Modersitzki

Teacher:

- Institute of Mathematics and Image Computing

- Prof. Dr. rer. nat. Jan Modersitzki
- N.N.

Literature:

- A. Meister: Numerik linearer Gleichungssysteme - Vieweg+Teubner, 2011
- G. Strang: Computational Science and Engineering - Wellesley-Cambridge Press, 2007
- P. Van Dooren, S. P. Bhattacharyya, V. Olshevsky, R. H. Chan, A. Routray: Numerical Linear Algebra in Signals, Systems and Control - Springer, 2011

Language:

- German and English skills required

MA4100 - Survival Analysis (UeberlAna)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

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

Workload:

- 90 Hours private studies
- 15 Hours exam preparation
- 15 Hours in-classroom work

Contents of teaching:

- Introduction to survival analysis
- Kaplan-Meier survival curves
- Log rank test
- The Cox proportional hazard model and its characteristics
- Evaluating the proportional hazards assumption
- Stratified Cox model
- Tobit Model

Qualification-goals/Competencies:

- Modelling competence for survival times
- Understanding of specific problems with the analysis of censored data
- Knowledge of the most important statistical methods for survival and their limits

Grading through:

- Exercises
- Oral examination
- written exam

Requires:

- Stochastics 2 (MA4020-KP04, MA4020)
- Stochastics 1 (MA2510-KP04, MA2510)
- Biostatistics 2 (MA2600-KP04, MA2600)
- Biostatistics 1 (MA1600-KP04, MA1600, MA1600-MML)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. nat. Andreas Ziegler

Literature:

- Kleinbaum DG, Klein M: Survival Analysis: A Self-Learning Text - 2005 - ISBN: 978-0-387-23918-7

Language:

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

MA4200 - Integralgleichungen (Integral)		
Duration: 1 Semester	**Turnus of offer:** every third semester	**Credit points:** 4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 6th semester

Classes and lectures:

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

Workload:

- 0 Hours

Contents of teaching:

- Volterrasche Integralgleichungen
- Fredholmsche Integralgleichungen
- Numerische Lösungsverfahren

Qualification-goals/Competencies:

- Modellierung praktischer Probleme der Life Sciences durch Integralgleichungen
- Verständnis des Zusammenhangs zwischen Integralgleichungen und Differentialgleichungen
- Klassifizierung von Integralgleichungen
- Praktische Umsetzung theoretischer Algorithmen

Grading through:

- Exercises
- programming project
- Oral examination
- written exam

Requires:

- Analysis 2 (MA2500-MML)

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Jürgen Prestin

Language:

- offered only in German

MA4330 - Biosignal analysis (BioSA)

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

Course of study, specific field and term:

- Master MES since 2014 (optional subject), mathematics / natural sciences, arbitrary semester
- Master MES before 2014 (optional subject), mathematics, 2nd semester
- Master Computer Science before 2014 (compulsory), advanced curriculum analysis, 2nd semester
- Master CLS (compulsory), mathematics, 2nd semester

Classes and lectures:

- Biosignal analysis (lecture, 2 SWS)
- Biosignal analysis (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Hilbert spaces
- Fourier series and Fourier transformation
- generalized functions
- discrete wavelet tranformation
- least square techniques
- application to biological and medical data

Qualification-goals/Competencies:

- Students have deepened knowledges of the mathematical background of signal analysis
- They master different methodsof one-dimensional signal analysis
- They have practical skills in the application of these methods
- They have skills in working with Mathematica or MatLab

Grading through:

- Exercises
- written exam

Requires:

- Analysis 2 (MA2500-KP04, MA2500)

Responsible for this module:

- Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller
- Prof. Dr. rer. nat. Jürgen Prestin

Literature:

- S. Mallat: A wavelet tour of signal processing - Academic Press, 1998
- A. N. Kolmogorov, S.V. Fomin: Reelle Funktionen und Funktionalanalysis - Deutscher Verlag der Wissenschaften 1975

Language:

- offered only in German

MA4341 - Time series analysis (Zeitreihen)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional suject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 6th semester

Classes and lectures:

- Time series analysis (lecture, 2 SWS)
- Time series analysis (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Simple discriptive and explorative methods: smoothing, differentiating, autocorrelation, cross correlation
- Linear time series models: MA-processes, AR-processes, ARIMA-processes
- Time series and models with longe-range dependencies
- Time series in the frequency domain:autocorrelation function, spectral density and its estimation
- nonlinear methods by examples
- analysis and modelling of data from life sciences (software: R, Mathematica, SPSS)

Qualification-goals/Competencies:

- Students have basic knowledge of concepts and ideas of time series analysis
- They master simple linear methods of time series analysis
- They have competencies in analysis and modelling of real-world time series

Grading through:

- Exercises
- Oral examination
- written exam

Requires:

- Stochastics 2 (MA4020-MML)

Responsible for this module:

- Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller

Literature:

- R. Schlittgen, B.Streitberg: Zeitreihenanalyse - Oldenburg-Verlag, München, Wien 1994
- P.J. Brockwell, R.A. Davis: Time Series: Theory and Methods - Springer, New York 1991

Language:

- offered only in German

Notes:

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

MA4400 - Chaos and Complexity of Biological Systems (CKBS)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Bachelor CLS (optional subject), mathematics, 5th or 6th semester
- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master Computer Science before 2014 (optional subject), specialization field bioinformatics, 2nd or 3rd semester
- Master MES before 2014 (advanced curriculum), biophysics and biomedical optics, 1st or 2nd semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Chaos and Complexity of Biological Systems (lecture, 2 SWS)
- Chaos and Complexity of Biological Systems (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Time-discrete dynamical systems and stochastic processes
- Nonlinearity and chaos
- Ergodicity
- Symbolic dynamics
- Information-theoretic complexity measures
- Ordinal time series analysis
- Biological and medical applications, in particular EEG analysis

Qualification-goals/Competencies:

- Students get insights into basic aspects of nonlinear dynamics
- They have skills in analyzing and modeling complex data and time series
- They have competencies in simulating and illustrating nonlinear dynamic phenomena

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Stochastics 1 (MA2510-KP04, MA2510)
- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller

Literature:

- M. Brin, G. Stuck: Introduction to Dynamical Systems - Cambridge University Press 2002
- J. M. Amigó: Permutation Complexity in Dynamical Systems - Springer 2010
- R. L. Devaney: An Introduction to Chaotic Dynamical Systems - Westview Press 2003

Language:

- depends on the chosen courses

Notes:

lecture notes in English

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

MA4405 - Nonlinear dynamic systems (NLinDynSys)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Bachelor CLS (optional subject), mathematics, 4th or 6th semester
- Bachelor CLS (optional subject), computer science, 4th or 6th semester
- Master CLS (optional suject), mathematics, arbitrary semester
- Master CLS (optional subject), computer science, arbitrary semester

Classes and lectures:

- Nonlinear dynamic systems (lecture, 2 SWS)
- Nonlinear dynamic systems (exercise, 1 SWS)

Workload:

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

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- Written or oral exam as announced by the examiner
- Oral examination
- Exercises

Requires:

- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)
- Analysis 2 (MA2500-MML)

Responsible for this module:

- PD Dr. rer. nat. Jens Christian Claussen

Teacher:

- Institute for Neuro- and Bioinformatics

- PD Dr. rer. nat. Jens Christian Claussen

Literature:

- Argyris, Faust, Haase: Die Erforschung des Chaos
- Jetschke: Mathematik der Selbstorganisation
- Heinz Georg Schuster: Deterministic Chaos
- Edward Ott: Nonlinear Dynamics and Chaos

Language:

- German and English skills required

MA4410 - Approximation Theory (Approx)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Bachelor CLS (optional subject), mathematics, 5th or 6th semester
- Master Computer Science before 2014 (optional subject), advanced curriculum analysis, 2nd or 3rd semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Approximation theory (lecture, 2 SWS)
- Approximation theory (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Fundamentals of functional analysis
- Best approximation
- Linear methods, trigonometric kernels
- Theorems of Jackson and Bernstein
- Moduli of continuity
- Singular integrals
- Theorem of Banach--Steinhaus
- Interpolation methods
- Stability inequalities

Qualification-goals/Competencies:

- Learning the basic principles of approximation theory
- Understanding the relationship between order of convergence and smoothness
- Knowledge of the basic approximation methods

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Jürgen Prestin

Literature:

- P. L. Butzer, R. J. Nessel: Fourier Analysis and Approximation - Birkhäuser Verlag 1971
- A. Schönhage: Approximationstheorie - de Gruyter 1971

Language:

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

MA4420 - Mathematics of Linear Inverse Problems (MathInvPro)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Mathematics of Linear Inverse Problems (lecture, 2 SWS)
- Mathematics of Linear Inverse Problems (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Ill-posed linear operator equations
- Spectral decomposition of compact operators
- Stabilization of ill-posed problems
- Regularization methods
- Numerical realization
- Application examples of linear inverse problems

Qualification-goals/Competencies:

- Study of the mathematical theory and the regularization possiblities of ill-posed linear inverse problems
- Learning analytical and numerical methods for the solution of linear inverse problems

Grading through:

- Exercises
- Oral examination

Responsible for this module:

- Dr. rer. nat. Wolfgang Erb

Teacher:

- Institute for Mathematics

- Dr. rer. nat. Wolfgang Erb

Literature:

- Engl, Hanke, Neubauer: Regularization of Inverse Problems - Kluwer, 2000
- Kirsch: An Introduction to the Mathematical Theory of Inverse Problems - Springer, 1996
- Louis: Inverse und schlecht gestellte Probleme - Teubner, 1989
- Rieder: Keine Probleme mit Inversen Problemen - Vieweg, 2003

Language:

- offered only in German

MA4430 - Approximation on Spheres (ApproxSph)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Master Computer Science before 2014 (optional subject), advanced curriculum analysis, 2nd or 3rd semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Approximation on spheres (lecture, 2 SWS)
- Approximation on spheres (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Polynomial systems on spheres
- Approximation methods
- Fast algorithms
- Scattered data

Qualification-goals/Competencies:

- Learning the basic principles of approximation theory on spheres
- Understanding the function systems on spheres
- Knowledge of the basic approximation methods on spheres

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Jürgen Prestin

Literature:

- V. Michel: Lectures on Constructive Approximation - Fourier, Spline, and Wavelet Methods on the Real Line, the Sphere, and the Ball - Birkhäuser Verlag, Boston, 2013
- W. Freeden, T. Gervens, and M. Schreiner: Constructive Approximation on the Sphere (With Applica- tions to Geomathematics) - Oxford Science Publication, Clarendon Press, 1998

Language:

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

MA4451 - Evolutionary Dynamics (EvoDyn)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Evolutionary Dynamics (lecture, 2 SWS)
- Evolutionary Dynamics (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Stochastic models of population genetics
- Dynamic systems
- Basics of classical game theory
- Evolutionary game theory
- Applications of evolutionary dynamics to medical problems

Qualification-goals/Competencies:

- Knowledge of elementary models in evolutionary dynamics
- Basic knowledge in game theory
- Modelling and simulation competence

Grading through:

- Exercises
- Oral examination

Responsible for this module:

- Prof. Dr. Arne Traulsen

Teacher:

- Institute for Mathematics

- Prof. Dr. Arne Traulsen
- Andere Dozenten

Literature:

- M.A. Nowak: Evolutionary Dynamics - Exploring the equations of life - Harvard University Press, 2006
- J. Hofbauer and K. Sigmund: Evolutionary Games and Population Dynamics - Cambridge University Press, 1998

Language:

- offered only in English

MA4452 - Evolutionary Game Theory - from Basics to Recent Developments (EvoGameTh)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Evolutionary Game Theory - from Basics to Recent Developments (lecture, 2 SWS)
- Evolutionary Game Theory - from Basics to Recent Developments (blockseminar (compact course), 1 SWS)

Workload:

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

Contents of teaching:

- Basics of classical game theory
- Deterministic and stochastic evolutionary game theory
- The evolution of cooperation and punishment
- Repeated games
- Adaptive dynamics

Qualification-goals/Competencies:

- Familiarity with mathematical concepts of classical and evolutionary game theory
- Understanding of recent developments and recently published literature in the field
- Familiarity with scientific communication at the interface between applied mathematics and biology

Grading through:

- written summary of an original research paper
- Oral presentation

Responsible for this module:

- Prof. Dr. Arne Traulsen

Teacher:

- Institute for Mathematics

- Prof. Dr. Arne Traulsen
- Andere Dozenten

Literature:

- M.A. Nowak: Evolutionary Dynamics - Exploring the equations of life - Harvard University Press, 2006
- K. Sigmund: The calculus of selfishness - Princeton University Press, 2010

Language:

- offered only in English

Notes:

The lecture is offered in German only if desired by all participants.

MA4453 - Evolutionary Dynamics: Population Genetic and Ecological Models (EvDyPopEco)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Evolutionary Dynamics: Population Genetic and Ecological Models (lecture, 2 SWS)
- Evolutionary Dynamics: Population Genetic and Ecological Models (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Basics of mathematical population genetics
- Discrete stochastic models
- Genetic drift
- Natural selection
- Diffusion approximation
- Coupling of genetic and ecological models

Qualification-goals/Competencies:

- The students can explain the basic biological and mathematical concepts of population genetics.
- The students can construct simple stochastic models and analyse them formally.
- The students can perform approximations of simple models.

Grading through:

- Exercises
- Oral examination

Responsible for this module:

- Prof. Dr. Arne Traulsen

Teacher:

- Institute for Mathematics

- Prof. Dr. Arne Traulsen
- N.N.

Literature:

- J. H. Gillespie: Population genetics - A concise guide - Johns Hopkins University Press, 2004

Language:

- offered only in English

Notes:

The lecture is offered in German only if desired by all participants.

For admission to the oral exam students must have obtained at least 50% of the points in the exercises.

MA4454 - Evolutionary Dynamics: Game Theory (EvDyGameTh)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Evolutionary Game Theory - from Basics to Recent Developments (lecture, 2 SWS)
- Evolutionary Game Theory - from Basics to Recent Developments (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Basics of classical game theory
- Deterministic and stochastic evolutionary game theory
- The evolution of cooperation and punishment
- Repeated games
- Applications in genetics, ecology and social dynamics

Qualification-goals/Competencies:

- The students can explain and apply the basic concepts of game theory.
- They can construct evolutionary models based on game theoretic interactions.
- They can analyse evolutionary games formally.

Grading through:

- Exercises
- Oral examination

Responsible for this module:

- Prof. Dr. Arne Traulsen

Teacher:

- Institute for Mathematics

- Prof. Dr. Arne Traulsen
- N.N.

Literature:

- M.A. Nowak: Evolutionary Dynamics - Exploring the equations of life - Harvard University Press, 2006
- Broom & Rychtar: Game-Theoretical Models in Biology - Chapman & Hall, 2013

Language:

- offered only in English

Notes:

The lecture is offered in German only if desired by all participants.

For admission to the oral exam students must have obtained at least 50% of the points in the exercises.

MA4500-KP04, MA4500 - Mathematical Methods in Image Processing (MatheBildv)

Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	every second winter semester	4

Course of study, specific field and term:

- Master Medical Informatics (optional subject), medical image processing, 1st or 2nd semester
- Master MES since 2014 (optional subject), mathematics / natural sciences, 1st or 3rd semester
- Master MES before 2014 (optional subject), mathematics, 1st or 3rd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 1st or 3rd semester
- Master Computer Science before 2014 (compulsory), advanced curriculum numerical image processing, 2nd or 3rd semester
- Master CLS (compulsory), mathematics, 1st or 3rd semester
- Master Medical Informatics since 2019 in planing (optional subject), medical image processing, 1st or 2nd semester

Classes and lectures:

- Mathematical Methods in Image Processing (lecture, 2 SWS)
- Mathematical Methods in Image Processing (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Image processing
- Digital images
- Operators in the spatial domain
- Operators in the Fourier domain
- Deblurring
- Total variation
- Segmentation
- Level-set methods

Qualification-goals/Competencies:

- Students have a solid mathematical understanding of typical image processing methods.
- They can compare and assess typical mathematical image processing methods.
- They can derive typical mathematical methods for image processing.
- They understand fundamental operators in image processing.
- They understand fundamental discretization techniques.
- They understand typical numerical methods for image processing.
- They are able to implement fundamental numerical methods for image processing.
- Interdisciplinary qualifications:
- Students have advanced skills in modeling.
- They can translate theoretical concepts into practical solutions.
- They are experienced in implementation.
- They can think abstractly about practical problems.

Grading through:

- Exercises
- Presentation of one´s own solution of an exercise
- Written or oral exam as announced by the examiner

Is requisite for:

- Calculus of Variations and Partial Differential Equations (MA5034-KP04, MA5034)

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Analysis 2 (MA2500-KP04, MA2500)

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:

- Gonzales/Woods: Digital Image Processing - Prentice Hall, 2007
- Russ: The Image Processing Handbook - CRC Press, 2011
- Handels: Medizinische Bildverarbeitung - Vieweg+Teubner, 2009

Language:

- German and English skills required

Notes:

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

MA4510 - Wavelet Theory (Wavelet)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master Computer Science before 2014 (optional subject), advanced curriculum analysis, 2nd or 3rd semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Wavelet Theory (lecture, 2 SWS)
- Wavelet Theory (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Haar system
- discrete Haar transformation
- orthonormal wavelet bases
- Multiresolution Analysis
- algorithms for reconstruction and decomposition
- multivariate generalizations

Qualification-goals/Competencies:

- Kenntnis der Grundlagen der Waveletanalysis
- Verständnis von Anwendungen in der Signalanalyse,
- Arbeiten mit Wavelettoolboxen

Grading through:

- exercises and project assignments
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Jürgen Prestin

Literature:

- :
- :

Language:

- offered only in German

MA4610 - Stochastic processes and modeling (StochPrzMd)

Duration:	Turnus of offer:	Credit points:
1 Semester	normally each year in the winter semester	4

Course of study, specific field and term:

- Master MES since 2014 (optional subject), mathematics / natural sciences, 1st or 2nd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum stochastics, 2nd or 3rd semester
- Master CLS (compulsory), mathematics, 1st or 3rd semester

Classes and lectures:

- Stochastic processes and modeling (lecture, 2 SWS)
- Stochastic processes and modeling (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Conditional expectation
- Stochastic processes
- Filtrations
- Martingales
- Brownian motion

Qualification-goals/Competencies:

- To develop some insight into stochastic processes based on selected classes of processes
- Training of a stochastic way of thinking
- Application of basic ideas and concepts of stochastic analysis

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Stochastics 2 (MA4020-MML)
- Stochastics 1 (MA2510-KP04, MA2510)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Rößler

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Andreas Rößler

Literature:

- :
- :
- Ioannis Karatzas, Steven E. Shreve: Brownian Motion and Stochastic Calculus - Springer Verlag, 2nd edition, 1991

Language:

- German and English skills required

MA4611 - Markov-Prozesse (MarkovProz)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Markov-Prozesse (lecture, 2 SWS)
- Markov-Prozesse (exercise, 1 SWS)

Workload:

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

Contents of teaching:

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller
- Prof. Dr. rer. nat. Jürgen Prestin

Language:

- offered only in German

MA4612 - Numerik dynamischer Systeme (NumDynSyst)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Master CLS (optional suject), mathematics, arbitrary semester
- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Bachelor CLS (optional subject), mathematics, 6th semester

Classes and lectures:

- Numerik dynamischer Systeme (lecture, 2 SWS)
- Numerik dynamischer Systeme (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Diskrete dynamische Systeme
- Kontinuierliche dynamische Systeme (Systeme gewöhnlicher Differentialgleichungen)
- Modellierungsaspekte

Qualification-goals/Competencies:

- Modellierung, Simulation und Analyse lebender Systeme
- Numerische Umsetzung der einzelnen Ansätze
- Anwendung auf praxisrelevante Fragestellungen

Grading through:

- Exercises
- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jan Modersitzki

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Jan Modersitzki

Language:

- offered only in German

MA4614 - Numerical methods for partial differential equations (NumMethPDE)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Bachelor CLS (optional subject), mathematics, 5th or 6th semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Numerical methods for partial differential equations (lecture, 2 SWS)
- Numerical methods for partial differential equations (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Numerics for partial differential equations
- Discretization of initial and boundary value problems
- Numerical approximation schemes
- Error analysis
- Stability and consistency

Qualification-goals/Competencies:

- To impart basic principles of numerics for partial differential equations
- To learn methods of proofs as well as the application of results from numerics for partial differential equations
- Accomplished handling of essential concepts and results as well as of selected advanced topics

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Numerics 2 (MA4040-MML)
- Numerics 1 (MA3110-MML)
- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)
- Analysis 2 (MA2500-MML)
- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Rößler

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Andreas Rößler
- MitarbeiterInnen des Instituts

Language:

- offered only in German

Notes:

Literature will be announced in the lecture.

Criteria for admission to the examination will be established by the lecturer.

MA4615 - Numerical methods for stochastic processes (NumStochPr)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Numerical methods for stochastic processes (lecture, 2 SWS)
- Numerical methods for stochastic processes (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Basic principles of stochastic processes in continuous time
- Stochastic differential equations
- Discrete time approximations for solutions of stochastic differential equations
- Numerical schemes for strong and weak approximations

Qualification-goals/Competencies:

- To impart basic principles of stochastic processes and of some numerical schemes
- To learn methods of proof as well as the application of algorithms
- Accomplished handling of essential concepts and results as well as of selected advanced topics

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Stochastics 2 (MA4020-KP04, MA4020)
- Stochastics 1 (MA2510-KP04, MA2510)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Rößler

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Andreas Rößler

Literature:

- P. E. Kloeden, E. Platen: Numerical Solution of Stochastic Differential Equations - Springer-Verlag, Berlin, 1999
- P. E. Kloeden, E. Platen, H. Schurz: Numerical Solution of SDE Through Computer Experiments - Springer-Verlag, Berlin, 2002
- G. N. Milstein, M. V. Tretyakov: Stochastic Numerics for Mathematical Physics - Springer-Verlag, Berlin, 2004

Language:

- offered only in German

Notes:

Criteria for admission to the examination will be established by the lecturer.

MA4616 - Advanced Numerics (HoehereNum)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master MES before 2014 (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Advanced Numerics (lecture, 2 SWS)
- Advanced Numerics (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Numerics for ordinary differential equations
- One-step methods, local and global error analysis
- Orders of consistence and convergence
- Stiff differentual equations, implicit schemes, stability

Qualification-goals/Competencies:

- To impart basic principles of numerics for differential equations
- To learn methods of proofs as well as the application of results from numerics for differential equations
- Accomplished handling of essential concepts and results as well as of selected advanced topics

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Numerics 2 (MA4040-MML)
- Numerics 2 (MA4040)
- Numerics 1 (MA3110-MML)
- Numerics 1 (MA3110-KP04, MA3110)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Rößler

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Andreas Rößler

Language:

- offered only in German

Notes:

Literature will be announced in the lecture.

Criteria for admission to the examination will be established by the lecturer.

MA4617 - Stochastic differential equations (StochDiff)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Stochastic differential equations (lecture, 2 SWS)
- Stochastic differential equations (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Stochastic processes, Brownian motion
- Stochastic integration
- Ito formula
- Stochastic differential equations

Qualification-goals/Competencies:

- To impart basic principles of stochastic processes and stochastic differential equations
- To learn methods of proof as well as the application of results from stochastic analysis
- Accomplished handling of essential concepts and results as well as of selected advanced topics

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Stochastic processes and modeling (MA4610)
- Stochastics 2 (MA4020-KP04, MA4020)
- Stochastics 1 (MA2510-KP04, MA2510)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Rößler

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Andreas Rößler

Literature:

- Bernt Oksendal: Stochastic Differential Equations: An Introduction with Applications - Springer Verlag, 6th edition, 2010
- Ioannis Karatzas, Steven E. Shreve: Brownian Motion and Stochastic Calculus - Springer Verlag, 2nd edition, 1991
- Philip Protter: Stochastic Integration and Differential Equations - Springer Verlag, 2010
- K. L. Chung, R. J. Williams: Introduction to Stochastic Integration - Birkhäuser, 2nd edition, 1990

Language:

- German and English skills required

Notes:

Criteria for admission to the examination will be established by the lecturer.

MA4618 - Introduction to stochastic partial differential equations (EinfSPDEs)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Introduction to stochastic partial differential equations (lecture, 2 SWS)
- Introduction to stochastic partial differential equations (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Gaussian measures on Hilbert spaces
- Infinite-dimensional Brownian motion
- Martingales on Banach spaces
- Stochastic integration in Hilbert spaces
- Existence of solutions for SPDEs
- Numerical methods for the approximation of solutions

Qualification-goals/Competencies:

- To impart basic principles of the theory for stochastic partial differential equations
- To learn methods of proofs as well as the application of results from the theory for stochastic partial differential equations
- Accomplished handling of essential concepts and results as well as of selected advanced topics

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Stochastic differential equations (MA4617)
- Stochastic processes and modeling (MA4610)
- Stochastics 2 (MA4020-MML)
- Stochastics 1 (MA2510-KP04, MA2510)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Rößler

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Andreas Rößler
- MitarbeiterInnen des Instituts

Language:

- offered only in German

Notes:

Literature will be announced in the lecture.

Criteria for admission to the examination will be established by the lecturer.

MA4630 - Fourier Analysis (FourierAna)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Bachelor CLS (optional suject), mathematics, 5th or 6th semester
- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Theory of the Fourier transform
- Fourier transform in the Hilbert space
- Summability methods
- Applying Fourier transforms in solving differential equations
- Laplace and Mellin transforms
- Numerical aspects and relation to discrete Fourier transforms

Qualification-goals/Competencies:

- Knowledge of integral transforms
- A comprehensive understanding for the Fourier transform

Grading through:

- Exercises
- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

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

Literature:

- Chandrasekharan, K.: Classical Fourier Transforms - Springer 1989

Language:

- offered only in German

MA4650 - Matrix algebra (MatrixAlg)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	irregularly	4	20

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Master MES before 2014 (optional subject), mathematics, 1st semester
- Bachelor CLS (optional subject), mathematics, 6th semester

Classes and lectures:

- Matrix algebra (lecture, 2 SWS)
- Matrix algebra (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Properties of matrices
- Special matrices
- Quadratic forms
- Decompositions
- Generalized inverses
- Differentiation
- Probability calculation
- Derivation and calculation of estimators
- Design matrices
- Linear hypotheses
- Examples: multiple linear regression, weighted least-squares estimation, shrinkage estimation

Qualification-goals/Competencies:

- Understanding of typical derivation techniques needed for generalized linear models and multivariate methods
- Command of matrix algebra
- Application of linear algebra to linear models
- Ability to work on practical statistical problems using matrix algebra

Grading through:

- written exam

Requires:

- Biostatistics 1 (MA1600-KP04, MA1600, MA1600-MML)
- Analysis 2 (MA2500-MML)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. nat. Andreas Ziegler
- Dr. Reinhard Vonthein

Literature:

- K. Schmidt, G. Trenkler: Einführung in die Moderne Matrix-Algebra: Mit Anwendungen in der Statistik - Springer: Heidelberg 2006, ISBN 9783540330073
- H. Toutenburg: Lineare Modelle - Physica: Heidelberg 1992 und 2006, ISBN 978-3790815191
- L. Fahrmeir, T. Kneib, S. Lang: Regression: Modelle, Methoden und Anwendungen - Springer: Heidelberg 2007, ISBN 9783642343339
- Michael Healy: Matrices for Statistics - ISBN 9780198507024

Language:

- offered only in German

MA4660 - Prognostic models (PM)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	irregularly	4	20

Course of study, specific field and term:

- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Prognostic models (lecture, 2 SWS)
- Prognostic models (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Aims and applications of prognostic models
- General approach to develop valid prognostic models
- Classical statistical approaches to develop prognostic models
- Approaches to validate prognostic models
- Alternative approaches to develop prognostic models: Classification and Regression Trees, ensemble methods, support vector machines

Qualification-goals/Competencies:

- Understanding the application as well as the general approach to develop valid prognostic models
- Mastering the most important classical statistical approaches to develop prognostic models
- Mastering the most important alternative approaches to develop prognostic models
- Mastering different methods to validated prognostic models
- Applying basic approaches by hand and more complex approaches computer-based

Grading through:

- written exam

Requires:

- Biostatistics 2 (MA2600-KP04, MA2600)
- Statistics - Practical Course (MA3210)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. biol. hum. Inke König
- Prof. Dr. rer. nat. Andreas Ziegler

Language:

- offered only in German

MA4661-KP08, MA4661 - Genetic Epidemiology 2 (GenEpi2)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each summer semester	8	20

Course of study, specific field and term:

- Bachelor CLS starting 2016 (optional subject), mathematics, 6th semester
- Master CLS starting 2016 (optional subject), MML with specialization in Genetic Statistics, 2nd semester
- Bachelor CLS (optional subject), mathematics, 6th semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Genetic Epidemiology 2 (lecture, 2 SWS)
- Genetic Epidemiology 2 (exercise, 1 SWS)
- Genetic Epidemiology 2 (practical course, 2 SWS)

Workload:

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

Contents of teaching:

- Study designs for genetic epidemiological linkage studies within families
- Model-based linkage analysis: Linkage of two markers, linkage of one marker with one phenotype
- Model-free linkage analysis: Tests for sib-pairs
- Model-free linkage analysis: Extensions to many markers and extended pedigrees
- Linkage analysis for quantitative phenotypes: Haseman-Elston method and its extensions, variance components models
- Sample size estimation for linkage analysis
- Data analysis for genetic association studies
- Data analysis for gene expression studies

Qualification-goals/Competencies:

- The students are able to describe the most important study designs for genetic epidemiological linkage studies within families.
- They are able to name and describe the most important approaches for linkage analysis with qualititative and quantitative phenotypes.
- They are able to apply basic test statistics manually and interpret the results.
- They are able to apply more complex test statistics using the computer and interpret the results.
- They can conduct a standard quality control in genetic association studies in R.
- They can conduct basic analyses of genetic association studies in R.
- They can conduct a standard quality control in gene expression studies in R.
- They can conduct basic analyses of gene expression studies in R.
- They have the methodological competence to solve large-scale tasks cost- and time- efficiently.
- They have the management competence to organize their own work and that of collaborators involved in the project.
- They have the methods competence to develop solutions with limited resources (time, personnel, etc.) that comply with general quality criteria.
- They have the communication competence to present ideas and solutions in oral and written form.

Grading through:

- continuous, successful participation in practical course
- written exam

Is requisite for:

- Seminar Genetic Epidemiology (MA5129-KP04, MA5129)

Requires:

- Statistics - Practical Course (MA3210)
- Genetic Epidemiology 1 (MA3200-KP04, MA3200)

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:

- Ziegler A, König IR.: A statistical approach to genetic epidemiology. Concepts and applications. - 2010. ISBN: 978-3-527-32389-0

Language:

- offered only in German

Notes:

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

MA4670 - Combinatorics (Kombi)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second year	4

Course of study, specific field and term:

- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Permutations, combinations, variations
- Partitions
- Generating functions
- Recurrence equations
- Sums and differences
- Inclusion - exclusion

Qualification-goals/Competencies:

- Learning the basics of combinatorics
- Knowledge of different proof techniques and combinatorial approaches
- Teaching fundamental results and deepening some selected aspects of combinatorics

Grading through:

- Exercises
- Oral examination

Requires:

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

Responsible for this module:

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

Teacher:

- Institute for Mathematics

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

Literature:

- Peter Tittmann: Einführung in die Kombinatorik - Spektrum Akademischer Verlag 2000
- Richard A. Brualdi: Introductory Combinatorics - Pearson Prentice Hall 2004

Language:

- offered only in German

MA4675 - Algebra (Algebra)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second year	4

Course of study, specific field and term:

- Bachelor CLS (optional subject), mathematics, 5th or 6th semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Groups (semigroups, subgroups, homomorphisms, invariant subgroups, isomorphism theorems, products of groups)
- Rings (units, ring homomorphisms, polynomial rings, quotient fields, ideals)
- Field extensions (field characteristic, prime fields, field degree, algebraic and transcendent elements, algebraical field extensions, splitting field of a polynomial)
- Geometric constructions (compass-and-straightedge construction, field of constructible points, constructing regular polygons)

Qualification-goals/Competencies:

- Learning the basics of algebra
- Knowledge of different proof techniques and algebraic approaches
- Teaching fundamental results and deepening some selected aspects of algebra

Grading through:

- Exercises
- Oral examination

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

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

Teacher:

- Institute for Mathematics

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

Literature:

- G. Fischer: Lehrbuch der Algebra - Vieweg, 2011 (2. Auflage)
- M. Artin: Algebra - Birkhäuser, 1998
- B. L. van der Waerden: Algebra I - Springer, 1993 (9. Auflage)

Language:

- offered only in German

MA4700 - Angewandte Analysis (AngewAna)

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

Course of study, specific field and term:

- Master MES before 2014 (optional subject), mathematics, 1st semester
- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 6th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Maße und ihre Konstruktion
- Messbare Funktionen, Integration, Konvergenzsätze
- Produktmaße, Fubini
- Satz von Radon-Nikodym
- Lebesgue-Maße, Transformationsformel
- Kurven- und Oberflächenintegrale
- Integralsätze
- Partielle Differentialgleichungen erster Ordnung (Zusammenhang mit Systemen gewöhnlicher Diffferentialgleichungen)
- Klassifikation von Gleichungen zweiter Ordnung
- Beispielhafte Behandlung der drei Grundtypen

Qualification-goals/Competencies:

- Anwendungsbereites Verständnis der abstrakten Maß- und Integrationstheorie und ihrer konkreten Anwendungen in euklidischen Räumen
- Einführung in die Theorie partieller Differentialgleichungen
- Erlernen hierzu grundlegender analytischer Hilfsmittel
- Stärkung des Verständnisses für Modellierung

Grading through:

- Exercises
- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Jürgen Prestin

Language:

- offered only in German

MA4710 - Functional Analysis (FunkAna)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Metric spaces and their topology
- Banach spaces, Hilbert spaces and their geometry
- Duality, Hahn-Banach theorems
- Bounded linear operators, open mapping principle
- L^p-spaces and the theorem of Riesz-Fischer
- Weak topologies and reflexive spaces

Qualification-goals/Competencies:

- Learning the basic techniques for the analysis of linear functionals and operators on Banach and Hilbert spaces
- Study of the fundamental principles of functional analysis

Grading through:

- Exercises
- Oral examination

Responsible for this module:

- Dr. rer. nat. Wolfgang Erb

Teacher:

- Institute for Mathematics

- Dr. rer. nat. Wolfgang Erb

Literature:

- Hirzebruch, Scharlau: Einführung in die Funktionalanlysis - BI-Hochschulbücher, 1991
- Rudin: Functional Analysis - McGraw Hill, 1991
- Heuser: Funktionalanalysis - 4. Auflage, Teubner, 2006
- Hille, Phillips: Functional Analysis and Semi-Groups - AMS, 1957

Language:

- offered only in German

MA4720 - Orthogonal Series in Banach Spaces (ORiBanachR)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Orthogonal Series in Banach Spaces (lecture, 2 SWS)
- Orthogonal Series in Banach Spaces (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Conditional und unconditional convergence and bases in general Banach spaces
- General existence- and non-existence results concerning basis especially in the spaces L1 and C(I)
- Haar and Franklin Systems as bases in the spaces Lp, H1 and BMO

Qualification-goals/Competencies:

- A competent knowledge of the construction methods of bases in special Banach spaces

Grading through:

- Oral examination
- planning and conducting exercises in a two-person-team
- active participation in the exercises

Responsible for this module:

- Dr. Jörn Schnieder

Teacher:

- Institute for Mathematics

- Dr. Jörn Schnieder

Literature:

- Kashin, B. S., Saakyan, A. A.: Orthogonal Series - AMS 1989

Language:

- offered only in German

MA4740 - Fractal Geometry (FraktGeo)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Fractal Geometry (lecture, 2 SWS)
- Fractal Geometry (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Exploring classical fractal sets (e.g. self-similar sets, Mandelbrot set and Julia sets)
- Geometric characterisation by means of dimensions and determination of these dimensions
- Further geometric characteristics (refining the notions of dimension)
- Thermodynamic formalism and symbolic dynamics

Qualification-goals/Competencies:

- The students are familiar with classical fractal sets and are able to classify them.
- They can characterise highly irregular sets with regard to their roughness.

Grading through:

- Exercises
- Oral examination

Responsible for this module:

- Dr. Sabrina Kombrink

Teacher:

- Institute for Mathematics

- Dr. Sabrina Kombrink

Literature:

- K. J. Falconer: Fractal Geometry. Mathematical foundations and applications - 2. edition, John Wiley & Sons, Inc., Hoboken, NJ, 2003
- K. J. Falconer: Techniques in fractal geometry - John Wiley & Sons Ltd., Chichester, 1997
- B. B. Mandelbrot: The fractal geometry of nature - W. H. Freeman and Co., San Francisco, Calif.,1982

Language:

- offered only in German

Notes:

For admission to the oral exam students must have obtained at least 50% of the points in the exercises.

MA4800 - Differenzialgeometrie (Diffgeo)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second year	4

Course of study, specific field and term:

- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 6th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. Reinhard Schuster

Teacher:

- Institute for Mathematics

- Prof. Dr. Reinhard Schuster

Language:

- offered only in German

MA4801 - Elliptische Funktionen (EllipFunk)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second year	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Elliptische Funktionen (lecture, 2 SWS)
- Elliptische Funktionen (exercise, 1 SWS)

Workload:

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

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. Reinhard Schuster

Teacher:

- Institute for Mathematics

- Prof. Dr. Reinhard Schuster

Language:

- offered only in German

MA4802 - Spezielle und allgemeine Relativitätstheorie (RelatiTheo)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second year	4

Course of study, specific field and term:

- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Spezielle und allgemeine Relativitätstheorie (lecture, 2 SWS)
- Spezielle und allgemeine Relativitätstheorie (exercise, 1 SWS)

Workload:

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

Contents of teaching:

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. Reinhard Schuster

Teacher:

- Institute for Mathematics

- Prof. Dr. Reinhard Schuster

Language:

- offered only in German

MA4803 - Number Theory (Zahlentheo)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second year	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Number Theory (lecture, 2 SWS)
- Number Theory (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Divisibility of integers, Farey sequencees, Fibonacci Numbers
- Approximation of real numbers by rational numbers
- Modulo operations: Complete and reduced residue system, Theorems of Euler and Fermat
- Representation of natural numbers sums of 2, 3 or 4 squares
- Quadratic residues
- Quadratic reciprocity
- Prime number criteria and pseudo prime numbers
- Pythagorean triples
- Rational points on curves of degree 2
- Number theoretic functions
- Prime number theorem, prime numbers in arithmetic progression
- Riemann zeta function and its functional equation
- Known problems and conjectures, i.e. Goldbach conjecture
- Stochastic prime numbers

Qualification-goals/Competencies:

- Theoretical knowledge of the mentioned topics
- Historical and most recent issues
- Solve questions in this filed
- Recognize interdisciplinary aspects

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. Reinhard Schuster

Teacher:

- Institute for Mathematics

- Prof. Dr. Reinhard Schuster

Literature:

- Chandrasekharan: Einführung in die analytische Zahlentheorie - Springer Lecture Notes 2008
- Bundschuh: Einführung in die Zahlentheorie - Springer 1992
- Menzer: Zahlentheorie: Fünf ausgewählte Themenstellungen der Zahlentheorie - Oldenbourg Wissenschaftsverlag 2010
- Remmert u. Ullrich: Elementare Zahlentheorie - Birkhäuser 1995
- Rempe: Primzahltests für Einsteiger: Zahlentheorie - Algorithmik - Kryptographie - Vieweg+Teubner 2009
- Scharlau, Opolka: Von Fermat bis Minkowski: Eine Vorlesung über Zahlentheorie und ihre Entwicklung - Springer 2009
- Scheid: Zahlentheorie - Spektrum 2003
- Schmidt: Einführung in die algebraische Zahlentheorie - Springer 2009
- Weil: Zahlentheorie - Spektrum 1992
- Winogradow: Elemente der Zahlentheorie - Prestel-Verlag 1956

Language:

- offered only in German

MA4804 - Special Functions (SpeFunktio)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Special Functions (lecture, 2 SWS)
- Special Functions (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Algebraic operations with complex numbers
- Exponential function, angle functions, hyperbolic angle functions, derived functions
- Gamma and beta functions
- Hypergeometric function
- Bessel function, Legendre function, Laguerre function, Tscheybyscheff function, Hermite function, Jacobi hypergeometric function
- Elliptic functions, theta functions
- Number theoretic functions
- Riemann zeta function
- Used mathematical theories and concepts:
- Complex function theory
- Infinite products
- Differential equations (ordinary, partial)
- Functional equations
- Integral representation
- Taylor series expansions for eigenvalues and eigenfunctions (using space and time, defined on geometric objects)
- Producing functions (a Taylor series in two variables is considered as a series in one variable and the coefficients are special functions in the other variable)
- Addition theorems
- Fourier transformations
- Transformation groups, matrix groups

Qualification-goals/Competencies:

- Theoretical knowlege of the mentioned topics
- Historical and latest questions
- Solve questions in this field
- Recognize interdisciplinary aspects

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. Reinhard Schuster

Teacher:

- Institute for Mathematics

- Prof. Dr. Reinhard Schuster

Literature:

- Andrews G.E., Askey R., Roy R.: Special Functions.Encyclopedia of Mathematics and its Application 71 - Cambridge University Press 2006
- Courant, R., Hilbert, D.: Methoden der mathematischen Physik - Springer 1993
- Erdélyi, A. , Magnus, W., Oberhettinger, F., Tricomi, F.: Higher Transcendental Functions - McGraw-Hill, New York, 1953
- Fichtenholz, G.M.: Differential- und Integralrechnung, Band 1-3 - H. Deutsch 1997

- Hurwitz, A., Courant, R.: Vorlesungen über Allgemeine Funktionentheorie und Elliptische Funktionen - Springer 2000
- Stegun, I. A., Abramowitz, M.: Handbook of Mathematical Functions - Dover Press
- Strampp, W., Ganzha, V., Vorozhtsov, E.: Höhere Mathematik mit Mathematica, Bd.4, Funktionentheorie, Fouriertransformationen und Laplacetransformationen: Funktionentheorie, Fourier- und Laplacetransformation - Vieweg 1997
- Wawrzynczyk, A.: Group Representations and Special Functions - Reidel Publishing Company 1983
- Whittaker, E. T., Watson, G. N.: A Cource of Modern Analysis - Cambridge University Press 1902 ... 1999

Language:

- offered only in German

MA4940 - Test and estimation theory (TestSchetz)

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

Course of study, specific field and term:

- Master CLS (compulsory), mathematics, 2nd semester

Classes and lectures:

- Test and estimation theory (lecture, 2 SWS)
- Test and estimation theory (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Point estimation (one parameter): Properties of point estimators (weak consistency, unbiasedness, Theorem of Rao-Crámer, sufficiency, completeness, Theorem of Rao-Blackwell)
- Exponential families, properties, maximum likelihood estimation in exponential families
- Likelihood ratio test, properties of statistical tests, Lemma of Neyman-Pearson, unbiasedness, monotone density ratios
- Powerfunction

Qualification-goals/Competencies:

- Knowledge of the theoretical foundations of testing and estimation
- Application of the theorems by Rao-Crámer and Rao-Blackwell
- Knowledge of the main characteristics of the linear exponential family
- Application of the fundamental lemma by Neyman-Pearson

Grading through:

- written exam

Requires:

- Stochastics 2 (MA4020-KP04, MA4020)
- Stochastics 1 (MA2510-KP04, MA2510)
- Biostatistics 2 (MA2600-KP04, MA2600)
- Biostatistics 1 (MA1600-KP04, MA1600, MA1600-MML)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. nat. Andreas Ziegler
- Dr. Reinhard Vonthein

Literature:

- E.L. Lehmann, Joseph P. Romano: Testing Statistical Hypotheses - ISBN-13 9780387988641
- E.L. Lehmann, George Casella: Theory of Point Estimation - ISBN-13 9780387985022

Language:

- offered only in German

MA4944 - Multivariate Statistics (MultivStat)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Bachelor CLS (optional subject), mathematics, 6th semester
- Master CLS (optional subject), mathematics, 2nd semester

Classes and lectures:

- Multivariate Statistics (lecture, 2 SWS)
- Multivariate Statistics (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Multivariate regression
- Discriminance analysis
- Logistic regression
- Cluster analysis
- Principal components and factor analysis

Qualification-goals/Competencies:

- Identification of applications in which multivariate statistical methods are required
- Knowledge of the fundamental ideas of various multivariate methods

Grading through:

- written exam

Requires:

- Biostatistics 2 (MA2600-KP04, MA2600)
- Biostatistics 1 (MA1600-KP04, MA1600, MA1600-MML)
- Stochastics 2 (MA4020-KP04, MA4020)
- Stochastics 1 (MA2510-KP04, MA2510)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. nat. Andreas Ziegler
- Dr. Reinhard Vonthein

Literature:

- Ludwig Fahrmeir, Alfred Hamerle, Gerhard Tutz: Multivariate statistische Verfahren - ISBN-13 9783110138061

Language:

- offered only in German

MA4947 - Nonparametric statistics (NichtpStat)		
Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, 2nd semester

Classes and lectures:

- Nonparametric statistics (lecture, 2 SWS)
- Nonparametric statistics (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Recall and extension: properties of parametric procedures
- Fundametal limit theorems (quantiles, U-statistics, M-estimators, rank statistics, empirical processes)
- Nonparametric estimation of functionals, confidence intervals, comparison to parametric methods
- Rank tests
- Selected applications in life sciences (reading and critique of medical publications, analysis of data from recent projects)

Qualification-goals/Competencies:

- Know the nonparametric statistical procedures of highest practical importance
- Understand pros and cons of parametric and nonparametric methods with resprect to efficiency, robustness and interpretability
- Competence in the selection of suitable procedures in applied work

Grading through:

- Exercises
- Oral examination
- written exam

Requires:

- Stochastics 2 (MA4020-KP04, MA4020)
- Stochastics 1 (MA2510-KP04, MA2510)
- Biostatistics 2 (MA2600-KP04, MA2600)
- Biostatistics 1 (MA1600-KP04, MA1600, MA1600-MML)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. nat. Andreas Ziegler
- Dr. Reinhard Vonthein

Literature:

- Herbert Büning, Götz Trenkler: Nichtparametrische statistische Methoden - ISBN-13 9783110163513

Language:

- offered only in German

MA4950 - Logistische Regression (LogRegress)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second year	4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Logistische Regression (lecture, 2 SWS)
- Logistische Regression (exercise, 1 SWS)

Workload:

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

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. nat. Andreas Ziegler

Language:

- offered only in German

MA4960 - Linear Models (LinModelle)		
Duration: 1 Semester	**Turnus of offer:** irregularly	**Credit points:** 4

Course of study, specific field and term:

- Master CLS (optional subject), mathematics, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 6th semester

Classes and lectures:

- Linear models (lecture, 2 SWS)
- Linear models (exercise, 1 SWS)

Workload:

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

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- Written or oral exam as announced by the examiner

Requires:

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

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. nat. Andreas Ziegler

Literature:

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Language:

- offered only in German

MA4962 - Generalized Linear Models (VLModelle)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Bachelor CLS (optional subject), mathematics, 5th or 6th semester
- Master CLS (optional subject), mathematics, arbitrary semester

Classes and lectures:

- Generalized Linear Models (lecture, 2 SWS)
- Generalized Linear Models (exercise, 1 SWS)

Workload:

- 46 Hours private studies
- 36 Hours in-classroom work
- 24 Hours programming
- 14 Hours exam preparation

Contents of teaching:

- General overview of generalized linear models (GLM): - derivation of GLM functions,- GLM algorithms: Fisher scoring, iteratively weighted least squares,- goodness of fit and residuals
- Continuous response models: Gaussian, log-normal, Gamma, log-Gamma for survival analysis, inverse Gaussian
- Discrete response models:- dichotomous: logit, probit, cloglog, loglog, - count data: Poisson, negative binomial, geometric
- Ordered logistic and probit regression
- Multinomial logit and probit model
- Introduction to panel models

Qualification-goals/Competencies:

- Knowledge of the theoretical foundation of the generalized linear model and its application
- Competence for the critical appraisal of regression models
- Competence to detect algorithmic issues in generalized linear models
- Knowledge of conceptual problems with models using categorical dependent variables
- Knowledge for the adequate interpretation of study results
- Competence in parameter interpretation and regression diagnostics

Grading through:

- written exam

Requires:

- Biostatistics 2 (MA2600-KP04, MA2600)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. nat. Andreas Ziegler

Literature:

- Dobson, Annette J & Barnett, Adrian: An Introduction to Generalized Linear Models, 3rd ed. - Chapman & Hall/CRC: Boca Raton (FL), 2008
- Hardin, James W & Hilbe, Joseph M: Generalized Linear Models and Extensions, 3rd ed. - College Station (TX), Stata Press, 2012

Language:

- offered only in German

MA4970 - Design of Experiments and Variance Analysis (VplVarianz)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master Computer Science before 2014 (optional subject), specialization field medical informatics, 3rd semester
- Master CLS (optional subject), mathematics, 1st or 3rd semester
- Bachelor CLS (optional subject), mathematics, 5th semester

Classes and lectures:

- Design of Experiments and Variance Analysis (lecture, 2 SWS)
- Design of Experiments and Variance Analysis (exercise, 1 SWS)

Workload:

- 50 Hours private studies
- 30 Hours in-classroom work
- 25 Hours programming
- 15 Hours exam preparation

Contents of teaching:

- Ability to calculate generalized inverse
- Knowledge of the differences between experiments and observational studies
- Knowledge of the advantages of the statistical design of multifactorial experiments
- Ability to interpret a suitable experimental ANOVA design
- Ability to implement a suitable experimental ANOVA design
- Ability to express the ANOVA model as regression model by matrix notation
- Ability to express and analyze models with repeated measurements
- Ability to draw up and analyze diagrams for an abstract of the results and a model diagnosis

Qualification-goals/Competencies:

- Comprehension of the theoretical principles of the design of experiments
- Comprehension of the theoretical principles of the analysis of variance

Grading through:

- written exam

Requires:

- Biostatistics 2 (MA2600-KP04, MA2600)
- Linear Models (MA4960)
- Biostatistics 1 (UngenutztMA1600-MML)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. nat. Andreas Ziegler

Literature:

- Kursbuch: Montgomery, Douglas C. 2012: Design and Analysis of Experiments. 8th ed. International Student Version - John Wiley & Sons, New York. ISBN 978-1-118-09793-9
- Supplementary literature: Kleppmann, Wilhelm. 2008: Taschenbuch Versuchsplanung. 5. Auflage - Carl Hanser, Wien. ISBN 978-3-446-41595-9
- Supplementary literature: Mason, Robert L., Gunst, Richard F., Hess, James L. 2003: Statistical Design and Analysis of Experiments. 2nd ed. - John Wiley & Sons, New York. ISBN 0-471-37216-1

Language:

- offered only in German

MA5008 - Mathematical course (PraktMathe)

Duration:	Turnus of offer:	Credit points:
1 Semester	on request	8 (Typ B)

Course of study, specific field and term:

- Master CLS (optional suject), mathematics, 2nd or 3rd semester

Classes and lectures:

- Mathematical course (practical course, 6 SWS)

Workload:

- 210 Hours in-classroom work
- 30 Hours written report

Contents of teaching:

- Planning and execution of a project by mathematical methods
- Presenting the methods and results in a detailed written report

Qualification-goals/Competencies:

- Ability to analyze a given problem and to develop mathematical approaches for it
- Ability to make oneself familiar with adequate mathematical structures without any help
- Ability to integrate partial results into the overall solution
- Proficiency in documenting and presenting results

Grading through:

- Written report

Responsible for this module:

- Studiengangsleitung MML

Teacher:

- Institute of Mathematics and Image Computing
- Institute for Mathematics

Language:

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

MA5009-KP04, MA5009 - Master's Seminar mathematics (MSMathe)

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

Course of study, specific field and term:

- Minor in Teaching Mathematics, Master of Education (compulsory), mathematics, 3rd semester
- Master CLS starting 2016 (optional subject), Interdisciplinary modules, 3rd semester
- Master CLS (optional subject), mathematics, 3rd semester

Classes and lectures:

- Advanced Master's Seminar mathematics (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- The students study a scientific topic of their specialization.
- They present the topic in written form.

Qualification-goals/Competencies:

- The students have gained experience of familiarizing themselves with the details of a given scientific topic.
- They are able to present the result of their studies in comprehensible written form.
- They are able to supply a coherent overview of a complex scientific area in a comprehensive oral presentation.
- They have gained experience of holding scientific discussions.
- They understand scientific presentations and know how to critically examine them in open discussions.

Grading through:

- oral presentation
- term paper

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute of Medical Biometry and Statistics
- Institute of Mathematics and Image Computing
- Institute for Mathematics

- Prof. Dr. rer. nat. Jürgen Prestin
- Prof. Dr. rer. nat. Jan Modersitzki
- Prof. Dr. rer. nat. Andreas Rößler
- Prof. Dr. rer. nat. Karsten Keller
- Prof. Dr. rer. nat. Jan Lellmann
- Prof. Dr. rer. biol. hum. Inke König
- Prof. Dr. rer. nat. Andreas Ziegler

Language:

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

MA5030-KP04, MA5030 - Image Registration (Bildregist)

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

Course of study, specific field and term:

- Master Medical Informatics (optional subject), medical image processing, 1st or 2nd semester
- Master MES since 2014 (optional subject), mathematics / natural sciences, 1st semester
- Master Computer Science before 2014 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master MES before 2014 (optional subject), mathematics, 1st or 3rd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 1st or 3rd semester
- Master CLS (optional subject), mathematics, 1st or 3rd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum numerical image processing, 2nd or 3rd semester
- Master Medical Informatics since 2019 in planing (optional subject), medical image processing, 1st or 2nd semester

Classes and lectures:

- Image Registration (lecture, 2 SWS)
- Image Registration (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction and basic principles
- Interpolation
- Deformation models
- Landmark-based registration
- Parametric registration
- Non-parametric registration and regularization strategies

Qualification-goals/Competencies:

- Students know the fundamental concepts in image registration.
- They are able to translate concrete problems into suitable models.
- They have experience with parametric and non-parametric registration problems.
- Interdisciplinary qualifications:
- Students have advanced skills in modeling.
- They can translate theoretical concepts into practical solutions.
- They are experienced in implementation.
- They can think abstractly about practical problems.

Grading through:

- Exercises
- Presentation of one´s own solution of an exercise
- Written or oral exam as announced by the examiner

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Analysis 2 (MA2500-KP04, MA2500)

Responsible for this module:

- Prof. Dr. rer. nat. Jan Modersitzki

Teacher:

- Institute of Mathematics and Image Computing

- Prof. Dr. Martin Leucker
- Prof. Dr. rer. nat. Jan Modersitzki

Literature:

- Goshtasby: 2D and 3D Image Registration - Wiley 2005
- Modersitzki: Numerical Methods for Image Registration - Oxford University Press 2004

- Modersitzki: FAIR: Flexible Algorithms for Image Registration - SIAM 2009
- Rohr: Landmark-Based Image Analysis - Kluwer 2001

Language:

- German and English skills required

Notes:

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

MA5032-KP04, MA5032 - Numerical Methods for Image Computing (NumerikBV)

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

Course of study, specific field and term:

- Master MES since 2014 (optional subject), mathematics / natural sciences, arbitrary semester
- Master Medical Informatics (optional subject), medical image processing, 1st or 2nd semester
- Master MES before 2014 (optional subject), advanced curriculum imaging systems, 2nd or 4th semester
- Master Computer Science before 2014 (optional subject), advanced curriculum numerical image processing, 2nd or 3rd semester
- Master CLS (optional subject), mathematics, 2nd or 4th semester
- Master Medical Informatics since 2019 in planing (optional subject), medical image processing, 1st or 2nd semester

Classes and lectures:

- Numerical Methods for Image Computing (lecture, 2 SWS)
- Numerical Methods for Image Computing (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Modeling
- Discretization
- Numerical methods for partial differential equations
- Multilevel and multiscale approaches
- Optimization methods
- Multigrid methods
- Operator splitting

Qualification-goals/Competencies:

- The students are familiar with fundamental numerical concepts in image computing.
- They have experience in realizing practical solutions.
- They can implement numerical algorithms on a computer.
- They understand selected methods for solving large linear systems.
- They can implement selected methods for solving large linear systems.
- Interdisciplinary qualifications:
- Students have advanced skills in modeling.
- They can translate theoretical concepts into practical solutions.
- They are experienced in implementation.
- They can think abstractly about practical problems.

Grading through:

- Exercises
- Presentation of one´s own solution of an exercise
- Written or oral exam as announced by the examiner

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:

- Nocedal Wright: Numerical Optimization - Springer, 2006
- Modersitzki: FAIR: Flexible Algorithms for Image Registration - SIAM, 2009
- Weickert: Anisotropic Diffusion in Image Processing - Wiley, 1998

Language:

- German and English skills required

Notes:

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

MA5034-KP04, MA5034 - Calculus of Variations and Partial Differential Equations (VariPDE)

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

Course of study, specific field and term:

- Master MES since 2014 (optional subject), mathematics / natural sciences, arbitrary semester
- Bachelor CLS (optional subject), mathematics, 4th or 6th semester
- Master Medical Informatics (optional subject), medical image processing, 1st or 2nd semester
- Master MES before 2014 (optional subject), mathematics, 2nd or 4th semester
- Master Computer Science before 2014 (optional subject), advanced curriculum numerical image processing, 2nd or 3rd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 2nd or 4th semester
- Master CLS (optional subject), mathematics, 2nd or 4th semester
- Master Medical Informatics since 2019 in planing (optional subject), medical image processing, 1st or 2nd semester

Classes and lectures:

- Calculus of Variations and Partial Differential Equations (lecture, 2 SWS)
- Calculus of Variations and Partial Differential Equations (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Fundamentals of functional analysis
- Introduction to the calculus of variations
- Introduction to partial differential equations
- Applications in image and data processing

Qualification-goals/Competencies:

- Students understand variational modeling.
- They are able to formulate basic physical problems in a variational setting.
- They understand the connections between variational methods and partial differential equations.
- They can derive optimality conditions for energy functionals.
- They understand the mathematical theory behind selected variational problems.
- They can implement selected fundamental variational problems.
- They can formulate selected practical problems in the variational setting.
- Interdisciplinary qualifications:
- Students have advanced skills in modeling.
- They can translate theoretical concepts into practical solutions.
- They are experienced in implementation.
- They can think abstractly about practical problems.

Grading through:

- Exercises
- Presentation of one´s own solution of an exercise
- Written or oral exam as announced by the examiner

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:

- Chan & Shen: Image Processing and Analysis - SIAM
- Modersitzki: Flexible Algorithms for Image Registration - SIAM
- Vogel: Computational Methods for Inverse Methods - SIAM

- Aubert, Kornprobst: Mathematical Problems in Image Processing: Partial Differential Equations and the Calculus of Variations - Springer
- Scherzer, Grasmair, Grossauer, Haltmeier, Lenzen: Variational Methods in Imaging - Springer

Language:

- German and English skills required

Notes:

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

MA5129-KP04, MA5129 - Seminar Genetic Epidemiology (SemGenEpi)

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

Course of study, specific field and term:

- Master CLS starting 2016 (compulsory), MML with specialization in Genetic Statistics, 3rd semester
- Master CLS (optional suject), mathematics, 3rd semester
- Master CLS (compulsory), computational life science / biostatistics, 3rd semester

Classes and lectures:

- Seminar Genetic Epidemiology (seminar, 2 SWS)

Workload:

- 90 Hours work on an individual topic with written and oral presentation
- 30 Hours in-classroom work

Contents of teaching:

- Become acquainted with current topics in genetic epidemiology overall and in detail, typically using a current scientific publication, in written and oral form

Qualification-goals/Competencies:

- The students have the methodological competence to master the thorough analysis of a circumscribed scientific topic and to put it into scientific perspective.
- They are competent to present their results comprehensively in written form.
- They have the communication competence to orally present a scientifically complex topic in a coherent way.
- They have the communication competence to take an active part in a scientific discussion.

Grading through:

- Oral presentation and written report

Requires:

- Genetic Epidemiology 2 (MA4661-KP08, MA4661)
- Genetic Epidemiology 1 (MA3200-KP04, MA3200)

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

Language:

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

Notes:

Specialized literature will be named in class.

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

MA5610 - Selected stochastic processes (StochPrz2)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Bachelor CLS (optional suject), mathematics, 6th semester
- Master CLS (optional subject), mathematics, 2nd or 4th semester
- Master Computer Science before 2014 (optional subject), advanced curriculum stochastics, 2nd or 3rd semester

Classes and lectures:

- Selected stochastic processes (lecture, 2 SWS)
- Selected stochastic processes (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- branching processes
- Poisson process
- birth-and-death processes
- reneval processes
- Brownian and fractional Brownian motion
- life science applications

Qualification-goals/Competencies:

- Mastering some important classes of stochastic processes and understanding possible applications

Grading through:

- Oral examination

Requires:

- Stochastics 2 (MA4020-KP04, MA4020)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Ziegler
- Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute of Medical Biometry and Statistics
- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller
- Prof. Dr. rer. nat. Andreas Ziegler

Literature:

- R. Durrett: Probability: Theory and Examples - 3rd. edition, Thomson, 2005
- S. Karlin und H.M. Taylor: A First Course in Stochastic Processes - 2rd. edition, Academic Press, 1975

Language:

- offered only in German

MA5990-KP30, MA5990 - Master's thesis in Computational Life Science (MaArbMML)

Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	30

Course of study, specific field and term:

- Master CLS starting 2016 (compulsory), Interdisciplinary modules, 4th semester
- Master CLS (compulsory), mathematics, 4th semester

Classes and lectures:

- Master's thesis (supervised self studies, 1 SWS)
- Colloquium (presentation (incl. preparation), 1 SWS)

Workload:

- 870 Hours private studies
- 30 Hours oral presentation (including preparation)

Contents of teaching:

- Individual studies under supervision

Qualification-goals/Competencies:

- Ability to solve a complex scientific problem with state-of-the-art methods
- Experience in writing a scientific thesis within a given time period
- Becoming an expert in a special subfield of mathematics
- Experience in working with scientific literature
- Presentation skills

Grading through:

- oral presentation
- Written report

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institutes of the Department of Computer Science/ Engineering

- Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges

Language:

- thesis can be written in German or English

Notes:

The basic prerequisite for starting the Master's thesis is the successful completion of 75 credits.

ME4030-KP04, ME4030 - Inverse Problems in Imaging (InversProb)

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

Course of study, specific field and term:

- Master Medical Informatics since 2019 in planing (optional subject), medical image processing, 1st or 2nd semester
- Master Auditory Technology (optional subject), Auditory Technology, 2nd semester
- Master Robotics and Autonomous Systems (optional subject), Medical Engineering Science, 1st or 2nd semester
- Master MES since 2014 (optional subject), Medical Engineering Science, 1st or 2nd semester
- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field medical informatics, 3rd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 1st or 2nd semester
- Master CLS (optional subject), mathematics, 1st and 2nd semester

Classes and lectures:

- Tomographische Verfahren II: Inverse Probleme bei der Bildgebung (lecture, 2 SWS)
- Tomographische Verfahren II: Inverse Probleme bei der Bildgebung (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to inverse and ill-posed problems on the basis of selected examples (including seismology, impedance tomography, heat conduction, computed tomography, acoustic)
- Concept of ill-posedness of the inverse problem (Hadamard)
- Singular value decomposition and generalized inverse
- Regularization methods (eg Tikhonov, Phillips, Ivanov)
- Deconvolution
- Image restoration (deblurring, defocusing)
- Statistical methods (Bayes, maximum likelihood)
- Computed Tomography, Magnetic Particle Imaging

Qualification-goals/Competencies:

- Students are able to explain the concept of ill-posedness of the inverse problem and distinguish given inverse problems regarding good or bad posedness.
- They are able to formulate inverse problems of mathematical imaging and solve (approximate) with suitable numerical methods.
- They can assess the condition of a problem and the stability of a method.
- They master different regularization methods and are able to apply them to practical problems.
- They know methods to determine a suitable regularization.
- They can use methods of image reconstruction and restoration on real measurement data.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering

- Prof. Dr. rer. nat. Thorsten Buzug

Literature:

- Kak and Slaney: Principles of Computerized Tomographic Imaging - SIAM Series 33, New York, 2001
- Natterer and Wübbeling: Mathematical Methods in Image Reconstruction - SIAM Monographs, New York 2001
- Bertero and Boccacci: Inverse Problems in Imaging - IoP Press, London, 2002

- Andreas Rieder: Keine Probleme mit inversen Problemen - Vieweg, Wiesbaden, 2003
- Buzug: Computed Tomography - Springer, Berlin, 2008

Language:

- offered only in German

ME4040 - Quantenphysik der medizinischen Diagnostik und Therapie (QDT)		
Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master MES since 2014 (optional subject), Medical Engineering Science, 1st or 2nd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 1st or 2nd semester
- Master CLS (optional subject), mathematics, 2nd or 3rd semester

Classes and lectures:

- Quantenphysik der medizinischen Diagnostik und Therapie (seminar, 2 SWS)

Workload:

- 60 Hours private studies
- 35 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Uncertainty and metrology
- Elementary particles in medical technology
- Schrödinger equation: electrons in the wave picture
- Quantum mechanical foundations of electron, atomic force and scanning tunneling microscopy
- Quantum mechanical effects in magnetic resonance imaging and spectroscopy
- Radiotherapy: cross sections, proton and ion therapy; Interactions between radiation field and matter
- Quantum statistics in the nuclear medical diagnostics
- Infrared imaging and Planck's radiation law
- Synchrotron radiation in diagnosis and therapy
- Semiconductor detectors for biomedical imaging

Qualification-goals/Competencies:

- Students are able to explain the role of various quantum-mechanical processes in medical diagnostics and therapy.
- They can explain a number of diagnostic and therapeutic procedures, for which the understanding of quantum mechanics is important.
- They can name the pros and cons of competing procedures in radiotherapy.
- They can use the mathematical formulation of quantum mechanics to explain basic effects.

Grading through:

- presentation
- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Magdalena Rafecas

Teacher:

- Institute of Medical Engineering

- Prof. Dr. rer. nat. Thorsten Buzug
- Prof. Dr. rer. nat. Martin Koch
- Prof. Dr. rer. nat. Magdalena Rafecas

Literature:

- is selected individually:

Languages:

- offered only in German
- German and English skills required

MZ4373-KP03, MZ4373 - Human Genetics (HumGen)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Master Medical Informatics (optional subject), bioinformatics, 1st or 2nd semester
- Master CLS starting 2016 (compulsory), MML with specialization in Genetic Statistics, 1st semester
- Master CLS (compulsory), computational life science / biostatistics, 1st semester
- Master CLS (optional suject), mathematics, arbitrary semester
- Master Medical Informatics since 2019 in planing (optional subject), bioinformatics, 1st or 2nd semester

Classes and lectures:

- Human Genetics for MML (lecture, 2 SWS)

Workload:

- 40 Hours private studies
- 30 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Human genome
- Heredity
- Genetics of mitochondria
- Mutations, detection and nomenclature of sequence variations
- Polymorphisms and SNP
- Linkage analyses
- Repetitive sequences
- Methods: isolation, amplification, screening, and analysis of nucleic acids
- Data bases
- Epigenetics

Qualification-goals/Competencies:

- Students are able to explain basic principles of heredity, the organization of the human genome, the relevance of sequence variations, and their application for medical biometrics.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Christine Zühlke

Teacher:

- Institute of Human Genetics

- Prof. Dr. rer. nat. Christine Zühlke
- Dr. Andreas Dalski
- MitarbeiterInnen des Instituts

Literature:

- Tom Strachan & Andrew P. Read: Molekulare Humangenetik - 3. Auflage (2005)

Language:

- offered only in German

EC4020-KP04, EC4020 - Agile Project Management (Prjktmng)

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

Course of study, specific field and term:

- Master Psychology (optional subject), interdisciplinary competence, arbitrary semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, arbitrary semester
- Master psychology (optional subject), interdisciplinary competence, arbitrary semester
- Master CLS (optional suject), interdisciplinary competence, 3rd semester
- Master Entrepreneurship in Digital Technologies (optional subject), interdisciplinary competence, arbitrary semester

Classes and lectures:

- Project Management (lecture with exercises, 3 SWS)

Workload:

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

Contents of teaching:

- Within this module students will get insights to the foundations and disciplines of project management. Focus will be especially on agile project management. Through a mix of from theory and practice students will experience the different methods and their interdependencies.
- The popular methods Scrum and Kanban are trained so that the students are enabled to understand roles/, processes and agile principles.
- Also goals is to sensitive students towards change management through projects, which is typically a challenging aspect. The variance and the uniqueness of each project is another aspect that will be covered within this module.
- Finally the students should be able to select a fitting method based on the requirements and plan first steps to structure the project.
- The context and focus will be on software development projects.

Qualification-goals/Competencies:

- The students identify the major roles and processes in small and simple projects and get a broader knowledge about agile project management and to plan and execute projects.
- The students are able to plan and execute different process steps in a project. Especially the importance and impact of soft skills are part of the practical exercises.
- The students can define personal development area in the context of project work based on their experience and reflections during the module.
- The students are able to work in a team, take over responsibility and trained to critical reflect their own behavior in a team and finally improve.

Grading through:

- portfolio exam
- written exam
- written homework
- presentation

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development

- Dr. Sascha Schorr

Literature:

- Röpstorff, S., & Wiechmann, R.: Scrum in der Praxis: Erfahrungen. Problemfelder und Erfolgsfaktoren - (2012)
- Leopold, Klaus, et al.: Kanban in der IT - (2012)
- Andersen, J.: Retrospektiven in agilen Projekten: Ablauf, Regeln und Methodenbausteine - (2013)

Language:

- offered only in German

Notes:

(Formerly EC4020)

Formerly Projektmanagement

MA5330 - Projektmanagement (ProjMML)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional suject), interdisciplinary competence, 3rd semester

Classes and lectures:

- See EC4020: Project management (course, 3 SWS)

Workload:

- 0 Hours

Contents of teaching:

-

Qualification-goals/Competencies:

-

Grading through:

- as announced by examiner

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development

Language:

- German and English skills required

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

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

Course of study, specific field and term:

- Bachelor MLS starting 2016 (optional suject), interdisciplinary competence, arbitrary semester
- Bachelor Biophysics (optional subject), no specific field, 6th semester
- Master MES since 2014 (optional subject), no specific field, 2nd semester
- Bachelor MES since 2014 (optional subject), no specific field, 4th or 6th semester
- Master MLS (optional subject), interdisciplinary competence, arbitrary semester
- Bachelor Computer Science before 2014 (optional subject), computer science, arbitrary semester
- Bachelor MES before 2014 (optional subject), Medical Engineering Science, arbitrary semester
- Master CLS (optional subject), interdisciplinary competence, arbitrary semester
- Bachelor MLS (optional subject), interdisciplinary competence, arbitrary semester
- Bachelor MLS starting 2018 (optional subject), interdisciplinary competence, arbitrary semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

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

Qualification-goals/Competencies:

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

Grading through:

- Exercises
- continuous, successful participation in course
- written exam

Responsible for this module:

- B. Sc. Sara Meitner

Teacher:

-
- B. Sc. Sara Meitner

Literature:

- : - Publications and articles

Language:

- offered only in English

PS5810-KP04, PS5810 - Scientific Teaching and Tutoring (WLehrKP04)

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

Course of study, specific field and term:

- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, arbitrary semester
- Bachelor Interdisciplinary Courses (optional subject), Interdisciplinary modules, arbitrary semester
- Master CLS starting 2016 (optional subject), Interdisciplinary modules, 3rd semester
- Master Robotics and Autonomous Systems (optional subject), interdisciplinary competence, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies (optional subject), interdisciplinary competence, arbitrary semester
- Master Media Informatics (optional subject), interdisciplinary competence, arbitrary semester
- Master MES since 2014 (optional subject), no specific field, 1st or 2nd semester
- Bachelor MES since 2014 (optional subject), no specific field, arbitrary semester
- Master Computer Science since 2014 (optional subject), interdisciplinary competence, arbitrary semester
- Master CLS (optional suject), interdisciplinary competence, 3rd semester
- Master Computer Science before 2014 (optional subject), interdisciplinary competence, arbitrary semester

Classes and lectures:

- Theory and Practice of Good Teaching (seminar, 1 SWS)
- Work as a tutor in a lecture (practical course, 2 SWS)

Workload:

- 60 Hours private studies and exercises
- 45 Hours oral presentation (including preparation)
- 15 Hours in-classroom work

Contents of teaching:

- Organizing and running a scientific lecture
- Basic didactics of scientific teaching
- Practical work in tutorials

Qualification-goals/Competencies:

- Ability to run a tutorial and to explain topics of the relevant subfield of informatics.
- Basic pedagogical and didactical skills

Grading through:

- continuous participation in all courses of the module

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics

- Dr. Jörn Schnieder

Language:

- depends on the chosen courses

PS5830-KP04, PS5830 - Start-up and New Business (StartUp)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4 (Typ B)

Course of study, specific field and term:

- Master Media Informatics (optional subject), Interdisciplinary modules, arbitrary semester
- Bachelor Robotics and Autonomous Systems (optional subject), interdisciplinary competence, 5th or 6th semester
- Master Medical Informatics (optional subject), interdisciplinary competence, 1st or 2nd semester
- Master MES since 2014 (optional subject), no specific field, 1st or 2nd semester
- Bachelor MES since 2014 (optional subject), no specific field, arbitrary semester
- Master Computer Science since 2014 (optional subject), interdisciplinary competence, arbitrary semester
- Bachelor MES before 2014 (optional subject), interdisciplinary competence, arbitrary semester
- Bachelor Computer Science 2014 and 2015 (optional subject), central topics of computer science, 5th or 6th semester
- Master CLS (optional suject), interdisciplinary competence, 2nd or 3rd semester
- Master Computer Science before 2014 (optional subject), interdisciplinary competence, 2nd or 3rd semester

Classes and lectures:

- Start-up and New Business (seminar, 1 SWS)
- Start-up and New Business (practical course, 1 SWS)

Workload:

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

Contents of teaching:

- Entre-/ Intrapreneurship
- Business Modelling
- Technology product, value propositions, and customer benefit
- Target groups, customer segments, and customer relations
- Sales channels, marketing and sources of income
- Key ressources / activities / partners
- costs and financing, including funding programs
- special subjects: quality, acceptance for trading, legal form of organization, a.o.

Qualification-goals/Competencies:

- The students have gained basic insights in the field of Start-up, new product development and new business development.
- They have acquired a sound knowledge of business modelling and planing.
- They are able to develop a business plan based on a particular project.
- They are able to assess the chances and risks of a start-up and new product / new business development.

Grading through:

- oral presentation
- Written report
- continuous, successful participation in course
- successful addressing of the project goals
- contributions to the discussion

Responsible for this module:

- Prof. Dr. Martin Leucker

Teacher:

- Institute of Software Technology and Programming Languages

- Dr. Raimund Mildner

Literature:

- Aktuelle Forschungsartikel werden in der Veranstaltung bekanntgegeben.:

Language:

- offered only in German

CS5410 - Artificial Life (ArtiLife)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), computer science, arbitrary semester
- Master CLS (optional subject), life sciences, arbitrary semester
- Master Computer Science before 2014 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field bioinformatics, 3rd semester
- Master Biophysics (optional subject), Elective, 1st or 2nd semester

Classes and lectures:

- Artificial Life (lecture, 2 SWS)
- Artificial Life (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Properties, flavors and kinds of (artificial) life
- Artificial chemistry and self-replicating code
- Introduction to information theory
- Introduction to statistical mechanics and thermodynamics
- Complex networks and NK models
- Evolutionary algorithms
- Emergence
- Cellular automata
- Game of life
- Tierra
- Ant algorithms

Qualification-goals/Competencies:

- Understanding criteria and definitions of
- Understanding of
- Understanding (and ability to apply) evolutionary algorithms
- Understanding the principles of complex networks
- Knowledge of the main models of artificial life

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- PD Dr. rer. nat. Jens Christian Claussen

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr. rer. nat. Thomas Martinetz
- PD Dr. rer. nat. Jens Christian Claussen

Literature:

- Christoph Adami: Introduction to Artificial Life - Springer Verlag, 1998

Language:

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

MZ2200-MML - Physiology (PhysioMML)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	6

Course of study, specific field and term:

- Master CLS (optional subject), life sciences, 3rd semester

Classes and lectures:

- Physiology (lecture, 4 SWS)

Workload:

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

Contents of teaching:

- 1. Molecular physiology:
- 1.1 Electrical activity and action potentials
- 1.2 Synapses, transmitters, and receptors
- 1.3 Molecular contraction and cellular movement
- 1.4 Molecular physiology of the senses
- 2. Integrative physiology:
- 2.1 Blood (oxygen transport, defense, coagulation)
- 2.2 Hormones and second messengers
- 2.3 Heart and circulation
- 2.4 Breathing mechanics and gas exchange
- 2.5 Kidney (epithelial transport physiology)

Qualification-goals/Competencies:

- Understanding of cellular and molecular functions of life
- Understanding of integrative functions of human body systems in health
- Interpretation of physiological functions in human body

Grading through:

- continuous, successful participation in course
- written exam

Responsible for this module:

- Prof. Dr. med. Cor de Wit

Teacher:

- Institut of Physiology

- Prof. Dr. med. Cor de Wit
- Prof. Dr. med. Wolfgang Jelkmann
- Prof. Dr. rer. nat. Horst Pagel
- Dr. rer. nat. Reinhard Depping
- Dr. rer. nat. Thomas Hellwig-Bürgel

Literature:

- RF Schmidt, F Lang (Hrsg): Physiolologie des Menschen - 30. Aufl, Springer, Heidelberg
- R Klinke, HC Pape, S Silbernagl (Hrsg): Physiologie - 5. Aufl, Thieme, Stuttgart
- Silverthorn: Human Physiology
- Deetjen, Speckmann: Physiologie

Language:

- offered only in German

CS5255 - Elements of Audio and Image Coding (AudioBild)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), imaging systems, arbitrary semester
- Master Computer Science before 2014 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field media informatics, 2nd or 3rd semester

Classes and lectures:

- Elements of Audio and Image Coding (lecture, 2 SWS)
- Elements of Audio and Image Coding (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to information theory
- Fundamentals of data compression and quantization
- Wavelets, transforms, and filterbanks for coding
- Principles of perceptual audio coding
- Standardized audio coders, such as mp3 and AAC
- Lossless audio coding
- Principles and standards of image compression (JPEG, JPEG2000)
- Progressive image compression
- Visual perception and masking
- Principles of video coding
- Principles of error correction and concealment

Qualification-goals/Competencies:

- Students are able to describe the different models of auditory and visual perception.
- They are able to implement optimal transforms and coding techniques.
- They are able to explain various applications of the above mentioned principles in audio, image, and video coding.

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing

- Prof. Dr.-Ing. Alfred Mertins

Literature:

- K. Sayood: Introduction to Data Compression - San Diego: Academic Press, 2nd edition 2000

Language:

- offered only in German

ME3520-MML - Compulsory optional project in imaging (WPPrBildg)

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

Course of study, specific field and term:

- Master CLS (optional subject), imaging systems, 3rd semester

Classes and lectures:

- Compulsory optional project in imaging (project work, 3 SWS)

Workload:

- 95 Hours group work
- 55 Hours private studies
- 30 Hours written report

Contents of teaching:

- Participation in recent research projects of the Institute of Medical Engineering
- Project planning and problem analysis
- Writing requirement specifications
- Project coordination and work load distribution
- Project management
- Interface definition
- Implementation
- Validation
- Hands-on tests
- Project handover

Qualification-goals/Competencies:

- The students learn working methods in entering a current research project at the Institute.
- They learn and enhance their capacity to documentat and present project results.
- By working in groups, the skills to work in teams and division of labor can be improved.

Grading through:

- Written report
- continuous, successful participation in course
- contributions to the discussion

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering

- Prof. Dr. rer. nat. Thorsten Buzug
- MitarbeiterInnen des Instituts

Literature:

- Latest journal publications made available at the beginning of the project:

Language:

- offered only in German

CS2500-KP04, CS2500 - Robotics (Robotik)

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

Course of study, specific field and term:

- Bachelor Medical Informatics since 2019 in planning (optional subject), medical computer science, 4th to 6th semester
- Bachelor Computer Science since 2016 (optional subject), major subject informatics, arbitrary semester
- Bachelor Robotics and Autonomous Systems (compulsory), Robotics and Autonomous Systems, 3rd semester
- Bachelor IT-Security (optional subject), computer science, arbitrary semester
- Bachelor MES since 2014 (optional subject), computer science and electrical engineering, 5th semester
- Bachelor Medical Informatics since 2014 (optional subject), medical computer science, 5th or 6th semester
- Bachelor Computer Science 2014 and 2015 (optional subject), central topics of computer science, 5th semester
- Bachelor Computer Science 2014 and 2015 (compulsory), specialization field robotics and automation, 3rd semester
- Bachelor Medical Informatics before 2014 (optional subject), applied computer science, 4th to 6th semester
- Bachelor Computer Science before 2014 (optional subject), central topics of computer science, 5th semester
- Master CLS (optional subject), computer science, 3rd semester
- Bachelor MES before 2014 (optional subject), Medical Engineering Science, 3rd or 5th semester
- Bachelor Computer Science before 2014 (compulsory), specialization field robotics and automation, 3rd semester

Classes and lectures:

- Robotics (lecture, 2 SWS)
- Robotics Exercise (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Description of serial robotic systems: This part includes the basic components like different types of joints, sensors and actors. Exemplarily, the differing kinematic types are introduced. Also, the mathematical backgrounds are presented, necessary for the description of robots. The direct and inverse kinematics for typical 6-jointed industrial robots is explained.
- Parallel robot systems: This part deals with the transfer of the results and mathematical models of part 1 onto robotic systems with parallel kinematics.
- Movement: Robot movements along trajectories/geometric paths are analyzed. Different techniques of path planning are presented as well as methods to determine the configuration space and to perform velocity planning and kinematics.
- Robot Control: Techniques of control theory and examples of programming techniques in robotics are introduced. Sensor and systems calibration as a typical application of robotics is explained in detail.

Qualification-goals/Competencies:

- The students are able to solve application-oriented exercises with mathematical background self-dependent, timely and in team work.
- They have gained basic understanding for the kinematic features of serial and simple parallel robots (includes knowledge of transformations, Euler-/Tail-Bryan-Angles, quaternions, etc.)
- They made first experiences with the programming of simple robotic applications.
- They comprehend the complexity and necessity for different path and dynamic planning techniques.
- The students gained an insight into simple methods for system and sensor calibration.

Grading through:

- written exam

Is requisite for:

- Lab Course Robotics and Automation (CS3501-KP04, CS3501)

Requires:

- Analysis 1 (MA2000-KP08, MA2000)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

- Prof. Dr.-Ing. Achim Schweikard

Teacher:

- Institute for Robotics and Cognitive Systems

- Prof. Dr.-Ing. Achim Schweikard
- Prof. Dr. rer. nat. Floris Ernst

Literature:

- A. Schweikard, F. Ernst: Medical Robotics - Springer Verlag, 2015
- M. Spong et al.: Robot Modeling and Control - Wiley & Sons, 2005
- H.-J. Siegert, S. Bocionek:: Robotik: Programmierung intelligenter Roboter - Springer Verlag, 1996
- J.-P. Merlet: Parallel Robots - Springer Verlag, 2006
- M. Haun: Handbuch Robotik - Springer Verlag, 2007
- S. Niku: Introduction to Robotics: Analysis, Control, Applications - Wiley & Sons, 2010

Language:

- offered only in German

CS2700-KP04, CS2700 - Databases (DB)

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

Course of study, specific field and term:

- Bachelor Medical Informatics since 2019 in planning (compulsory), computer science, 3rd semester
- Bachelor Computer Science since 2016 (compulsory), foundations of computer science, 4th semester
- Bachelor Robotics and Autonomous Systems (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security (compulsory), computer science, 4th semester
- Bachelor Biophysics (optional subject), computer science, 6th semester
- Bachelor MES before 2014 (optional subject), computer science, 4th or 6th semester
- Bachelor Medical Informatics since 2014 (compulsory), computer science, 4th semester
- Bachelor MES since 2014 (optional subject), computer science and electrical engineering, 4th or 6th semester
- Bachelor Media Informatics (compulsory), foundations of computer science, 4th semester
- Bachelor Computer Science 2014 and 2015 (compulsory), foundations of computer science, 4th semester
- Bachelor Medical Informatics before 2014 (compulsory), computer science, 2nd semester
- Master CLS (optional subject), computer science, 2nd semester
- Bachelor CLS (optional subject), computer science, 6th semester
- Bachelor Computer Science before 2014 (compulsory), foundations of computer science, 4th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

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

Qualification-goals/Competencies:

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

Grading through:

- Exercises
- written exam

Is requisite for:

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

Requires:

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

Responsible for this module:

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

Teacher:

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

Literature:

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

Language:

- offered only in German

CS3050-KP04, CS3050 - Coding and Security (CodeSich)

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

Course of study, specific field and term:

- Bachelor Computer Science since 2016 (compulsory), Canonical Specialization Web and Data Science from WS19, 2nd semester
- Bachelor Medical Informatics since 2019 in planning (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science since 2016 (optional subject), major subject informatics, arbitrary semester
- Bachelor Computer Science since 2016 (optional subject), Canonical Specialization Web and Data Science WS16-SS19, 2nd semester
- Bachelor Computer Science since 2016 (optional subject), Canonical Specialization SSE, 2nd semester
- Bachelor Robotics and Autonomous Systems (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security (compulsory), IT-Security, 2nd semester
- Bachelor Medical Informatics since 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Media Informatics (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 and 2015 (optional subject), central topics of computer science, 6th semester
- Bachelor Computer Science 2014 and 2015 (compulsory), specialization field IT security and safety, 2nd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum security, 2nd semester
- Bachelor Computer Science before 2014 (compulsory), specialization field IT security and safety, 2nd semester
- Bachelor Medical Informatics before 2014 (optional subject), computer science, 4th to 6th semester
- Master CLS (optional suject), computer science, arbitrary semester
- Bachelor Computer Science before 2014 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

- Coding and Security (lecture, 2 SWS)
- Coding and Security (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- information, entropie
- discrete sources and channels
- coding systems, error-tolerant codes
- codes for digital media, compression
- threats to IT-systems
- formal definition of security properties
- security primitives

Qualification-goals/Competencies:

- detailed knowledge of the basics of information and coding theory
- deep knowledge of the concept of information
- being able to model information sources and communication networks
- being able to formalize the security of IT-systems
- knowing scenarios of attacks and protection methods

Grading through:

- Exercises
- Viva Voce or test

Requires:

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

Responsible for this module:

- Prof. Dr. Rüdiger Reischuk

Teacher:

- Institute for Theoretical Computer Science

- Prof. Dr. Rüdiger Reischuk
- Prof. Dr. Maciej Liskiewicz

Literature:

- R. Roth: Introduction to Coding Theory - Cambridge Univ. Press 2006
- D. Salomon: Coding for Data and Computer Communications - Springer 2005
- D. Salomon: Data Privacy and Security - Springer 2003
- Pieprzyk, Hardjono, Seberry: Fundamentals of Computer Security - Springer 2003
- M. Stamp: Information Security: Principles and Practice - Wiley 2006

Language:

- German and English skills required

CS3202-KP04, CS3202 - Nonstandard Database Systems (NDB)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Bachelor IT-Security (optional subject), computer science, arbitrary semester
- Bachelor Medical Informatics since 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Media Informatics (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 and 2015 (optional subject), central topics of computer science, 5th or 6th semester
- Bachelor Medical Informatics before 2014 (optional subject), applied computer science, 4th to 6th semester
- Master Computer Science before 2014 (optional subject), specialization field media informatics, 2nd or 3rd semester
- Master CLS (optional suject), computer science, arbitrary semester
- Bachelor CLS (optional subject), computer science, 6th semester
- Master Computer Science before 2014 (optional subject), advanced curriculum distributed information systems, 2nd or 3rd semester
- Bachelor Computer Science before 2014 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

- Nonstandard Database Systems (lecture, 2 SWS)
- Nonstandard Database Systems (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- introduction
- semistructured databases
- Temporal and spatial databases (temporally restricted validity, multidimensional index structures)
- Sequence Databases
- Databases for data streams (window concept)
- Databases for incomplete information (e.g., constraint databases)
- Probabilistic databases
- Databases with answer ranking (top-k queries)

Qualification-goals/Competencies:

- Knowledge:Students can name the main features of standard databases and, in addition, can explain which non-standard database models emerge if features are dropped. They can describe the main ideas behind non-standard databases presented in the course by explaining the main features of respective query languages (syntax and semantics) as well as the most important implementation techniques used for their practical realization.
- Skills:Students can apply query languages for non-standard data models introduced in the course to retrieve desired structures from sample datasets in order to satisfy information needs specified textually in natural language. Students are able to represent data in the relational data model using encoding techniques presented in the course such that they can demonstrate how new formalisms relate to or can be implemented in SQL (in particular, SQL-99). In case an SQL transformation cannot be found, students can explain and apply dedicated algorithms for query answering. Students can demonstrate how index structures help answering queries fast by showing how index structures are built, updated, and exploited for query answering. The participants of the course can derive query answers by evaluating queries step by step and by deriving optimized query execution plans.
- Social skills:Students work in teams to handle assignments, and they are encouraged to present their solution to other students in small presentations (in lab classes). In addition, self-dependence is fostered by giving pointers to query evaluation engines for various formalism presented in the lecture such that students get familiar with data models and query languages by self-controlled work.

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Databases (CS2700-KP04, CS2700)

Responsible for this module:

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

Teacher:

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

Literature:

- S. Abiteboul, P. Buneman, D. Suciu: Data on the Web - From Relations to Semistructured Data and XML - Morgan Kaufmann, 1999
- J. Chomicki, G. Saake (Eds.): Logics for Databases and Information Systems - Springer, 1998
- P. Rigaux, M. Scholl, A. Voisard: Spatial Databases With Applications to GIS - Morgan Kaufmann, 2001
- P. Revesz: Introduction to Constraint Databases - Springer, 2002
- P. Revesz: Introduction to Databases- From Biological to Spatio-Temporal - Springer 2010
- S. Ceri, A. Bozzon, M. Brambilla, E. Della Valle, P. Fraternali, S. Quarteroni: Web Information Retrieval - Springer, 2013
- S. Chakravarthy, Q. Jiang: Stream Data Processing A Quality of Service Perspective - Springer, 2009
- D. Suciu, D. Olteanu, Chr. Re, Chr. Koch: Probabilistic Databases - Morgan & Claypool, 2011

Language:

- offered only in German

CS4000 - Algorithmics (ALG)

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

Course of study, specific field and term:

- Master CLS (optional subject), computer science, 1st or 3rd semester
- Master Computer Science before 2014 (compulsory), computer science mandatory courses, 1st semester

Classes and lectures:

- Algorithmics (lecture with exercises, 3 SWS)

Workload:

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

Contents of teaching:

- satisfiability and constraint satisfaction problems
- randomized search
- discrete optimization problems, linear programming
- Las-Vegas- and Monte-Carlo-algorithms
- complexity analysis of algorithmic problems
- approximation algorithms
- heuristic search

Qualification-goals/Competencies:

- ability to model real problems in an algorithmic manner
- ability to design efficient algorithms for complex problems
- good practice in applying basic algorithmic techniques
- skill in analyzing algorithms, in particular with respect to corrrectness and complexity

Grading through:

- exercises and project assignments
- Viva Voce or test

Is requisite for:

- Seminar Algorithmics and Complexity Theory (CS5099)
- Advanced Algorithmics and Data Structures (CS4008)
- Computer Algebra (CS4018)

Requires:

- Theoretical Computer Science (CS2000-KP08, CS2000)
- Algorithm Design (CS3000-KP04, CS3000)

Responsible for this module:

- Prof. Dr. Rüdiger Reischuk

Teacher:

- Institute for Theoretical Computer Science

- Prof. Dr. Rüdiger Reischuk
- Prof. Dr. rer. nat. Till Tantau
- Prof. Dr. Maciej Liskiewicz

Literature:

- Aho, Hopcroft, Ullman: Design and Analysis of Computer Algorithms - Addison Wesley, 1978
- Motwani, Raghavan: Randomized Algorithms - Cambridge University Press, 2000
- Mitzenmacher, Upfal: Probability and Computing - Cambridge University Press, 2005
- Kreher, Stinson: Combinatorial Algorithms - CRC Press, 1999
- Williamson, Shmoys: The Design of Approximation Algorithms - Cambridge University Press, 2011

Language:

- offered only in German

CS4003 - Computational Complexity (Komplex)

Duration:	Turnus of offer:	Credit points:
1 Semester	normally each year in the summer semester	4

Course of study, specific field and term:

- Master Computer Science before 2014 (optional subject), specialization field IT security and safety, 2nd or 3rd semester
- Master Computer Science before 2014 (compulsory), advanced curriculum algorithmics and complexity theory, 2nd or 3rd semester
- Master CLS (optional subject), computer science, 2nd semester

Classes and lectures:

- Computational Complexity (lecture with exercises, 3 SWS)

Workload:

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

Contents of teaching:

- structure of time and space classes
- comparison of different reducibilities
- circuit complexity
- probabilistic complexity classes
- Polynomial Hierarchy
- separation of complexity classes
- oracle Turing machines and relativisation

Qualification-goals/Competencies:

- ability to classify problems according to various complexity measures
- knowledge of relations between different machine models and complexity measures
- understanding of the terms diagonalisation, simulation, configuration graph, reductions and completeness, relativisation, and logical characterisation

Grading through:

- Exercises
- Oral examination

Requires:

- Algorithmics (CS4000)

Responsible for this module:

- Prof. Dr. Rüdiger Reischuk

Teacher:

- Institute for Theoretical Computer Science

- Prof. Dr. Rüdiger Reischuk
- Prof. Dr. rer. nat. Till Tantau

Literature:

- :
- :
- :
- :
- :

Language:

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

CS4018 - Computer Algebra (CompAlgebr)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Master CLS (optional suject), computer science, arbitrary semester
- Master Computer Science before 2014 (optional subject), advanced curriculum algorithmics and complexity theory, 2nd or 3rd semester

Classes and lectures:

- Computer Algebra (lecture with exercises, 3 SWS)

Workload:

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

Contents of teaching:

-
-
- Polynome, Matrizen
- Multiplikationsalgorithmen, FFT, DFT
- Gr
- formale Differentiation und

Qualification-goals/Competencies:

-
-
-
-

Grading through:

- exercises and project assignments
- Oral examination

Requires:

- Algorithmics (CS4000)

Responsible for this module:

- Prof. Dr. Rüdiger Reischuk

Teacher:

- Institute for Theoretical Computer Science

- Prof. Dr. Rüdiger Reischuk

Literature:

- :
- :

Language:

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

CS4020 - Specification and Modelling (SpezMod)

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

Course of study, specific field and term:

- Master CLS (optional subject), computer science, arbitrary semester
- Master Computer Science before 2014 (compulsory), computer science mandatory courses, 1st semester

Classes and lectures:

- Specification and Modelling (lecture, 2 SWS)
- Specification and Modelling (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to modelling and specification
- Modelling concepts (data, streams, traces, diagrams, tables)
- Modelling software components (state, behaviour, structure, interface)
- Modelling concurrency
- Algebraic specification
- Composing, refining, analysing and transforming specifications and models
- Specification languages and tools for specification and modelling

Qualification-goals/Competencies:

- The students can argue on the importance of specifications and models for software development.
- Sie können wichtige Spezifikations- und Modellierungstechniken charakterisieren, anwenden, anpassen und erweitern.
- They can model and specify simple software/hardware system in an adequate way.
- They can describe a system from different views and on different levels of abstraction.
- They can apply specifications and modelsin software development.

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. Martin Leucker

Teacher:

- Institute of Software Technology and Programming Languages

- Dr. Annette Stümpel
- Prof. Dr. Martin Leucker

Literature:

- V.S. Alagar, K. Periyasamy: Specification of Software Systems - Springer 2011
- M. Broy, K. Stølen: Specification and Development of Interactive Systems - Springer 2001
- J. Loeckx, H.-D. Ehrich, M. Wolf: Specification of Abstract Data Types - John Wiley & Sons 1997
- D. Bjorner: Software Enginneering 1-3 - Springer 2006
- U. Kastens, H. Kleine Büning: Modellierung - Grundlagen und formale Methoden - Hanser 2005

Language:

- German and English skills required

CS4330-KP04, CS4330 - Image Analysis and Visualization in Diagnostics and Therapy (BAVIS)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each summer semester	4	99

Course of study, specific field and term:

- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 2nd semester
- Master CLS (optional suject), computer science, arbitrary semester
- Master Computer Science before 2014 (compulsory), specialization field medical informatics, 2nd semester
- Master MES since 2014 (optional subject), Medical Engineering Science, 1st or 2nd semester

Classes and lectures:

- Image Analysis and Visualization Systems in Diagnostics and Therapy (lecture, 2 SWS)
- Image Analysis and Visualization Systems in Diagnostics and Therapy (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Methods and algorithms for the analysis and visualization of medical images including current research activities in the field of medical image computing. The following methods and algorithms are explained:
- Data driven segmentation of multispectral image data
- Random Decision Forests for the segmentation of medical image data
- Convolutional Neural Networks and Deep Learning in Medical Image Processing
- live wire segmentation
- segmentation with active contour models and deformable models
- level set segmentation
- statistical shape models
- image registration
- atlas-based segmentation and multi atlas segmentation using non-linear registration
- visualization techniques in medicine
- direct volume rendering
- indirect volume rendering, ray tracing, ray casting
- haptic 3D interactions in virtual bodies
- virtual reality techniques in medical applications

Qualification-goals/Competencies:

- Increase knowledge in medical image processing and visualization
- Knowledge of the individual steps of pattern recognition
- Understanding of the underlying algorithms
- Ability to select appropriate methods for a given problem
- Implementation of the methods
- Application to practical problems
- Overview of medical image processing techniques with many examples

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Image and Signal Processing in Medicine 1 (CS3310-INF)

Responsible for this module:

- Prof. Dr. rer. nat. habil. Heinz Handels

Teacher:

- Institute of Medical Informatics

- Prof. Dr. rer. nat. habil. Heinz Handels

Literature:

- H. Handels: Medizinische Bildverarbeitung - 2. Auflage, Vieweg u. Teubner 2009
- T. Lehmann: Handbuch der Medizinischen Informatik - München: Hanser 2005
- M. Sonka, V. Hlavac, R. Boyle: Image Processing, Analysis and Machine - 2nd edition. Pacific Grove: PWS Publishing 1998
- B. Preim, D. Bartz: Visualization in Medicine - Elsevier, 2007

Language:

- offered only in German

CS4385-KP08, CS4385 - Autonomous Learning Agents (ALA)

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

Course of study, specific field and term:

- Master CLS (optional subject), computer science, 1st or 2nd semester
- Master Robotics and Autonomous Systems (optional subject), computer science, 1st or 2nd semester
- (optional subject), computer science, 1st or 2nd semester

Classes and lectures:

- See CS4385 T: Autonomous Learning Agents (lecture, 4 SWS)
- See CS4385 T: Autonomous Learning Agents (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- Rational autonomous agents as a formal basis for the design of information retrieval and robotic systems
- Repetition of stochastics and generative models for discrete data, Gauss-models and their application for information retrieval, vector space model with probabilistic information retrieval
- Dynamic graphical probability models (dynamic Bayesian netzworks, Markov assumptions, state transition and sensor models, computational Problems, such as filtering, prediction, smoothing, most probable state sequence), hidden-Markov-models, kalman filter, conditional random field, exact and approximate methods for the solution of computational problems, automatic Determination of Parameters and structure of dynamic graphical probability models. Application: POS-tagging, semantic annotation
- Mixed models, latent linear models (LDA, LSI, PCA). Application: Determination of themes, multimedia Interpretation for web search (identification of known entities, elimination of duplicates, interpretation of content, probabilistic Evaluation of interpretations, link analysis, network analysis)
- Generation of plans, decision making under uncertainty: utilitarism, decision networks, value of information, sequential decision making problems and algorithms (value-iteration, strategy-iteration), Markov decision problems (MDPs), decision theoretically constructed agents, Markov decision making problems with partial observability (POMDP), dynamic decision networks, parameter- and structure determination via repeated amplification (reinforcement learning). Application: Determination of dynamic information search plans
- Interaction of agents: game theory, decisions and Actions of multiple agents (Nash equilibrium, Bayes-Nash equilibrium), social decisions (elections, preferences, paradoxes, Arrow's Theorem), mechanisms, design of mechanisms (controlled autonomy), bilateral mechanisms: Rules of encounter. Application: Exchange of interpretations between search agents.
- First order probabilistic logic, probabilistic doxastic temporal logic. Application: Design and exchange of symbolic annotations and interpretations for multimodal web data, association of information and search, response to requests and generation of recommendations

Qualification-goals/Competencies:

- Knowledge:
- Students are able to explain the agent abstraction and the application of information retrieval in the web (web mining) as rational behaviour.
- Students are able to explain details of the architecture of mining agents (goals, utility, environment). Students are able to discuss cooperative and non-cooperative agents in the context of decision making.
- Students are able to explain the relevant tools for representation (e.g. Bayesian networks) and algorithms for the computation of static and dynamic Scenarios, in order to equip agents with the ability to cope with uncertainty during information retrieval in real world scenarios.
- Students are able to explain techniques for the automatic computation of employed representations and models.
- Students are able to describe and design decision making processes for simple and sequential contests, in order to equip agents with decision making competences (e.g. to determine further search options within the web). Thus, Scenarios can be handled, in which agents have full or partial access to the state of the context system and may estimate the value of information that may be possible to acquire for specificied tasks.
- The students have Knowledge to explain classical and modern techniques for the effective accumulation of unstructured data with symbolic descriptions (interpretation of multimedia Contents, annotation)
- Skills:
- Students are able to select representatins and forms of cooperation for subprocesses and agents for the design of web search and robotic systems.
- Based on multimodal data, students are able to design mining systems to evaluate explicitly defined units of data (text documents, relational data, pictures, videos) for the purpose of returning a symbolic, summarizing description.

- Students are able to design competition-based systems with autonomous agents, constructed by various parties. The interaction or cooperation of web mining agents then generates mutual benefit.
- Students are able to treat problems of coordination and decision making in multi-agent scenarios via consensus protocols.
- Social skills and self-reliance:
- The participants practice cooperative programming: They are able to explain problems to their partner and develop Solutions.
- The students communicate in english.
- Via online-quizzes and supplementary material for self-study, students are able to evaluate and increase their knowledge continuously.
- The students' work on exercise problems allows to practice giving feedback.

Grading through:

- exercises and project assignments
- exam type depends on main module

Requires:

- Statistics 1 (PY1800-KP06)
- Stochastics 1 (MA2510-KP04, MA2510)
- Databases (CS2700-KP04, CS2700)
- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)
- Algorithms and Data Structures (CS1001-KP08, CS1001)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- D. Koller, N. Friedman: Probabilistic Graphical Models: Principles and Techniques - MIT Press, 2009
- Chr. Manning, P. Raghavan, H. Schütze: Introduction to Information Retrieval - Cambridge University Press. 2008
- K. Murphy: Machine Learning: A Probabilistic Perspective - MIT Press, 2012
- S. Russel, P. Norvig: Artificial Intelligence: A Modern Approach - Pearson Education, 2010
- Y. Shoham, K. Leyton-Brown: Multiagent-Systems: Algorithmic, Game-Theoretic, and Logical Foundations - Cambridge University Press, 2009

Language:

- offered only in English

CS4405-KP04, CS4405 - Neuroinformatics (NeuroInf)

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

Course of study, specific field and term:

- Master CLS starting 2016 (compulsory), computer science, 2nd semester
- Master Robotics and Autonomous Systems (optional subject), computer science, 1st or 2nd semester
- Master MES since 2014 (optional subject), computer science and electrical engineering, arbitrary semester
- Master MES before 2014 (optional subject), mathematics, 2nd semester
- Bachelor MES before 2014 (optional subject), optional subject medical engineering science, 6th semester
- Master Computer Science before 2014 (optional subject), advanced curriculum organic computing, 2nd or 3rd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 2nd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester
- Master Computer Science before 2014 (compulsory), specialization field robotics and automation, 2nd semester
- Master Computer Science before 2014 (compulsory), specialization field bioinformatics, 2nd semester
- Master CLS (compulsory), computer science, 2nd semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- The human brain and abstract neuron models
- Learning with a single neuron:* Perceptrons* Max-Margin Classification* LDA and logistic Regression
- Network architectures:* Hopfield-Networks* Multilayer-Perceptrons* Deep Learning
- Unxupervised Learning:* k-means, Neural Gas and SOMs* PCA & ICA* Sparse Coding

Qualification-goals/Competencies:

- The students are able to understand the principle function of a single neuron and the brain as a whole.
- They know abstract neuronal models and they are able to name practical applications for the different variants.
- They are able to derive a learning rule from a given error function.
- They are able to apply (and implement) the proposed learning rules and approaches to solve unknown practical problems.

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Martinetz

Teacher:

- Institute for Neuro- and Bioinformatics

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

Literature:

- S. Haykin: Neural Networks - London: Prentice Hall, 1999
- J. Hertz, A. Krogh, R. Palmer: Introduction to the Theory of Neural Computation - Addison Wesley, 1991
- T. Kohonen: Self-Organizing Maps - Berlin: Springer, 1995
- H. Ritter, T. Martinetz, K. Schulten: Neuronale Netze: Eine Einführung in die Neuroinformatik selbstorganisierender Netzwerke - Bonn: Addison Wesley, 1991

Language:

- offered only in German

CS4440-KP04, CS4440 - Molecular Bioinformatics (MolBioInfo)

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

Course of study, specific field and term:

- Master CLS starting 2016 (optional subject), computer science, 3rd semester
- Master MES before 2014 (advanced curriculum), biophysics and biomedical optics, 2nd semester
- Master CLS (optional subject), computer science, 1st or 3rd semester
- Master Computer Science before 2014 (compulsory), specialization field bioinformatics, 1st semester

Classes and lectures:

- Molecular Bioinformatics (lecture, 2 SWS)
- Molecular Bioinformatics (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Methods for fast genome comparison
- Analysis of data describing gene expression profiles and sequence variation
- Advanced usage of biological databases (for sequences, motifs, structures, gene regulation and interactions)

Qualification-goals/Competencies:

- The students can apply indexing based software to Next Generation sequence data.
- They can use and design databases for molecularbiological research.
- They are able to detect statistically significant changes in Microarray data.

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Requires:

- Introduction to Bioinformatics (CS1400-KP04, CS1400)

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Martinetz

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr. Bernhard Haubold
- Prof. Dr. rer. nat. Thomas Martinetz
- MitarbeiterInnen des Instituts

Literature:

- M. S. Waterman: Introduction to Computational Biology - London: Chapman and Hall 1995
- B. Haubold, T. Wiehe: Introduction to Computational Biology - Birkhäuser 2007
- R. Durbin, S. Eddy, A. Krogh, G. Mitchison: Biological sequence analysis. Probabilistic models - Cambridge, MA: Cambridge University Press
- J. Setubal, J. Meidanis: Introduction to computational molecular - Pacific Grove: PWS Publishing Company
- D. M. Mount: Bioinformatics - Sequence and Genome - New York: Cold Spring Harbor Press

Language:

- offered only in German

CS4513-KP12, CS4513 - Web and Data Science (WebScience)

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

Course of study, specific field and term:

- Master CLS (optional subject), computer science, arbitrary semester
- Master Entrepreneurship in Digital Technologies (advanced module), technology field computer science, 2nd or 3rd semester
- Master Computer Science since 2014 (advanced module), advanced curriculum, 2nd or 3rd semester

Classes and lectures:

- CS5130 T: Foundations of Ontologies and Databases for Information Systems (lecture with exercises, 3 SWS)
- CS5131 T: Web Mining Agents (lecture with exercises, 6 SWS)

Workload:

- 180 Hours private studies
- 135 Hours in-classroom work
- 45 Hours exam preparation

Contents of teaching:

- The term Web and Data Science refers to the study of the connection between data on the web and associated web services for the benefit of humans. Phenomena of technical, economic and social contexts of a system design perspective are examined so that web and data analysis drive new applications for people.
- Web and Data Science introduces the basics of the analysis and design of large networked information systems. The lack of a global control for distributed data (with different structure) and the lack of formal structure is an essential element we investigate in this module.
- The modules sets out how autonomous units can analyze data in a controlled cooperation scenario such that data can become information for humans and formally defined requirements are met.
- For more information see the module parts.

Qualification-goals/Competencies:

- Students will gain in-depth knowledge, solid skills and extensive expertise in the field of information systems, so that, for example, latest achievements of Web search engines can be exploited (see, e.g., Google Knowledge Vault), and students can successfully work in research projects as well as practical projects in industry.
- For more information see the module parts.

Grading through:

- exercises and project assignments
- Oral examination

Responsible for this module:

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

Teacher:

- Institute of Information Systems

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

Language:

- offered only in English

Notes:

A combination with the advance IFIS module Data Management (CS4508) is useful for studying aspects of distributed and mobile data management, and for performing complementary practical work in the field of parallel processing of large data volumes. In contrast to the mobile-data assumption in Data Management, it is assumed in Web and Data Science that rather than data, interpretation processes are mobile in the form of agents. Agents have the task to autonomously determine and integrate a high-level data interpretation which is ultimately communicated to a user process.

Other complementary advanced modules such as Internet Technologies or Learning Systems offer interesting perspectives as well.

This module will be replaced by CS4514-KP12 Intelligent Agents.

CS5130 T - Module part: Foundations of Ontologies and Databases for Information Systems (OntoDBa)

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

Course of study, specific field and term:

- Master CLS (module part), computer science, arbitrary semester
- Master Entrepreneurship in Digital Technologies (module part), module part, arbitrary semester
- Master Computer Science since 2014 (module part), module part, arbitrary semester

Classes and lectures:

- Foundations of Ontologies and Databases in Information Systems (lecture, 2 SWS)
- Foundations of Ontologies and Databases in Information Systems (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Fundamentals of databases, conceptual modeling languages (ontologies), query languages, processes, and agents
- Ontology based data access (OBDA)
- Ontology evolution and ontology integration
- Data exchange and data integration (schema mappings, duplicate detection, inconsistency handling, integration with relational and ontological constraints as well as with incomplete data)
- Data stream processing (e.g., for sensor networks, robotics, web agents) with OBDA and complex event processing (CEP)
- Non-symbolic data and their symbolic annotations (e.g., for applications in bioinformatics/computational biology and for media interpretation), syntax, semantics, hybrid decision and computation problems and their complexity, (analysis of) algorithms
- Data- and ontology-oriented process analysis (e.g., for biological pathways) and process design (e.g., for non-trivial business processes)

Qualification-goals/Competencies:

- Knowledge: The module aims at introducing the students to the formal basics of databases and ontologies, so that they get an overview of concepts, methods, and theories for understanding, analyzing, and designing information systems in open large contexts, such as the web.
- Skills: The students get a basic understanding of logical and formal methods, which allows them to assess the possibilities and limitations of information systems, be it concrete ones or those that still have to be designed. Assessment parameters are correctness and completeness (Does the system produce what is expected? If so, does it produce all results?) as well as expressiveness (Is it possible to formulate all required queries? What are equivalent query languages?) and, last but not least, performance (How long does it take the system to come up with an answer? How much space does it need?). In addition to these analysis skills, students receive logical modeling skills using real application scenarios from industry (business processing, integration of data resources, processing of time-based and event data), and medicine (sensor networks, genomic ontologies, annotation). Based on these, the student not only acquires the ability to assess which logical model is suitable for which application scenario, but also the ability to construct their own logical models where necessary.
- Social Competence und Independent Work: Students work in groups to solve small exercises and project problems and sketch their solutions in short presentations. Independent work is promoted by exercises with practical ontology and database systems.

Grading through:

- exercises and project assignments
- exam type depends on main module

Is requisite for:

- Web-Mining Agents (CS5131-KP08, CS5131)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Information Systems

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

Literature:

- S. Abiteboul, R. Hull, V. Vianu: Foundations of Databases - Addison-Wesley, 1995
- M. Arenas, P. Barcelo, L. Libkin, and F. Murlak: Foundations of Data Exchange - Cambridge University Press, 2014
- F. Baader, D. Calvanese, D.L. McGuinness, D. Nardi, and P.F. Patel-Schneider (Eds.): The Description Logic Handbook: Theory, Implementation, and Applications - Cambridge University Press, 2010
- S. Chakravarthy, Q. Jiang: Stream Data Processing A Quality of Service Perspective - Springer, 2009
- L. Libkin: Elements Of Finite Model Theory (Texts in Theoretical Computer Science. An Eatcs Series) - SpringerVerlag, 2004

Language:

- offered only in English

Notes:

Prerequisites for this module are:
- Algorithm and Data Structures (CS1001)
- Linear Algebra and Discrete Structures I+II (MA1000, MA1500)
- Databases (CS2700)

Recommended additional modules:
- Logic (CS1002)
- Bachelor Project Computer Science (CS3701), topic: logic programming
- Nonstandard Database Systems (CS3202)

CS5130-KP04, CS5130 - Foundations of Ontologies and Databases for Information Systems (OntoDB)

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

Course of study, specific field and term:

- Master CLS (optional subject), computer science, arbitrary semester
- Master Media Informatics (optional subject), computer science, arbitrary semester
- Master Medical Informatics (optional subject), ehealth / infomatics, 1st or 2nd semester

Classes and lectures:

- Foundations of Ontologies and Databases in Information Systems (lecture, 2 SWS)
- Foundations of Ontologies and Databases in Information Systems (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Fundamentals of databases, conceptual modeling languages (ontologies), query languages, processes, and agents
- Ontology based data access (OBDA)
- Ontology evolution and ontology integration
- Data exchange and data integration (schema mappings, duplicate detection, inconsistency handling, integration with relational and ontological constraints as well as with incomplete data)
- Data stream processing (e.g., for sensor networks, robotics, web agents) with OBDA and complex event processing (CEP)
- Non-symbolic data and their symbolic annotations (e.g., for applications in bioinformatics/computational biology and for media interpretation), syntax, semantics, hybrid decision and computation problems and their complexity, (analysis of) algorithms
- Data- and ontology-oriented process analysis (e.g., for biological pathways) and process design (e.g., for non-trivial business processes)

Qualification-goals/Competencies:

- Knowledge: The module aims at introducing the students to the formal basics of databases and ontologies, so that they get an overview of concepts, methods, and theories for understanding, analyzing, and designing information systems in open large contexts, such as the web.
- Skills: The students get a basic understanding of logical and formal methods, which allows them to assess the possibilities and limitations of information systems, be it concrete ones or those that still have to be designed. Assessment parameters are correctness and completeness (Does the system produce what is expected? If so, does it produce all results?) as well as expressiveness (Is it possible to formulate all required queries? What are equivalent query languages?) and, last but not least, performance (How long does it take the system to come up with an answer? How much space does it need?). In addition to these analysis skills, students receive logical modeling skills using real application scenarios from industry (business processing, integration of data resources, processing of time-based and event data), and medicine (sensor networks, genomic ontologies, annotation). Based on these, the student not only acquires the ability to assess which logical model is suitable for which application scenario, but also the ability to construct their own logical models where necessary.
- Social Competence und Independent Work: Students work in groups to solve small exercises and project problems and sketch their solutions in short presentations. Independent work is promoted by exercises with practical ontology and database systems.

Grading through:

- exercises and project assignments
- written exam

Is requisite for:

- Web-Mining Agents (CS5131-KP08, CS5131)

Responsible for this module:

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

Teacher:

- Institute of Information Systems

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

Literature:

- S. Abiteboul, R. Hull, V. Vianu: Foundations of Databases - Addison-Wesley, 1995
- M. Arenas, P. Barcelo, L. Libkin, and F. Murlak: Foundations of Data Exchange - Cambridge University Press, 2014
- F. Baader, D. Calvanese, D.L. McGuinness, D. Nardi, and P.F. Patel-Schneider (Eds.): The Description Logic Handbook: Theory, Implementation, and Applications - Cambridge University Press, 2010
- S. Chakravarthy, Q. Jiang: Stream Data Processing A Quality of Service Perspective - Springer, 2009
- L. Libkin: Elements Of Finite Model Theory (Texts in Theoretical Computer Science. An Eatcs Series) - SpringerVerlag, 2004

Language:

- offered only in English

Notes:

Prerequisites for this module are:
- Algorithm and Data Structures (CS1001)
- Linear Algebra and Discrete Structures I+II (MA1000, MA1500)
- Databases (CS2700)

Recommended additional modules:
- Logic (CS1002)
- Bachelor Project Computer Science (CS3701), topic: logic programming
- Nonstandard Database Systems (CS3202)

CS5131-KP08, CS5131 - Web-Mining Agents (WebMining)

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

Course of study, specific field and term:

- Master CLS (optional subject), computer science, arbitrary semester
- Master Media Informatics (optional subject), computer science, arbitrary semester
- Master Medical Informatics (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master Medical Informatics since 2019 in planing (optional subject), ehealth / infomatics, 1st or 2nd semester

Classes and lectures:

- Web-Mining Agents (lecture, 4 SWS)
- Web-Mining Agents (Excercises with project, 2 SWS)

Workload:

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

Contents of teaching:

- Probabilities and generative models for discrete data
- Gaussian models, Bayesian and frequentist statistics, regression,
- Probabilistic graphical models (e.g., Bayesian networks), learning parameters and structures of probabilistic graphical models (BMA, MAP, ML, EM algorithm), probabilistic classification, probabilistic relational models
- Probabilistic reasoning over time (dynamic Bayesian networks, Markov assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation, hidden Markov models, Kalman filters, exact inferences and approximations, learning dynamic Bayesian networks)
- Mixture models, latent linear models (LDA, LSI, PCA), sparse linear models,
- Decision tree and version space acquisition from data streams, ensemble learning
- Decision making under uncertainty (utility theory, decision networks, value of information, sequential decision problems, value iteration, policy iteration, MDPs, decision-theoretic agents, POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks, Reinforcement learning)
- Clustering: distance measures, k-means clustering, nearest neighbor clustering
- Game theory, decisions with multiple agents (Nash equilibrium, Bayes-Nash equilibrium), social choice (voting, preferences, paradoxes, Arrow's Theorem, mechanism design (controlled autonomy), rules of encounter
- Multimedia interpretation for web (re-)search (named entity recognition, duplicate elimination, probabilistic ranking of interpretations, link analysis (e.g., citations), social network analysis)
- Building and exchanging symbolic annotations for web data (Google: from strings to things)
- Information association and retrieval, query answering and recommendation

Qualification-goals/Competencies:

- Knowledge: Students can explain the agent abstraction, define web mining of rational behavior, and give details about the design of mining agents (goals, utilities, environments). The notion of adversarial agent cooperation can be discussed in terms of decision problems and algorithms for solving these problems. For dealing with uncertainty in real-world scenarios, students can summarize how Bayesian networks can be employed as a knowledge representation and reasoning formalism in static and dynamic settings. In addition, students can define decision making procedures in simple and sequential settings, with and without complete access to the state of the environment. In this context, students can describe techniques for solving (partially observable) Markov decision problems, and they can recall techniques for measuring the value of information. Students can explain coordination problems and decision making in a multi-agent setting in terms of different types of equilibria, social choice functions, voting protocol, and mechanism design techniques. Students can explain the difference between instance-based and model-based learning approaches for data analysis, and they can enumerate basic machine learning technique for each of the two basic approaches, either on the basis of static data, or on the basis of incrementally incoming data. For dealing with uncertainty, students can describe suitable representation formalisms, and they explain how axioms, features, parameters, or structures used in these formalisms can be learned automatically with different algorithms (deep learning for data analysis). Students are also able to sketch different clustering techniques. They depict how the performance of learned classifiers can be improved by ensemble learning, and they can summarize how this influences computational learning theory. Algorithms for reinforcement learning can also be explained by students.
- Skills: Students can select an appropriate agent architecture for concrete agent data analysis application scenarios. For simplified data analysis applications, such as information retrieval, students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesian networks/dynamic Bayesian networks and apply bayesian reasoning for simple queries. Students can also apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situations students are able to apply techniques for finding different equilibria states, e.g., Nash equilibria. For multi-agent decision making students will apply different voting

protocols and compare and explain the results.Students derive decision trees and, in turn, propositional rule sets from static data as well and temporal or streaming data. Students present and apply the basic idea of first-order inductive leaning. They apply the BMA, MAP, ML, and EM algorithms for learning parameters of Bayesian networks and compare the different algorithms. They are also able to carry out Gaussian mixture learning. Students can describe basic clustering techniques and explain the basic components of those techniques. Students compare related machine learning techniques, e.g., k-means clustering and nearest neighbor classification. They can distinguish various ensemble learning techniques and compare the different goals of those techniques.
- Social skills (social competence, self dependence): Students practice peer programming. They explain problems and solutions to their peer. They communicate in English. Using on-line quizzes and accompanying material for self study, students can assess their competence level continuously and adjust it appropriately. Working on exercise problems, they receive additional feedback.

Grading through:

- exercises and project assignments
- written exam

Responsible for this module:

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

Teacher:

- Institute of Information Systems

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

Literature:

- M. Hall, I. Witten and E. Frank: Data Mining: Practical Machine Learning Tools and Techniques - Morgan Kaufmann, 2011
- D. Koller, N. Friedman: Probabilistic Graphical Models: Principles and Techniques - MIT Press, 2009
- K. Murphy: Machine Learning: A Probabilistic Perspective - MIT Press, 2012
- S. Russel, P. Norvig: Artificial Intelligence: A Modern Approach - Pearson Education, 2010
- Y. Shoham, K. Leyton-Brown: Multiagent-Systems: Algorithmic, Game-Theoretic, and Logical Foundations - Cambridge University Press, 2009

Language:

- offered only in English

Notes:

Prerequisites for this module are:
- Algorithm and Data Structures (CS1001)
- Linear Algebra and Discrete Structures I+II (MA1000, MA1500)
- Databases (CS2700)
- Stochastics (MA2510) or Statistics (PY1800)

Recommended additional modules:
- Logic (CS1002)
- Artificial Intelligence (CS3204)
- Bachelor Project Computer Science (CS3701), topic: logic programming
- Foundations of Ontologies and Databases for Information Systems (SC5130)
- Web-based Information Systems (CS4130)

CS5150-KP04, CS5150 - Organic Computing (OrganicCom)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master Medical Informatics since 2019 in planing (optional subject), bioinformatics, 1st or 2nd semester
- Master Medical Informatics (optional subject), bioinformatics, 1st or 2nd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum parallel and distributed system architecutres, 2nd or 3rd semester
- Master CLS (optional subject), computer science, arbitrary semester
- Master Computer Science before 2014 (compulsory), advanced curriculum organic computing, 2nd or 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field robotics and automation, 3rd semester

Classes and lectures:

- Organic Computing (lecture, 2 SWS)
- Organic Computing (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Basic principles of Organic Computing
- Self-organization and emergence
- Architecture and design of Organic Computing systems
- Organic Computing for distributed systems
- Organic Computing in Neuro- and Bionformatics
- Organic Grid
- Autonomous Systems

Qualification-goals/Competencies:

- Students are able to utilize the principles of organic computing on exemplary designs.
- They are able to explain the principles of Organic Computing.
- They are able to analyze emergence behavior in Organic Computing systems.

Grading through:

- Oral examination
- written exam

Responsible for this module:

- Prof. Dr.-Ing. Heiko Hamann

Teacher:

- Institute of Computer Engineering
- Prof. Dr.-Ing. Heiko Hamann

Literature:

- C. Müller-Schloer, H. Schmeck, T. Ungerer: Organic Computing A Paradigm Shift for Complex Systems - Birkhäuser, 2011
- R. P. Würtz: Organic Computing - Springer, 2008
- C. Klüver, J. Kluever, J. Schmidt: Modellierung komplexer Prozesse durch naturanaloge Verfahren - Springer Vieweg 2012

Language:

- offered only in German

CS5260-KP04, CS5260SJ14 - Speech and Audio Signal Processing (SprachAu14)		
Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	every second semester	4

Course of study, specific field and term:

- Master Auditory Technology (optional subject), Auditory Technology, 1st or 2nd semester
- Master MES since 2014 (optional subject), Medical Engineering Science, arbitrary semester
- Master CLS (optional suject), computer science, arbitrary semester
- Master Medical Informatics (optional subject), computer science, 1st or 2nd semester
- Master Media Informatics (optional subject), computer science, arbitrary semester
- Master Medical Informatics since 2019 in planing (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester

Classes and lectures:

- Speech and Audio Signal Processing (lecture, 2 SWS)
- Speech and Audio Signal Processing (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Speech production and human hearing
- Physical models of the auditory System
- Dynamic compression
- Spectral analysis: Spectrum and cepstrum
- Spectral perception and masking
- Vocal tract models
- Linear prediction
- Coding in time and frequency domains
- Speech synthesis
- Noise reduction and echo compensation
- Source localization and spatial reproduction
- Basics of automatic speech recognition

Qualification-goals/Competencies:

- Students are able to describe the basics of human speech production and the corresponding mathematical models.
- They are able to describe the process of human auditory perception and the corresponding signal processing tools for mimicing auditory perception.
- They are able to present basic knowledge of statistical speech modeling and automatic speech recognition.
- They can describe and use signal processing methods for source separation and room-acoustic measurements.

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing

- Prof. Dr.-Ing. Alfred Mertins

Literature:

- L. Rabiner, B.-H. Juang: Fundamentals of Speech Recognition - Upper Saddle River: Prentice Hall 1993
- J. O. Heller, J. L. Hansen, J. G. Proakis: Discrete-Time Processing of Speech Signals - IEEE Press

Language:

- offered only in German

Notes:

Prerequisites are exercises. These must have been done and graded before the first exam.

Mentioned in SGO MML under CS5260 (without SJ14).

CS5275-KP04, CS5275 - Selected Topics of Signal Analysis and Enhancement (AMSAV)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second semester	4

Course of study, specific field and term:

- Master Medical Informatics since 2019 in planing (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester
- Master MES since 2014 (optional subject), Medical Engineering Science, arbitrary semester
- Master Medical Informatics (optional subject), medical image processing, 1st or 2nd semester
- Master CLS (optional subject), computer science, arbitrary semester
- Master Computer Science before 2014 (optional subject), specialization field bioinformatics, 3rd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 1st or 2nd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester

Classes and lectures:

- Selected Topics of Signal Analysis and Enhancement (lecture, 2 SWS)
- Selected Topics of Signal Analysis and Enhancement (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to statistical signal analysis
- Autocorrelation and spectral estimation
- Linear estimators
- Linear optimal filters
- Adaptive filters
- Multichannel signal processing, beamforming, and source separation
- Compressed sensing
- Basic concepts of multirate signal processing
- Nonlinear signal processing algorithms
- Application scenarios in auditory technology, enhancement, and restauration of one- and higher-dimensional signals, Sound-field measurement, noise reduction, deconvolution (listening-room compensation), inpainting

Qualification-goals/Competencies:

- Students are able to explain the basic elements of stochastic signal processing and optimum filtering.
- They are able to describe and apply linear estimation theory.
- Students are able to describe the concepts of adaptive signal processing.
- They are able to describe and apply the concepts of multichannel signal processing.
- They are able to describe the concept of compressed sensing.
- They are able to analyze and design multirate systems.
- Students are able to explain various applications of nonlinear and adaptive signal processing.
- They are able to create and implement linear optimum filters and nonlinear signal enhancement techniques on their own.

Grading through:

- Exercises
- Written or oral exam as announced by the examiner

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
- S. Haykin: Adaptive Filter Theory - Prentice Hall, 1995

Language:

- German and English skills required

CS5430 - Seminar Machine Learning (SemMaschL)

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

Course of study, specific field and term:

- Master CLS (optional subject), computer science, arbitrary semester
- Master Computer Science before 2014 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field bioinformatics, 3rd semester

Classes and lectures:

- Seminar Machine Learning (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Independent study of a specific field of machine learning

Qualification-goals/Competencies:

- The students are able to read and understand scientific publications in the field of machine learning.
- They are able to present orally and in a written paper the content of scientific publications in the field of machine learning.

Grading through:

- oral presentation
- term paper

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Martinetz

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr. rer. nat. Thomas Martinetz
- Prof. Dr.-Ing. Erhardt Barth
- MitarbeiterInnen des Instituts

Language:

- German and English skills required

CS5440-KP04, CS5440 - Seminar Neuro- and Bioinformatics (SemNeurBio)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master Computer Science before 2014 (optional subject), specialization field bioinformatics, 3rd semester
- Master CLS (optional subject), computer science, arbitrary semester
- Master Biophysics (optional subject), Elective, 1st or 2nd semester

Classes and lectures:

- Seminar Neuro- and Bioinformatics (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Introduce students to a current research topic in Neuro- and Bioinformatics

Qualification-goals/Competencies:

- The students are able to read and understand scientific publications in the field of neuro- uand bioinformatics.
- They are able to present orally and in a written paper the content of scientific publications in the field of neuro- and bioinformatics.
- They can master basic scientific methodology.
- They can summarize a scientific topic in written form.
- They can give an intelligible and concise oral presentation of a current research topic.
- They have communication competency to discuss a current research topic.

Grading through:

- oral presentation
- term paper

Responsible for this module:

- Prof. Dr.-Ing. Erhardt Barth
- Prof. Dr. rer. nat. Thomas Martinetz

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr. rer. nat. Thomas Martinetz
- Prof. Dr.-Ing. Erhardt Barth
- MitarbeiterInnen des Instituts

Language:

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

CS5450-KP04, CS5450 - Machine Learning (MaschLern)

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

Course of study, specific field and term:

- Master Auditory Technology (optional subject), computer science, 1st semester
- Master CLS starting 2016 (optional subject), computer science, 3rd semester
- Master MES since 2014 (optional subject), computer science and electrical engineering, arbitrary semester
- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 1st or 2nd semester
- Master Medical Informatics (optional subject), computer science, 1st or 2nd semester
- Master CLS (optional suject), computer science, arbitrary semester
- Master Computer Science before 2014 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field bioinformatics, 3rd semester
- Master Medical Informatics since 2019 in planing (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester

Classes and lectures:

- Machine Learning (lecture, 2 SWS)
- Machine Learning (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Representation learning, including manifold learning
- Statistical learning theory
- VC dimension and support vector machines
- Boosting
- Deep learning
- Limits of induction and importance of data ponderation

Qualification-goals/Competencies:

- Students can understand and explain various machine-learning problems.
- They can explain and apply different machine learning methods and algorithms.
- They can chose and then evaluate an appropriate method for a particular learning problem.
- They can understand and explain the limits of automatic data analysis.

Grading through:

- Exercises
- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Erhardt Barth

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr.-Ing. Erhardt Barth
- Prof. Dr. rer. nat. Thomas Martinetz

Literature:

- Chris Bishop: Pattern Recognition and Machine Learning - Springer ISBN 0-387-31073-8
- Vladimir Vapnik: Statistical Learning Theory - Wiley-Interscience, ISBN 0471030031

Language:

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

Notes:

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

MA4640 - Sampling in der Signalanalyse (SampSignal)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4 (Typ B)

Course of study, specific field and term:

- Bachelor CLS (optional suject), mathematics, 5th or 6th semester
- Master MES before 2014 (optional subject), mathematics, 1st or 2nd semester
- Master CLS (optional subject), computer science, arbitrary semester

Classes and lectures:

- Sampling-Verfahren in der Signalanalyse (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Hilberträume, Basen und Frames
- Endliches und Unendliches Sampling
- Anwendungen auf lineare gewöhnliche Differentialgleichungen
- Multi-band und Multi-channel Sampling
- Sampling und Eigenwert-Probleme

Qualification-goals/Competencies:

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-
-

Grading through:

- oral presentation
- Written report
- participation in discussions

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Jürgen Prestin

Language:

- offered only in German

LS2000-MML - Biochemistry 1 (Bioche1MML)

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

Course of study, specific field and term:

- Master CLS (optional subject), computational life science / life sciences, 1st or 3rd semester

Classes and lectures:

- Biochemistry 1 (lecture, 4 SWS)

Workload:

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

Contents of teaching:

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

Qualification-goals/Competencies:

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

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Rolf Hilgenfeld

Teacher:

- Institute of Biochemistry

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

Literature:

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

Language:

- offered only in English

Notes:

Compulsory elective subject for students specializing in life science

LS2300-KP08, LS2301 - Biophysical Chemistry (BPCKP08)

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

Course of study, specific field and term:

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

Classes and lectures:

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

Workload:

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

Contents of teaching:

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

Qualification-goals/Competencies:

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

Grading through:

- written exam

Requires:

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

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Chemistry and Metabolomics

- Prof. Dr. rer. nat. Thomas Peters
- PD Dr. phil. nat. Thomas Weimar

Literature:

- Peter Atkins and Julio de Paula: Physical Chemistry for the Life Sciences - Oxford, University Press, Freeman and Company, 2006, ISBN

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

Language:

- offered only in German

Notes:

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

LS2300-MML, LS2300-KP04 - Biophysical Chemistry (BPCMML)

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

Course of study, specific field and term:

- Master CLS (compulsory), computational life science / life sciences, 1st semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Lecture:Structural principles of biological macromolecules
- Molecular mechanics
- NMR spectroscopy
- ThermodynamicsLigand binding
- KineticsLigand binding
- Excercises:Parallel to the lectures presentation of related sub topics
- Practicals Teams of two students (some scripts are in English):Determination of dissociation constants using fluorescence spectroscopy
- Polarimetric determination of the kinetics of the hydrolysis of sucrose
- Surface plasmon resonance to determine association constants and thermodynamic parameters
- Structural characterization of biomolecules using molecular modeling
- Structural analysis of molecules using one and two dimensional NMR experiments

Qualification-goals/Competencies:

- Structural principles of biological macromolecules
- Basic thermodynamics and kinetics, enzyme kineticsBasics of molecular mechanics
- NMR spectroscopy and structure analysis (phenomenological
- Basic thermodynamics and kinetics, enzyme kinetics
- Scientific documentation and presentation of data; scientific reading of texts in English; improvement of teamwork skills
- Acquisition of skills to work independently and self-determined in the laboratory

Grading through:

- Exercises
- protocols
- written exam

Requires:

- Physics 2 (ME1020-MLS)
- Physics 1 (ME1010-KP06, ME1010-MLS)
- Organic Chemistry (LS1600-MLS)

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Chemistry and Metabolomics

- Prof. Dr. rer. nat. Thomas Peters
- PD Dr. phil. nat. Thomas Weimar

Literature:

- Peter Atkins and Julio de Paula: Physical Chemistry for the Life Sciences - Oxford, University Press, Freeman and Company, 2006, ISBN 0-1992-8095-9
- Thomas Engel und Philip Reid: Physikalische Chemie - Pearson Studium, 2006, ISBN 13: 978-3-8273-7200-0
- van Holde, Johnson & HoPrentice Hall: Principles of Physical Biochemistry - New Jersey, 1998, 2006, ISBN 0-13-720459-0
- Atkins: Physical Chemistry - Oxford University Press, Oxford Mel-bourne Tokyo, 1998, ISBN 0-19-850101-3 Paperback, Deutsche Ausgabe (dritte Auflage) bei Wiley VCH, 2002: ISBN 3-527-30236-0 Wiley-VCH, Weinheim

- Fersht, W. H.: Structure and Mechanism in Protein Science - New York, 1999, ISBN 0-7167-3268-8
- Cantor & Schimmel: Biophysical Chemistry, Parts I-III - Freeman and Company, New York, 1980, ISBN 0-71671188-5 Paperback
- H. Friebolin: Ein- und zweidimensionale NMR-Spektroskopie - Wiley-VCH

Language:

- offered only in German

Notes:

Basics for the Examination are the subjects of Cap. 1-3 of lessons, and practical course

LS2510-MML - Biochemistry 2 (Bioche2MML)

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

Course of study, specific field and term:

- Master CLS (optional subject), computational life science / life sciences, 2nd semester

Classes and lectures:

- Biochemistry 2 (lecture, 4 SWS)

Workload:

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

Contents of teaching:

- Structure and function of DNA and RNA
- Signal transduction and hormones
- Viruses
- Amino acid metabolism

Qualification-goals/Competencies:

- Understanding structures and functions of biochemical important biomolecules
- Understanding biochemical interrelations and their importance for cellular metabolism
- Understanding the principles of complex cell biological processes

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Rolf Hilgenfeld

Teacher:

- Institute of Biochemistry

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

Literature:

- Berg/Tymoczko/Stryer: Biochemistry 7ed - Freeman, 2012
- 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

LS3500 - Introduction into Structural Analysis (EinStrukAn)

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

Course of study, specific field and term:

- Master CLS (compulsory), computational life science / life sciences, 2nd semester
- Bachelor MLS (compulsory), life sciences, 6th semester

Classes and lectures:

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

Workload:

- 120 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:

- attendance at exercises
- attendance, >90%
- presentation
- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Peters

Teacher:

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

- Prof. Dr. rer. nat. Thomas Peters
- Prof. Dr. rer. nat. Rolf Hilgenfeld
- Dr. math. et dis. nat. Jeroen Mesters
- PD Dr. rer. nat. Karsten Seeger
- Dr. Dominik Schwudke

Literature:

- Wird den aktuellen Gegebenheiten angepasst und in der Vorlesung angegeben. Siehe auch in den entsprechenden Skripten:

- Teil B: Horst Friebolin: Ein- und zweidimensionale NMR-Spektroskopie. Eine Einführung - Wiley-VCH
- Alexander Mc Pherson: Introduction to Macromolecular Crystallography - 1st edition, 2003, Wiley

Language:

- offered only in German

LS4020 A - Module part LS4020A: Crystallography (StrAnaKris)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each winter semester	3	60

Course of study, specific field and term:

- Master MLS starting 2018 (module part), structure biology, 1st semester
- Master Infection Biology ab 2018 (module part), Interdisciplinary modules, 1st semester
- Master Biophysics (module part), biophysics, 1st semester
- Master CLS starting 2016 (module part), MML with specialization in Life Science, 3rd semester
- Master MLS starting 2016 (module part), structure biology, 1st semester
- Master Infection Biology (module part), Interdisciplinary modules, 1st semester
- Master CLS (module part), computational life science / life sciences, 3rd semester
- Master MLS (module part), structure biology, 1st semester

Classes and lectures:

- Crystallography (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Crystal growth, precipitant and phase diagram, crystal morphology, symmetry and space groups, crystallogenesis
- X-rays, X-ray sources, X-ray diffraction, Bragg's law, reciprocal lattice and Ewald-sphere construction
- X-ray diffraction by electrons, Fourier analysis and synthesis
- Protein structure determination by X-ray diffraction, crystallographic phase problem, Patterson map, molecular replacement (MR), multiple isomorphous replacement (MIR), multi-wavelength anomalous diffraction (MAD)
- Crystallography and the drug discovery process: studying protein-ligand interactions
- Practical exercises employing an X-ray generator (collection of a diffraction image) and the computer (MR; calculation and interpretation of electron density maps)
- Site visit at the Synchrotron DESY (Hamburg)

Qualification-goals/Competencies:

- They have a general scientific competence in macromolecular X-ray diffraction analysis
- They have the methodological competence to grow protein crystals by hanging or sitting drops
- They have the methodological competence to correctly interpret (salt or protein) the diffraction image of a crystal using the Ewald Sphere construction
- They have the methodological competence to tackle the phase problem either by MR, MIR or MAD
- They can calculate and interprete electron density maps
- They have the methodological competence, to apply structure- or fragment-based techniques for lead compound identification
- They have the communication competency to convey the principles of X-ray diffraction theory

Grading through:

- see Notes

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner
- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Biochemistry

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

Literature:

- Jan Drenth: Principles of Protein X-ray Crystallography - Science+Business Media, LLC, New York

Language:

- offered only in English

Notes:

Is part of Module:
- LS4021-KP06 (former LS4020-IB) -> Prof. Hübner
- LS4020-KP06 (former LS4020-MLS) and LS4020-KP12 -> Prof. Peters

4 exercises, 2 hours each, are offered in addition to the lecture. Dates are given at the start of the semester.

For Master MLS with specialization Structure Biology the module is mandatory.

LS4020 B - Module part LS4020B: NMR Spectroscopy (StrAnaNMR)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Master Infection Biology ab 2018 (module part), Interdisciplinary modules, 1st semester
- Master Biophysics (module part), biophysics, 1st semester
- Master CLS starting 2016 (module part), MML with specialization in Life Science, 3rd semester
- Master MLS starting 2016 (module part), structure biology, 1st semester
- Master Infection Biology (module part), Interdisciplinary modules, 1st semester
- Master CLS (module part), computational life science / life sciences, 3rd semester
- Master MLS (module part), structure biology, 1st semester
- Master MLS starting 2018 (module part), structure biology, 1st semester

Classes and lectures:

- NMR-Spectroscopy (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Lecture topics:
- Assignment of NMR spectra
- Description of the NOESY experiment using the vector model
- Chemical Exchange and Transfer-NOEs
- Multidimensional NMR spectroscopy
- Assignment strategy for peptides
- Introduction into the product operator formalism (POF)
- Description of the COSY and of the HSQC experiment using POF
- NMR experiments for the assignment of proteins
- NMR structural analysis of proteins
- Experiments to probe the motions of protein

Qualification-goals/Competencies:

- Advanced techniques to assign and analyze NMR spectra
- Understanding of NMR experiments based on the product operator formalism
- Basic knowledge about NMR experiments to analyze structure and dynamics of proteins

Grading through:

- see Notes

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Chemistry and Metabolomics

- Prof. Dr. rer. nat. Thomas Peters
- PD Dr. rer. nat. Karsten Seeger

Literature:

- James Keeler: Understanding NMR Spectroscopy - Wiley
- :
- Malcolm H. Levitt: Spin Dynamics - Basics of Nuclear Magnetic Resonance - Wiley-VCH
- D. Neuhaus & M. P. Williamson: The Nuclear Overhauser Effect in Structural and Conformational Analysis - Wiley-VCH
- Timothy Claridge: High-Resolution NMR Techniques in Organic Chemistry - Pergamon Press
- : Current scientific literature

Language:

- offered only in English

Notes:

This lecture is a part of modules:
- LS4021-KP06 (former LS4020-IB) -> Prof. Hübner
- LS4020-KP06 (former LS4020-MLS) and LS4020-KP12 -> Prof. Peters

Exercises are integrated into the lectures.
It is a compulsory module part for the Master MLS with a focus on structural biology.

LS4020 C - Module part LS4020C: Single Molecule Methods (Einzelstru)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Master MLS starting 2018 (module part), structure biology, 1st semester
- Master Infection Biology ab 2018 (module part), Interdisciplinary modules, 1st semester
- Master Biophysics (module part), biophysics, 1st semester
- Master CLS starting 2016 (module part), MML with specialization in Life Science, 3rd semester
- Master MLS starting 2016 (module part), structure biology, 1st semester
- Master Infection Biology (module part), Interdisciplinary modules, 1st semester
- Master CLS (module part), computational life science / life sciences, 3rd semester
- Master MLS (module part), structure biology, 1st semester

Classes and lectures:

- Single Molecule Methods (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Physical basics of fluorescence
- Photo physics
- Microscopy techniques
- Protein labeling
- Fluorescence resonance energy transfer
- Single molecule enzymology
- Single molecule protein folding
- Physical basics of optical tweezers
- Protein folding with optical tweezers

Qualification-goals/Competencies:

- Understanding of the physical basics of single molecule methods
- Understanding of the benefits of single molecule methods
- Understanding of the limits of single molecule methods

Grading through:

- see Notes

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Physics

- Prof. Dr. rer. nat. Christian Hübner

Literature:

- Lakowicz, Joseph R: Principles of Fluorescence Spectroscopy - ISBN 978-0-387-46312-4
- Markus Sauer, Johan Hofkens, Jörg Enderlein: Handbook of Fluorescence Spectroscopy and Imaging: From Ensemble to Single Molecules - ISBN: 978-3-527-31669-4

Language:

- offered only in English

Notes:

Is module part of:
- LS4021-KP06 (former LS4020-IB) -> Prof. Hübner
- LS4020-KP06 (former LS4020-MLS) and LS4020-KP12 -> Prof. Peters

This module part is identical to LS4020 C-MIW without seminar.
For Master MLS with specialization in structure biology the module is mandatory.

LS4020 D - Module part LS4020D: Microscopy: techniques and applications (StrAnaMikr)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Master Infection Biology ab 2018 (module part), Interdisciplinary modules, 1st semester
- Master Biophysics (module part), biophysics, 1st semester
- Master CLS starting 2016 (module part), MML with specialization in Life Science, 3rd semester
- Master MLS starting 2016 (module part), structure biology, 1st semester
- Master Infection Biology (module part), Interdisciplinary modules, 1st semester
- Master CLS (module part), computational life science / life sciences, 3rd semester
- Master MLS (module part), structure biology, 1st semester
- Master MLS starting 2018 (module part), structure biology, 1st semester

Classes and lectures:

- Microscopy: techniques and applications (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Light microscopy
- Confocal microscopy
- 2-photon microscopy
- Light sources and detectors
- Fluorescent Dyes; GFP and genetically encoded fluorescence markers; Live Cell/tissue imaging: considerations/limitations
- Labelling/identifying cell components using fluorescence techniques
- Protein-protein Interactions in living cells: FRET, FLIM; Biosensors
- Photo-activatable/-switchable Fluorescent Proteins; Fluorescent Timers
- Advanced 3D-Fluoresence Microscopy, STED, PALM, STORM
- In vivo imaging in tissues and living animals
- Applications of Flow Cytometry & Fluorescence-activated Cell Sorting
- Electron Microscopy: TEM, Immunogold label; Survey of cell ultrastructure; Correlative EM/light microscopy; Scanning Electron Microscopy (SEM)
- Bioluminescence; high-content screening; outlook: emerging technologies
- Data storage/formats; Course discussion; and then: Cinema of the Cell

Qualification-goals/Competencies:

- Basics of light and fluorescence microscopy and electron microscopy
- Detailed knowledge of methods for labelling and visualization of proteins and subcellular compartments
- Applications of live cell imaging, in vivo imaging and quantitative fluorescence techniques

Grading through:

- see Notes

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Biology

- Prof. Dr. rer nat. Rainer Duden

Literature:

- -: http://micro.magnet.fsu.edu/primer/index.html
- -: http://www.microscopyu.com/smallworld/
- -: http://www.olympusmicro.com/

Language:

- offered only in English

Notes:

Is module part of:
- LS4021-KP06 (former LS4020-IB) -> Prof. Hübner
- LS4020-KP06 (former LS4020-MLS) and LS4020-KP12 -> Prof. Peters

For Master MLS with specialization in Structure Biology the module is mandatory.

(Contribution to lecture, Biology 60%)
(Contribution to lecture, Biomedical Optics 40%)

LS4020-MLS - Structure Analysis (StrAna)

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

Course of study, specific field and term:

- Master CLS (optional subject), computational life science / life sciences, 3rd semester
- Master MLS (compulsory), structure biology, 1st semester

Classes and lectures:

- Part of the module A: Crystallography (lecture, 2 SWS)
- Part of the module B: NMR-Spectroscopy (lecture, 2 SWS)
- Part of the module C: Single Molecule Methods (lecture, 2 SWS)
- Part of the module D: Microscopy: techniques and applications (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- See module parts A to D

Qualification-goals/Competencies:

- See module parts A to D

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Physics
- Institute for Biology
- Institute of Biochemistry
- Institute of Chemistry and Metabolomics

- Prof. Dr. rer. nat. Thomas Peters
- Prof. Dr. rer. nat. Rolf Hilgenfeld
- Dr. math. et dis. nat. Jeroen Mesters
- PD Dr. rer. nat. Karsten Seeger
- Prof. Dr. rer. nat. Christian Hübner
- Prof. Dr. rer nat. Rainer Duden

Language:

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

Notes:

This modul has 4 parts: LS4020A-D.
BSc in Molecular Life Science or related fields.
One written examination with all parts, each valued 25%.

ME2050 - Theoretical Physics 2 (TheoPhys2)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master CLS (optional subject), computational life science / life sciences, arbitrary semester
- Bachelor MES before 2014 (compulsory), physics, 4th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Schrödinger equation
- Double slit experiment and wave-particle duality
- Expectation values and uncertainty relation
- Hilbert space and differential operators; momentum operator
- One-dimensional quantum systems
- Harmonic oscillator
- Ladder operators, operator algebras and commutator relations
- Connection between wave and matrix quantum mechanics
- Central forces and potential; torque

Qualification-goals/Competencies:

- Understanding the basic concepts, foundations and mathematical structure of quantum mechanics
- In-depth recall of Fourier methods by their application in wave mechanics
- Acquisition of solution methods for differential equations
- Thorough acquaintance of handling operators, expectation values and commutator relations

Grading through:

- solving exercises and presenting solutions
- Written or oral exam as announced by the examiner

Requires:

- Analysis 2 (MA2500-MML)
- Analysis 2 (MA2500-KP05, MA2500-MLS)
- Analysis 2 (MA2500-KP04, MA2500)

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institute of Medical Engineering
- Institute of Physics

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

Literature:

- Thorsten Fließbach: Quantenmechanik - Spektrum Akademischer Verlag
- Gerald Grawert: Quantenmechanik - Aula Verlag
- H. Haken, H. C. Wolf: The Physics of Atoms and Quanta - Springer
- Richard P. Feynman, Leighton, Sands: The Feynman Lectures on Physics, Vol. 3 - Oldenbourg
- J. J. Sakurai, Jim Napolitano: Modern Quantum Mechanics - Pearson

Language:

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

MZ4120 A - Module part A: Biology of Infections (BiomInfecb)

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

Course of study, specific field and term:

- Master Nutritional Medicine in planning (module part), life sciences, 2nd semester
- Master CLS (module part), computational life science / life sciences, 3rd semester
- Master MLS (module part), cell biology, 2nd semester

Classes and lectures:

- Specific Topics of Infection Biology (lecture, 2 SWS)
- Specific Topics of Infection Biology (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Infectious diseases, viral, prokaryotic and eukaryotic infectious agents, parasites, zoonotic diseases
-
-
-
-
-
-
-
-

Qualification-goals/Competencies:

- Students will have detailed knowledge of infectious agents, infectious diseases and their pathomechanisms
- They have a detailed understanding of antimicrobial defence mechanisms at the cellular and molecular level. They are able to understand mechanisms of vaccination and immune deficiencies.
- They have knowledge of in vivo and in vitro techniques of infection biology.
- They will improve their ability to present data and to scientific problems in English.

Grading through:

- presentation
- written exam

Responsible for this module:

- Prof. Ph.D. Tamás Laskay

Teacher:

- Research Center Borstel
- Department of Infectious Diseases and Microbiology

- Prof. Ph.D. Tamás Laskay
- Dr. rer. nat. Bianca Schneider
- Dr. rer. nat. Christoph Hölscher
- PD Dr. rer. nat. Norbert Reiling
- Prof. Dr. rer. nat. Stefan Niemann
- Prof. Dr. Ulrich Schaible
- Dr. rer. nat. Tobias Dallenga
- Dr. rer. nat. Matthias Hauptmann
- Dr. rer. nat. Gabi Schramm

Literature:

- : - Books, Original publications and Reviews

Language:

- offered only in English

Notes:

Part of the module MZ4120
BSc in Molecular Life Science or in related fields
One choise of two

MZ5110 - Medical Cell Biology 1 (MZB1)

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

Course of study, specific field and term:

- Master MLS (compulsory), cell biology, 1st semester
- Master CLS (optional subject), computational life science / life sciences, 3rd semester

Classes and lectures:

- See MZ5110 A: Immunology (course, 4 SWS)
- See MZ5110 B: Neuroscience 1 (course, 4 SWS)
- See MZ5110 C: Frontiers in Frontiers in Metabolic Medicine Research (course, 4 SWS)

Workload:

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

Contents of teaching:

- Lecture MZ5110 A: Immunology, B: Neuroscience 1 and C: Frontiers in Metallic Medicine Research

Qualification-goals/Competencies:

- see MZ5110 Part A: Immunology, Part B: Neuroscience 1 and C: Frontiers in Metallic Medicine Research

Grading through:

- presentation
- continuous, successful participation in course
- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Rudolf Manz

Teacher:

- Medical Clinic I
- Institut of Physiology
- Institute of Experimental and Clinical Pharmacology and Toxicology
- Institute for Systemic Inflammation Research (ISEF)

- Prof. Dr. rer. nat. Rudolf Manz
- Prof. Dr. med. Jörg Köhl
- Prof. Dr. rer. nat. Marc Ehlers
- Prof. Dr. rer. nat. Olaf Jöhren
- Prof. Dr. med. Sebastian Schmid
- Prof. Dr. Jens Mittag
- Dr. rer. nat. Carla Schulz
- Dr. Stefanie Fliedner
- Prof. Dr. rer. nat. Henrik Oster
- Prof. Dr. med. Christian Sina

Language:

- offered only in English

Notes:

MLS: one of three choices

(Consists of MZ5110 A, MZ5110 B, MZ5110 C)

MZ5110 A - Medical Cell Biology 1: Part A: Immunology (MZB1AImmu)

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

Course of study, specific field and term:

- Master MLS (module part), neuroscience, 1st semester
- Master CLS (module part), computational life science / life sciences, 3rd semester

Classes and lectures:

- Immunology (lecture, 2 SWS)
- Immunology (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Lecture: Introduction to immunology
- Cells of the innate immune system
- Innate immune system: pathogen recognition
- Complement and inflammation
- Introduction into the adaptive immune system
- Antigen-presentation and T cell activation
- Immunological memory
- Immune system and infektion I: bacteria, worms, fungi
- Immune system and infektion II: Viruses
- Signal transduktion in immune cells
- Organs and tissues of the immune system, homing
- Immunpathogenesis I: allergy and asthma
- Immunpathogenesis II: autoimmune diseases
- Immunprivileged Organs
- Hematopoiesis and hematopoietic stem cells
- Experimental and clinically applied biologicals
- Seminar: PCR
-
- ELISA/ELISPOT
- Flow cytometry I: FACS-Analysis
- Flow cytometry II: MACS, FACS-Sort
- Flow cytometry III: Practical course at the ISEF (MACS, Analysis, Sort)
- Conventional and confocal microscopy
- Methods in signal transduction
- Migration: transwell assay; adhesion test etc.
- 2-Photon microscopy
- Animal models in life science
- Genetically modified mice I: conventional transgenics and KO mice
- Genetically modified mice II: conditional KO und Knock In Mice

Qualification-goals/Competencies:

- Students are able to:
- Name cells of the immune system and allocate their functions
- Name organs that belong to the immune system and allocate their functions
- Name mechanisms, cells and molecules of the innate and adaptive immune system and allocate their functions during bacterial, viral and fungal infections
- Name and allocate functions of molecules important for B cell -T cell co-cooperation
- Name and allocate the functions of molecules and antigen-presenting cells important for T cell activation and differentiation
- Name molecules of the complement system and allocate their functions for immune protection and immune diseases
- Name structure and function of the distinct antibody classes
- Name and allocate functions of molecules important for homing and migration of immune cells
- Name and allocate functions of molecules important for the initiation and resolution of inflammation
- Name the functions of immunological memory
- Name molecules and mechanisms involved in the development of B cell and T cell memory
- Describe the principal sequence of an immune reaction during infection and after vaccination

- Name genetic, molecular and cellular disturbances of the immune system relevant for immune deficiency, autoimmune and allergic diseases
- Describe the basic mechanisms of signal transduction in immune cells
- Name mechanisms and molecules involved in hematopoiesis
- Name and explain immunological methods
- Present and discuss scientific data

Grading through:

- presentation
- continuous, successful participation in course
- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Rudolf Manz

Teacher:

- Institute for Systemic Inflammation Research (ISEF)

- Prof. Dr. rer. nat. Rudolf Manz
- Prof. Dr. med. Jörg Köhl
- Prof. Dr. rer. nat. Marc Ehlers

Literature:

- Janeway, Travers, Walport, Shlomchik: Immunologie - Spektrum Akademischer Verlag
- : Original- und Übersichtsartikel

Language:

- offered only in English

Notes:

(Part of the module MZ5110)

MZ5110 B - Medical Cell Biology 1: Part B: Neuroscience 1 (MZB1BNeur1)

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

Course of study, specific field and term:

- Master MLS (module part), neuroscience, 1st semester
- Master CLS (module part), computational life science / life sciences, 3rd semester
- Master Biophysics (module part), advanced curriculum, 1st semester

Classes and lectures:

- Neuroscience 1 (lecture, 2 SWS)
- Neuroscience 1 (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Micro- and macroscopic anatomy of the CNS
- Electrical activity of neurons
- Channels and transporters in neurons
- Synaptic transmission
- Neurotransmitters and their receptors
- Intracellular signaling in neurons
- Plasticity and memory
- Circadian rhythms and sleep
- The visual system
- Development of the nervous system

Qualification-goals/Competencies:

- Understanding basics of neuroscience
- Understanding the structure and development of the brain
- Understanding neuronal excitation and signal transmission
- Introduction to examples of behavior and plasticity

Grading through:

- presentation
- continuous, successful participation in course
- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Rudolf Manz

Teacher:

- Medical Clinic I
- Department of Neurosurgery
- Institut of Physiology
- Institute of Experimental and Clinical Pharmacology and Toxicology

- Prof. Dr. rer. nat. Olaf Jöhren
- Prof. Dr. med. Cor de Wit
- Prof. Dr. rer. nat. Henrik Oster
- Prof. Dr. med. Markus Schwaninger
- PD Dr. rer. nat. Christina Zechel

Literature:

- Nicholls: From Neuron to Brain: A Cellular and Molecular Approach to the Function of the Nervous System - ISBN-10: 0878936092, 679 Seiten, Palgrave Macmillan; 5th edition (2012
- Purves: Neuroscience - ISBN-10: 0878936955, 858 Seiten, Palgrave Macmillan; 5th edition. (2011)
- Brady: Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology - ISBN-10: 0123749476, 1096 Seiten, Academic Press; 8th Edition (2011)
- : Original publications and Reviews

Language:

- offered only in German

Notes:

Part of the module MZ5110
MLS: one of two choises

MZ5110 C - Medical Cell Biology 1: Part C: Frontiers in Metabolic Medicine Research (MZCFronMet)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each winter semester	6	10

Course of study, specific field and term:

- Master CLS (module part), computational life science / life sciences, 3rd semester
- Master MLS (module part), cell biology, 1st semester

Classes and lectures:

- Frontiers in Metabolic Medicine Research (lecture, 2 SWS)
- Frontiers in Metabolic Medicine Research (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Central regulation of adipose tissues
- Thyroid hormones
- Central adipokine action
- Tumor metabolism
- Chronometabolism
- Nutrient barriers

Qualification-goals/Competencies:

- Know about some current themes in metabolic physiology and medicine
- Know about some experimental paradigms to address metabolism-related problems
- Understand the molecular basis of metabolic disorders and know how to develop strategies for experimentally addressing scientific problems

Grading through:

- presentation
- continuous, successful participation in course
- written exam

Requires:

- Module part LS3250 B: Metabolic Medicine (LS3250 B)

Responsible for this module:

- Prof. Dr. rer. nat. Henrik Oster

Teacher:

- Institute for Systemic Inflammation Research (ISEF)

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

Literature:

- Keith N. Frayn: Metabolic Regulation: A Human Perspective - Wiley-Blackwell (2010), ISBN : 978-1-4051-8359-8
- : Original- und Übersichtsartikel

Language:

- German and English skills required

Notes:

Part of the module MZ5110
If their is space in the course students can participate even if they did not pass modul LS3250-B.
MLS: compulsory, 1. Term, either MZ5110 A, MZ5110 B or MZ5110 C needs to be selected.

CS4250-KP04, CS4250 - Computer Vision (CompVision)

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

Course of study, specific field and term:

- Master Biomedical Engineering (optional subject), advanced curriculum, 2nd semester
- Master CLS starting 2016 (optional subject), computer science, 2nd or 3rd semester
- Master MES since 2014 (optional subject), computer science and electrical engineering, 1st or 2nd semester
- Master Media Informatics (optional subject), computer science, arbitrary semester
- Master Computer Science before 2014 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master CLS (compulsory), computational life science / imaging, 2nd semester
- Master MES before 2014 (advanced curriculum), imaging systems, signal and image processing, 2nd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester
- Master Computer Science before 2014 (compulsory), specialization field robotics and automation, 2nd semester
- Master Computer Science before 2014 (compulsory), specialization field bioinformatics, 2nd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum intelligent embedded systems, 2nd semester
- Master Biophysics (optional subject), Elective, 2nd semester

Classes and lectures:

- Computer Vision (lecture, 2 SWS)
- Computer Vision (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to human and computer vision
- Sensors, cameras, optics and projections
- Image features: edges, intrinsic dimension, Hough transform, Fourier descriptors, snakes
- Range imaging and 3-D cameras
- Motion and optical flow
- Object recognition
- Example applications

Qualification-goals/Competencies:

- Students can understand the basics of computer vision.
- They can explain and perform camera choice and calibration.
- They can explain and apply the basic methods for feature extraction, motion estimation, and object recognition.
- They can indicate appropriate methods for different kinds of computer-vision applications.

Grading through:

- Exercises
- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Erhardt Barth

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr.-Ing. Erhardt Barth

Literature:

- Richard Szeliski: Computer Vision: Algorithms and Applications - Springer, Boston, 2011
- David Forsyth and Jean Ponce: Computer Vision: A Modern Approach - Prentice Hall, 2003

Language:

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

Notes:

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

Prerequisites for admission to the examination:
Successful participation in the exercises,
minimum pass percentage: 70 %

ME4000 - Imaging Systems 1 (BildgbSys1)

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

Course of study, specific field and term:

- Master Computer Science before 2014 (compulsory), specialization field robotics and automation, 1st semester
- Master Computer Science before 2014 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester
- Master Computer Science before 2014 (optional subject), specialization field medical informatics, 3rd semester
- Master Computer Science before 2014 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master CLS (compulsory), computational life science / imaging, 1st semester

Classes and lectures:

- Imaging systems 1 (lecture, 2 SWS)
- Imaging systems 1 (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Signal processing (recapitulation of fundamental principles in signal processing)
- Mathematical methods in image reconstruction and signal processing
- X-Ray (fundamental principles, quantum statistics)
- Computed Tomography * devices, * current and past technology, * signal processing, * Fourier-based 2D and 3D image reconstruction, * algebraic and statistical image reconstruction, * image artifacts, * technical and clinical applications, * dose.

Qualification-goals/Competencies:

- Students are able to create an overview of the signal chain for medical imaging.
- They are able to explain the mathematical background for the reconstruction of CT images.
- They are able to explain the basics for the creation of X-ray.
- They are able to list all generations of CT devices and explain differences and advances.
- They are able to apply the Fourier transform.
- They are able to explain the mathematical basics for the two-dimensional image reconstruction.
- They are able to create and apply an algebraic approach for the reconstruction of CT images.
- They are able to create and apply an statistical approach for the reconstruction of CT images.
- They are able to outline the differences between two dimensional and three dimensional image reconstruction.
- They are able to transfer methods from two dimensional to three dimensional image reconstruction.

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering

- Prof. Dr. rer. nat. Thorsten Buzug

Literature:

- T. M. Buzug: Computed Tomography, From Photon Statistics to Modern Cone Beam CT - Springer-Verlag, Berlin/Heidelberg, 2008
- T. M. Buzug: Einführung in die Computertomographie, Mathematisch-physikalische Grundlagen der Bildrekonstruktion - Springer-Verlag, Berlin/Heidelberg, 2004

Language:

- offered only in English

ME4020 - Imaging Systems 2 (BildgbSys2)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each winter semester	4	99

Course of study, specific field and term:

- Master Computer Science before 2014 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master CLS (compulsory), computational life science / imaging, 2nd semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Physical fundamentals of magnetic resonance imaging: nuclear magnetic resonance, relaxation mechanisms, principles of position encodingprinciples of spatial encoding, relaxation)
- Construction of basic imaging sequences, weighting
- Concept of k-space
- Coherence pathways
- Hardware components of a clinical MR system
- Possible sources of hazard for patients
- Influence of measurement parameters on signal-to-noise ratio
- Causes of image artefacts

Qualification-goals/Competencies:

- The students can explain the physical principles of NMR and MRI.
- They can explain the idea behind important imaging sequences, using a pulse sequence diagram.
- They can recognise the causes of important image artefacts.
- They can list advantages and disadvantages of MRT, compared to other imaging techniques.
- They can list possible sources of hazard for patients, explain their causes and point out strategies for avoiding these.

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Martin Koch

Teacher:

- Institute of Medical Engineering

- Prof. Dr. rer. nat. Martin Koch

Literature:

- Liang, Z.-P., Lauterbur, P. C.: Principles of Magnetic Resonance Imaging: A Signal Processing Perspective - IEEE Press, New York 2000

Language:

- German and English skills required

Notes:

In summer semester 2015 this course is replaced by ME4413 Nuklear Imaging for MML students.

ME4413 - Nuclear Imaging (NuklBG)		
Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master CLS (compulsory), computational life science / imaging, 2nd semester

Classes and lectures:

- Nuclear Imaging (lecture, 2 SWS)
- Nuclear Imaging (exercise, 1 SWS)

Workload:

- 45 Hours in-classroom work
- 40 Hours private studies
- 20 Hours in-classroom exercises
- 15 Hours exam preparation

Contents of teaching:

- Physical, biological and medical basics of nuclear imaging
- Scintigraphy
- Positron emission tomography (PET)
- Single photon emission computed tomography (SPECT)
- Clinical and preclinical applications

Qualification-goals/Competencies:

- Students are able to explain the physical principles and phenomena of nuclear imaging.
- They can describe relevant phenomena and procedures mathematically.
- They can understand the basics of nuclear medicine.
- They can explain the applications of nuclear imaging techniques.
- They can name and explain the advantages and disadvantages and limitations of nuclear imaging methods.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Magdalena Rafecas

Teacher:

- Institute of Medical Engineering

- Prof. Dr. rer. nat. Magdalena Rafecas

Literature:

- S. R. Cherry, J. A. Sorenson, M. E. Phelps: Physics in Nuclear Medicine - Elsevier, 2012
- M. N. Wernick, J. N. Aarsvold: Emission Tomography: The Fundamentals of PET and SPECT - Elsevier, 2004
- D. L. Bailey, D. W. Townsend, P. E. Valk , M N. Maisey (Editors): Positron Emission Tomography: Basic Sciences - Springer, 2005

Language:

- offered only in English

MZ4010-KP04, MZ4010 - Clinical Epidemiology (KlinEpi)

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

Course of study, specific field and term:

- Bachelor Medical Informatics since 2019 in planning (optional subject), medical computer science, 4th to 6th semester
- Master CLS starting 2016 (compulsory), MML with specialization in Genetic Statistics, 3rd semester
- Bachelor Medical Informatics since 2014 (compulsory), medical computer science, 5th semester
- Bachelor Medical Informatics before 2014 (compulsory), medical computer science, 3rd semester
- Master CLS (compulsory), computational life science / biostatistics, 1st semester
- Master Computer Science before 2014 (compulsory), specialization field medical informatics, 3rd semester

Classes and lectures:

- Clinical Epidemiology (lecture, 2 SWS)
- Clinical Epidemiology (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to epidemiology
- Diagnosis
- Frequencies
- Registers and data sources
- Geographical epidemiology
- Study designs (RCT, cohort study, case control study, cross sectional study)
- Effect measures
- Causality
- Chance, bias and confounding
- Control of errors
- Outbreak investigation

Qualification-goals/Competencies:

- Students are able to explain technical terms such as disease register, incidence, prevalence, mortality, lethality, standardization.
- They are able to explain and interpret epidemiological measures.
- They are able to assess which study design is appropriate for a certain research question.
- They are able to identify possible sources of error, bias and confounding and how they affect the study results.
- They are able to assess causal inferences in the context of different study types.
- They are able to critically appraise data, results, and epidemiological research methods as well as scientific literature in the context of medicine and epidemiology.

Grading through:

- Exercises
- written exam
- e-tests

Responsible for this module:

- Prof. Dr. med. Alexander Katalinic

Teacher:

- Institute for Social Medicine and Epidemiology

- Prof. Dr. med. Alexander Katalinic
- MitarbeiterInnen des Instituts

Literature:

- L. Gordis: Epidemiology - Oxford: Elsevier; 5th edition 2013
- R. H. Fletcher: Clinical Epidemiology. The Essentials. - Lippincott Williams & Wilki; 5th rev. edition 2012
- :

Language:

- offered only in German

MZ4374-KP03, MZ4374 - Molecular Human Genetics (MolHumGen)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3 (Typ B)

Course of study, specific field and term:

- Master CLS starting 2016 (compulsory), MML with specialization in Genetic Statistics, 1st semester
- Master Medical Informatics (optional subject), bioinformatics, 1st or 2nd semester
- Master CLS (compulsory), computational life science / biostatistics, 1st semester
- Master Medical Informatics since 2019 in planing (optional subject), bioinformatics, 1st or 2nd semester

Classes and lectures:

- Molecular Human Genetics (practical course, 2 SWS)

Workload:

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

Contents of teaching:

- Safety instructions
- Isolation of nucleic acids
- Preparation and separation of nucleic acids
- Amplification of nucleic acids (PCR)
- Restriction of nucleic acids
- Theoretical consideration of pedigrees
- Data base search

Qualification-goals/Competencies:

- Students can perform fundamental molecular genetic experiments, they get basic knowledge in laboratory work

Grading through:

- continuous, successful participation in practical course, >80%

Requires:

- Human Genetics (MZ4373-KP03, MZ4373)

Responsible for this module:

- Prof. Dr. rer. nat. Christine Zühlke

Teacher:

- Institute of Human Genetics

- Prof. Dr. rer. nat. Christine Zühlke
- Dr. Andreas Dalski

Literature:

- Lecture notes: -

Language:

- offered only in German

MZ4120 B - Module part MZ4120 B: Neuroscience 2 (BiomNeuro2)

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

Course of study, specific field and term:

- Master Nutritional Medicine in planning (module part), life sciences, 2nd semester
- Master CLS (module part), neuroscience, 3rd semester
- Master MLS (module part), cell biology, 2nd semester
- Master Biophysics (module part), advanced curriculum, 2nd semester

Classes and lectures:

- Neuroscience 2 (lecture, 2 SWS)
- Neuroscience 2 (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Stem and progenitor cells
- Alzheimer's disease
- Pathophysiology of cerebrovascular disorders
- Neuroimmunology of Multiple Sclerosis
- Epilepsy
- Pahtogens of the brain
- Parkinson's disease and other movement disorders
- Neurogenetic diseases
- Schizophrenia
- Neuropathies
- Neurometabolic diseases

Qualification-goals/Competencies:

- Introduction to neuronal stem cells
- Introduction to various neuropathological diseases
- Understanding molecular mechanisms of neuropathological diseases

Grading through:

- presentation
- continuous, successful participation in course, >80%
- written exam

Responsible for this module:

- Prof. Ph.D. Tamás Laskay

Teacher:

- Department of Neurosurgery
- Department of Neurology
- Institute of Experimental and Clinical Pharmacology and Toxicology

- Prof. Dr. med. Markus Schwaninger
- PD Dr. rer. nat. Christina Zechel
- Prof. Dr. rer. nat. Katja Lohmann
- PD Dr. Sc. Ana Westenberger

Literature:

- Purves: Neuroscience - ISBN-10: 0878936955, Palgrave Macmillan; 5th edition. (2011)
- : Original publications and Reviews

Language:

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

Notes:

Part of the module MZ4120
BSc in Molecular Life Science or in related fields
Choose one Modulpart of two