UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Master Auditory Technology 2022

Version from 4. April 2024

1st and 2nd semester

1st or 2nd semester

1st semester

2nd semester

3rd semester

4th semester

Arbitrary semester

AT4100-KP06 - Audiological Diagnostics and Technology (AudDiaTec)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory), Auditory Technology, 1st and 2nd semester
- Master Auditory Technology 2017 (compulsory), Auditory Technology, 1st and 2nd semester

Classes and lectures:

- see AT4102 T: Hearing Aid Technology (lecture, 2 SWS)
- see AT4101 T: Audiological Diagnostics (lecture, 1 SWS)
- see AT4101 T: Audiological Diagnostics (exercise, 1 SWS)

Workload:

- 180 Hours (see module parts)

Contents of teaching:

- see description of module parts

Qualification-goals/Competencies:

- see description of module parts

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Tchorz
- Prof. Dr.-Ing. Markus Kallinger

Teacher:

- external institution

- Dr. Hendrik Husstedt
- Siegrid Meier

Literature:

- see description of module parts:

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- AT4100-L1: Regular participation in the exercises as specified at the beginning of the semester
- AT4100-L1: Successful submission of a term paper
- AT4100-L2: None

Modul exam:
- AT4100-L1: Audiological Diagnostics, written exam, 60min, 50% of modul grade
- AT4100-L2: Hearing Aid Technology, written exam, 90min, 50% of modul grade

Due to technical reasons of the internal booking, there may be special announcements for the registration and the booking of grades for these exams every semester.

CS4353-KP07 - Medical Data Science (MDS4HAT)

Duration:	Turnus of offer:	Credit points:
2 Semester	beginning each winter semester	7

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory module depending on previous knowledge), compulsory module depending on previous knowledge , 1st and 2nd semester

Classes and lectures:

- CS4353-V: Medical Data Science (lecture, 2 SWS)
- CS4353-Ü: Medical Data Science (exercise, 4 SWS)

Workload:

- 90 Hours in-classroom work
- 70 Hours private studies
- 50 Hours exam preparation

Contents of teaching:

- General Approach to Supervised Classification
- Extraction, Selection and Transformation of Features
- Linear Classification
- Statistical Classification
- General Approach towards Sensor-based Human Monitoring
- Software Architecture for Sensor-based Human Monitoring
- Feature Learning from Multimodal Sensor Data
- Supervised Classification using Support Vector Machine
- General Approach towards Sleep Lab Data Interpretation
- Time Series Preprocessing and Fusion
- Time Series Representation and Classification using Neural Networks
- Traceability of Complex Neural Networks

Qualification-goals/Competencies:

- Students know fundamentals of Python and are able to implement data science algorithms in this programming language.
- Students know the term Medical Data Science and are able to define and clearly distinguish it from other related terms.
- Students know the concept of supervised classification.
- Students know selected approaches to feature extraction, selection, and transformation and are able to implement it in the medical context using a programming language.
- Students know the linear classification approach and are able to implement it in the medical context using a programming language.
- Students know the statistical classification approach and are able to implement it in the medical context using a programming language.
- Students have an overview of known assistive health technologies and are able to motivate their application from the medical perspective.
- Students know the general approach towards sensor-based human monitoring.
- Students know the software architecture for sensor-based human monitoring.
- Students know selected feature learning methods and are able to implement them in a programming language.
- Students know the classification algorithm Support Vector Machine and are able to implement it in a programming language.
- Students know the general approach aiming at the interpretation of data recorded in a sleep lab.
- Students know selected methods for preprocessing and fusion of time series and are able to implement them in a programming language.
- Students know the neural networks approach for the representation and classification of time series and are able to implement it in a programming language.
- Students are able to qualitatively and quantitatively assess the traceability of complex neural networks.
- Students know the objectives and function of software systems from selected current medical data science research projects.
- Students know the societal relevance of assistive health technologies.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr.-Ing. Marcin Grzegorzek

Teacher:

- Institute of Medical Informatics

- Prof. Dr.-Ing. Marcin Grzegorzek

Literature:

- Peter J. Brockwell and Richard A. Davis: Introduction to Time Series and Forecasting - ISBN: 978-3-319-29852-8
- Marcin Grzegorzek: Sensor Data Understanding - ISBN: 978-3-8325-4633-5
- Andrew R. Webb: Statistical Pattern Recognition - ISBN: 978-0-470-68228-9
- Sergios Theodoridis and Konstantinos Koutroumbas: Pattern Recognition - ISBN: 978-1-597-49272-0

Language:

- German or English

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise

Module Exam(s):
- CS4353-L1: Medical Data Science, written exam, 90min, 100% module grade

AT4180-KP04 - Seminar Auditory Technology (SemHAT)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), Auditory Technology, 1st or 2nd semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 1st or 2nd semester

Classes and lectures:

- Seminar Auditory Technology (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Familiarization in a scientific topic
- Working on a scientific problem and its answers for problems
- Presentation and discussion of the topic

Qualification-goals/Competencies:

- The students can work up a scientific topic thoroughly
- The students are able to present the results in a written report and oral presentation
- They are able to present and to discuss a scientific problem in English

Grading through:

- B-Certificate (not graded)

Responsible for this module:

- Studiengangsleitung Hörakustik und Audiologische Technik

Teacher:

- Lübeck University of Applied Sciences
- Institute for Signal Processing

- Prof. Dr.-Ing. Alfred Mertins
- Prof. Dr.-Ing. Markus Kallinger
- Prof. Dr. rer. nat. Jürgen Tchorz

Literature:

- is selected individually:

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- AT4180-L1: Seminar, not graded, 0% of modul grade, must be passed

AT4101 T - Module part: Audiological Diagnostics (AudDiag)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (Module part of a compulsory module), Auditory Technology, 1st semester
- Master Auditory Technology 2017 (Module part of a compulsory module), Auditory Technology, 1st semester

Classes and lectures:

- Audiological Diagnostics (lecture, 1 SWS)
- Audiological Diagnostics (exercise, 1 SWS)

Workload:

- 45 Hours private studies and exercises
- 32 Hours in-classroom work
- 13 Hours exam preparation

Contents of teaching:

- Principle structure of the measurement technique for the determination of the audiological parameters in the context of diagnostics and rehabilitation
- Implementation and application of objective and subjective measurements for differential diagnosis, topodiagnostics up to neurophysiological assessment of partial performance (auditory processing and perception)
- Comparison of different measurement systems

Qualification-goals/Competencies:

- Students are given an insight into the technical background of different audiological measurement methods
- They have built up a competent knowledge of physiological and psychoacoustical measurement methods and technologies in audiology
- They can carry out independently comparative measurements on the different measuring techniques
- They know how to apply the measurements

Grading through:

- written exam

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- external institution
- Siegrid Meier

Literature:

- Böhme, Gerhard; Welzl-Müller, Kunigunde: Audiometrie. Hörprüfungen im Erwachsenen- und Kindesalter - 5. Aufl. Bern: Huber, 2005
- Lehnhardt, Ernst: Praxis der Audiometrie. 14 Tabellen - 9. Aufl. Stuttgart: Thieme, 2009

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
-Regular participation in the exercises and a successful submission of a term paper

Modul exam:
- AT4100-L1: Audiological Diagnostics, written exam, 60min, 50% of modul grade Audiological Diagnostics and Technology.

AT4110-KP06 - Auditory Cognition (AudCog)

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

Course of study, specific field and term:

- Master Psychology - Cognitive Systems 2022 (optional subject), psychology, 1st or 3rd semester
- Master Auditory Technology 2022 (compulsory), Auditory Technology, 1st semester
- Master Psychology 2016 (optional subject), psychology, 1st or 3rd semester
- Master Auditory Technology 2017 (compulsory), Auditory Technology, 1st semester

Classes and lectures:

- Basics in neurocognition of speech and hearing (lecture, 2 SWS)
- Advances in auditory cognition and auditory neurophysiology (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Basics of neuroanatomy
- Basic concepts of sensory physiology and perception
- Hearing, listening, and language comprehension as neural processes
- A neuropsychological view on language disorders across the life span (specific language impairment, aphasia)
- Basics of neural plasticity (with a focus on hearing loss, deafness, and cochlear implants)
- Basics of computational neuroscience

Qualification-goals/Competencies:

- Students develop the knowledge required to foster a more profound understanding on auditory cognitive processes, and on how they relate to physiology, perception, neuropsychology, and neuroscience.
- Students can actively use this knowledge, relate it to current topics in the literature, and transfer it onto new problems.

Grading through:

- written homework

Responsible for this module:

- Prof. Dr. rer. nat. Jonas Obleser

Teacher:

- Department of Neurology
- Institute for Psychology I

- Prof. Dr. rer. nat. Jonas Obleser
- PD Dr. rer. nat. Dipl.-Psych. Marcus Heldmann

Literature:

- Poeppel, D., Overath, T., Popper, A.N. & Fay, R.R.: The Human Auditory Cortex - (Springer Handbook of Auditory Research; Vol. 43). New York, NY: Springer. DOI: 10.1007/978-1-4614-2314-0

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- presentation

Modul exam:
- AT4110-L1: Auditory Cognition, written homework, 100% of modul grade

(Part of Institute of Psychology I at lecture is 60%)
(Part of Institute of Psychology I at seminar 60%)
(Part of Clinic of Neurology at lecture is 40%)
(Part of Clinic of Neurology at seminar is 40%)

AT4120-KP03 - Spatial Audio Rendering and Virtual Acoustics (SpatAudio)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), Auditory Technology, 1st semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 1st semester

Classes and lectures:

- Spatial Audio Rendering (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Inverse filtering, acoustic equalization
- Equalization in loudspeaker an headphone playback
- Crosstalk cancellation
- Principles of spatial Sound perception
- (Higher-order)ambisonsics

Qualification-goals/Competencies:

- Students know the main issues of loudspeaker or headphone playback
- Understanding and solving the main problems of equalization and inverse filtering, respectively
- Understanding and applying important principles of spatial sound perception
- Knowing and applying most common rendering techniques for spatial sound

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr.-Ing. Markus Kallinger

Teacher:

- Lübeck University of Applied Sciences
- Prof. Dr.-Ing. Markus Kallinger

Literature:

- Oppenheim, Schäfer: Discrete-Time Signal Processing - Pearson, 2010
- U. Zölzer: Digitale Audiosignalverarbeitung - Vieweg-Teubner, 2004
- P. Vary, R. Martin: Digital Speech Transmussion: Enhancement, Coding and Error Concealment - Wiley, 2006
- J. Breebaart, C. Faller: Spatial Audio Processing: MPEG Surround and Other Applications - Wiley, 2008

Language:

- offered only in English

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- AT4120-L1: Spatial Audio Rendering and Virtual Acoustics, the portfolio examination consists of the following two parts:
- Programming task (maximum achievable number of points: 60)
- Presentation (maximum number of points: 40)

The maximum total number of points is 100 points. The grade is calculated from the total number of points achieved for both

examination parts.

AT4140-KP04 - Audiological Measuring Methods, Systems and Fitting (AudMess)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory module depending on previous knowledge), Auditory Technology, 1st semester
- Master Auditory Technology 2017 (compulsory module depending on previous knowledge), Auditory Technology, 1st semester

Classes and lectures:

- Audiological Measuring Methods, Systems and Fitting (lecture, 4 SWS)

Workload:

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

Contents of teaching:

- Basics of standard audiometric assessment methods for adults and children
- Pure-tone and speech audiometry
- Objective audiometric methods
- Tinnitus
- Fitting strategies based on threshold and supra-threshold data
- Outcome measures

Qualification-goals/Competencies:

- The students acquire sufficient knowledge to consider appropriate audiometric measurement methods within hearing aid fittings.
- The students know the background of different fitting strategies and can rate them under consideration of the individual needs of a hearing impaired person.

Grading through:

- Viva Voce or test

Responsible for this module:

- Prof. Dr. Tim Jürgens

Teacher:

- Lübeck University of Applied Sciences
- Prof. Dr. Tim Jürgens

Literature:

- Lehnhard, E., Laszig, R.: Praxis der Audiomietrie - 8. Aufl., Thieme, 2001
- Böhme, G., Welzl-Müller, K.: Audiometrie - Hörprüfungen im Erwachsenen- und Kindesalter - Hogrefe, 2005
- Dillon, H.: Hearing Aids - 2nd edition, Thieme Medical Publishers, 2012

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- AT4140-L1: Audiological Measuring Methods, Systems and Fitting, written exam, 90 Min, 100% of modul grade

AT4160-KP03 - Sound Technology (BesTech)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3 (Typ B)

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), Auditory Technology, 1st semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 1st semester

Classes and lectures:

- Sound Technology (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Basics of sound propagation and topics in room acoustics
- Signal cables, analogue and digital multicore technique
- Mixing consoles for live mixing
- Setting up and configuring PA systems individually
- Topics for stages and musicians
- Introduction into stage lights and devices
- Stage light control
- Concepts of stage lights and surrounding light

Qualification-goals/Competencies:

- Students can handle band sound in different situations
- They can configure and use PA systems
- They can operate analogue and digital mixing consoles
- They know the basics of stage light and sound and they can evaluate systems and services of others

Grading through:

- active participation in the exercises

Responsible for this module:

- Thomas Fricke-Masur

Teacher:

- University of Music Lübeck
- Thomas Fricke-Masur

Literature:

- Stefan Weinzierl: Handbuch der Audiotechnik - Springer, e-ISBN 978-3-540-34301-1
- Eberhard Sengpiel: Forum für Mikrofonaufnahmetechnik und Tonstudiotechnik
- Michael Dickreiter: Handbuch der Tonstudiotechnik - Saur, 1987, ISBN 3-598-10589-4

Language:

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

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- AT4160-L1: Sound Technology, constant participation during lecture, 100% of modul grade, has to be passed

AT4170-KP04 - Acoustic measurement technology and simulations (AMSi)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), Auditory Technology, 1st semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 1st semester

Classes and lectures:

- AT4170-V: Acoustic Measurement and Simulation (lecture, 2 SWS)
- AT4170-Ü: Acoustic Measurement and Simulation (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Basics of acoustic systems
- Acoustic measurement devices
- Filter design
- Measurement of sound quantities and noise measurement
- Measurement, processing and analysis of acoustic transfer functions
- Calibration and equalization of microphones, loudspeakers and headphones
- Multi-microphone technology, impedance measurements
- Acoustic measurements and simulation of rooms
- Binaural recordings, simulations and reproduction
- Basics of nonlinear system measurement
- Effective simulation of acoustic systems

Qualification-goals/Competencies:

- The students can calibrate and equalize acoustic measurement setups.
- The students have a detailed understanding of acoustic measurement technologies and associated data processing.
- The students can implement and apply methods for the characterization of linear and nonlinear (electro-) acoustic systems.
- The students can simulate (electro-) acoustic systems on the basis of measurements or simple effective models.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Tim Jürgens

Teacher:

- external institution
- Lübeck University of Applied Sciences

- Dr. Florian Denk

Literature:

- M. Möser: Messtechnik der Akustik - Springer Berlin Heidelberg, 2010.
- M. Vorländer: Akustische Messtechnik - in: Taschenbuch der Technischen Akustik, Springer Berlin Heidelberg, 2015.
- A. Oppenheim & R. Schafer: Digital Signal Processing - Prentice Hall, 1999.
- M. Vorländer: Auralization - Springer Berlin Heidelberg, 2020.
- Brüel & Kjær: The Microphone Handbook - 2019.

Language:

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Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Regular participation in exercises as specified at the beginning of the semester

Modul exam:
- AT4170-L1: Portfolio examination: collected report on programming tasks (1/3 of modul grade) and oral exam (2/3 of modul grade)

AT4300-KP06 - Research Methods in Behavioral Sciences and Neurosciences (ForVerNeu)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory), Auditory Technology, 1st semester

Classes and lectures:

- PY2300-V: Basics in statistics 2 (lecture, 2 SWS)
- AT4300-Ü: Basics in statistics 2 (exercise, 1 SWS)
- AT4300-S: Research methods: Imaging and biosignal analysis (seminar, 1 SWS)

Workload:

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

Contents of teaching:

- Analysis of Variance (ANOVA)
- General linear model, incl.simple and multiple regression, outlier testing
- Relationship of ANOVA and Regression
- Robust testing
- Basics of non-parametric testing
- CLINICAL AND NEUROSCIENTIFIC RESEARCH METHODS:
- An introduction to the relevant research methods, incl. PET, fMRI, EEG, eye tracking
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Qualification-goals/Competencies:

- Mastering and judging basic concepts and techniques in analysis of variance and regression
- Applying this new knowledge in solving statistical problems and in interpreting statistical results
- Experience in working with statistical software packages
- Extended ability to choose the adequate methods for a given research problem
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Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jonas Obleser
- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Psychology I
- Institute for Signal Processing

- Prof. Dr.-Ing. Alfred Mertins
- Prof. Dr. rer. nat. Jonas Obleser
- Dr. phil. Sarah Tune

- Dr. rer. nat. Malte Wöstmann

Literature:

- Eid, M., Gollwitzer, M. & Schmitt, M.: Statistik und Forschungsmethoden - Beltz. 1. Auflage, 2010
- Wirtz, M., Nachtigall, C.: Wahrscheinlichkeitsrechnung und Inferenzstatistik. Statistische Methoden für Psychologen Teil 2 - Beltz Juventa. 6. Auflage, 2012

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful submission of exercises and a presentation

Modul exam:
- AT4300-L1: Research Methods in Behavioral Sciences and Neurosciences, written exam, 100& of modul grade

The module examination is considered to have been completed if it was graded with at least sufficient.

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 CLS 2023 (optional subject), computer science, 3rd semester
- Master Auditory Technology 2022 (optional subject), computer science, 1st semester
- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester
- Master Auditory Technology 2017 (optional subject), computer science, 1st semester
- Master CLS 2016 (optional subject), computer science, 3rd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master MES 2011 (optional subject), mathematics, 1st or 2nd semester
- Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 1st or 2nd semester
- Master Medical Informatics 2014 (optional subject), computer science, 1st or 2nd semester
- Master CLS 2010 (optional suject), computer science, Arbitrary semester
- Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science 2012 (optional subject), specialization field bioinformatics, 3rd 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:

- 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:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- None

Module exam(s):
- CS5450-L1: Machine Learning, oral examination, 100% of module grade

ME3100-KP04, ME3100SJ14 - Medical Imaging (MBG14)

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

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (optional subject), Additionally recognized elective module, 5th semester
- Master Auditory Technology 2022 (optional subject), Auditory Technology, 1st semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), medical image processing, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester

Classes and lectures:

- Medical Imaging (lecture, 2 SWS)
- Medical Imaging (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to the theory of imaging systems
- Ultrasound imaging
- Conventional X-ray imaging, Computed Tomography
- Magnetic Resonance Imaging

Qualification-goals/Competencies:

- The students can characterise linear translation-invariant imaging systems by means of impulse response and transfer function.
- They can explain the Nyquist-Shannon theorem and justify its validity.
- They can describe what is meant by spatial resolution of an imaging system.
- They can give an overview of important medical imaging techniques.
- They can explain the physical foundations of ultrasound imaging.
- They can describe the behaviour of ultrasound waves at tissue borders.
- They can reason the fundamental limit to spatial resolution in US.
- They can list the interdependence between ultrasound frequency, spatial resolution, and penetration depth.
- They can elucidate how technical parameters are chosen for a given target to be imaged.
- They can discuss aim and realisation of beam forming in US imaging.
- They can explain how Doppler US works.
- They can describe why important US image artefacts occur.
- They can explain the physical and technical foundations of X-ray generation.
- They can sketch the typical spectrum of a technical X-ray source.
- They can list and describe the most important interaction processes between X-rays and matter.
- They can mention possible sources of hazard in X-ray imaging and discuss strategies for avoiding them.
- They can describe the influence of technical parameters in X-ray imaging systems.
- They can describe and justify important reconstruction principles in CT and their mathematical foundations.
- They can explain the physical foundations of nuclear magnetic resonance (NMR).
- They can describe how spatial resolution is achieved in NMR imaging.
- They can justify the occurrence of different types of radio frequency echoes in NMR.
- They can explain the concept of k-space.
- They can describe how different weightings are achieved in MR images.
- They can list sources of hazard in MRI and explain their causes.
- They can describe the technical components of an MR imaging system.
- They can implement important algorithms used in imaging systems.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Martin Koch

Teacher:

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

Literature:

- O. Dössel: Bildgebende Verfahren in der Medizin - Springer, Berlin 2000
- H. Morneburg (Hrsg.): Bildgebende Systeme für die medizinische Diagnostik. 3. Aufl. - Publicis MCD Verlag, München 1995

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None

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

Module Exam(s):
- ME3100-L1: Medical Imaging, written exam, 60min, 100% of the module grade.

ME4412-KP03 - Magnetic Resonance Imaging (MRTKP03)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), Auditory Technology, 1st semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 1st semester

Classes and lectures:

- Magnetic Resonance Imaging (lecture, 2 SWS)

Workload:

- 45 Hours private studies
- 30 Hours in-classroom work
- 15 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.
- The 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:

Prerequisites for attending the module:
- None

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

PY1300-KP06 - Basics of Experimental and Scientific Work (Empirie)

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

Course of study, specific field and term:

- Master Auditory Technology 2017 (optional subject), psychology, 1st semester
- Bachelor Psychology 2020 (compulsory), psychology, 1st semester
- Bachelor Psychology 2016 (compulsory), psychology, 1st semester
- Master Auditory Technology 2022 (optional subject), psychology, 1st semester

Classes and lectures:

- lecture in basics in statistics I (lecture, 2 SWS)
- practice in empirical-scientific working (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- Psychological Science
- Features of the empirical sciences
- Brief review on the history of psychological science
- PLANNING RESEARCH:
- Hypotheses and Theories
- Operationalising your research question
- Ethics of psychological testing
- Rules of good scientific practice
- MEASURING:
- To observe, to count, to measure
- Quantitative methods of data acquisition
- Objective, reliable, valid: Basics of classical testing theory
- Levels of measurement
- PERFORMING RESEARCH:
- Study design
- Confounding variables and their control
- Sample and Population
- The idea of hypothesis testing
- Writing up your results
-
-

Qualification-goals/Competencies:

- The ability to conceive and test research hypotheses according to the scientific criteria in psychology
- The ability to transform research questions into research designs
- Initial competence to understand, to criticise and to write scientific reports
- Mastering the rules of good scientific practice
- Developing a critical, scientific mind

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jonas Obleser

Teacher:

- Institute for Psychology I
- Prof. Dr. rer. nat. Jonas Obleser

Literature:

- Hussy, W., Schreier, M., & Echterhoff, G.: Forschungsmethoden in Psychologie und Sozialwissenschaften für Bachelor - Berlin [u.a.]: Springer, 2010

- Sedlmeier, P., & Renkewitz, F: Forschungsmethoden und Statistik in der Psychologie - München [u.a.]: Pearson Studium, 2008
- Huber, O.: Das psychologische Experiment: Eine Einführung - (5. Aufl.) Bern: Huber, 2009

Language:

- offered only in German

Notes:

The module examination is considered passing if it was graded as at least sufficient.

AT4102 T - Module part: Hearing Aid Technology (HearTec)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (Module part of a compulsory module), Auditory Technology, 2nd semester
- Master Auditory Technology 2017 (Module part of a compulsory module), Auditory Technology, 2nd semester

Classes and lectures:

- Hearing Aid Technology (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Review of hearing aid technology
- Advanced insights into hearing aid transducers: Capacitive and electro-magnetic principles
- Hearing assistive Technology: Concept, validation and evaluation of wireless remote microphone systems
- Function and proof of hearing aid Features: Analysis of features with the percentile analysis according to IEC 60118-15, Special techniques for individual features (e.g. method of Hagerman and Olofsson, etc.)
- Extrinsic factors effecting the performance of hearing aids: Individual factors influencing the input signal of hearing aids; Acoustic coupling of a hearing aid to the individual ear

Qualification-goals/Competencies:

- The students gain knowledge about hearing aid technology so that they understand the underlying physical principles.
- The students get insight into the function of hearing aid features and how the effect of these features can be analyzed with measurements.
- The students get an understanding what extrinsic factor effect the performance of hearing aids, e.g. the position of the microphone or the coupling of the transducer to the ear.
- Possibilities of hearing assistive technology are presented.
- The participants are able to see how additional technology, e.g. a wireless remote microphone system, can support the hearing aid user.

Grading through:

- written exam

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- external institution
- Dr. Hendrik Husstedt

Literature:

- Dillon, Harvey: Hearing Aids - 2 ed., Thieme Medical Publishers, 2012
- Valente, Michael: Hearing Aids: Standards, Options, andLimitations - Thieme Verlag, 1996
- Sandlin, Robert E.: Textbook of Hearing Aid Amplification - Singular Pub, 2000
- Katz, J., Chasin, M., English, K. & Hood, L: Handbook of Clinical Audiology - 7 ed., Lippincott Williams & Wilkins, 2014
- Davis, D. & Patronis, E.: Sound System Engineering - 3 ed., Focal Press, 2014

Language:

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

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- AT4100-L2: Hearing Aid Technology, written exam, 90min, 50% of modul grade Audiological Diagnostics and Technology.

AT4130-KP03 - Implantable Hearing Devices (IHD)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), Auditory Technology, 2nd semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 2nd semester

Classes and lectures:

- Implantable Hearing Devices (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Assessment of candidacy for implantation
- Psychosocial development of deaf children
- Medical and surgical aspects of implantation
- The design of implants
- Outcome measures
- Music perception with cochlea implants
- Rehabilitation

Qualification-goals/Competencies:

- The students have the necessary specialist knowledge to take account of audiological measuring procedures within the scope of the hearing system adaptation.
- The students are familiar with the background of the various adaptation methods and concepts and can evaluate them in consideration of the individual requirements of the hearing impaired.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. Tim Jürgens

Teacher:

- Lübeck University of Applied Sciences
- Prof. Dr. Tim Jürgens

Literature:

- Niparko, J.K: Cochlea Implants: Principles and Practices - 2nd edition, LWW, 2009
- Waltzman, S.B., Roland, J.T.: Cochlear Implants - 3rd edition, Thieme, 2014
- Ruckenstein M.J.: Cochlear Implants and other Implantable Hearing Devices - 1tt edition, Plural Publishing, 2012
- Cooper, H. R., Craddock, L. C.: Cochlear implants: a practical guide - Whurr publishers, 2009
- Zeng, F., Popper, A. N., Fay, R. R.: Cochlear implants: auditory prostheses and electric hearing - Springer, 2004
- Ernst, A., Battmer, R., Todt, I.: Cochlear Implant heute - Springer, 2009
- Wolfe, J., Schafer, E.: Programming cochlear implants - Plural Publishing, 2015

Language:

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

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- AT4130-L1:Implantable Hearing Devices, 60 Min, 100% of modul grade

AT4500-KP05 - Audiology (Audio)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory), Auditory Technology, 2nd semester
- Master Auditory Technology 2017 (compulsory), Auditory Technology, 2nd semester

Classes and lectures:

- Audiology (lecture, 3 SWS)
- Audiology (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Molecular and cellular processes
- Objective diagnostics
- Speech development
- Auditory processing disorders
- Tinnitus, hyperacusis
- Rehabilitation of adults and children with hearing aids and implantable hearing systems
- Aural rehabilitation training
- Binaural hearing: basics and perception of motion
- Psychoacoustics and speech perception with impaired hearing
- Psychoacousic models of auditory processing
- Comodualtion masking
- Models of speech perception
- Auditory scene analysis
- Music perception
- Cochlear implants: design, algorithms, temporal and spectral resolution, speech understanding
- Selected topics of hearing research and audiology

Qualification-goals/Competencies:

- The students understand important mechanisms of the auditory system which enable speech understanding, music perception, localization, and their application to models of auditory processing.
- The students are able to apply methods to conduct and analyze listening experiments in research and audiological practice.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Tim Jürgens

Teacher:

- Lübeck University of Applied Sciences
- Prof. Dr. Tim Jürgens

Literature:

- E. Zwicker, H. Fastl:: Psychoacoustics: facts and models - Springer, 2007
- J. Katz: Handbook of clinical Audiology - Lippincott Raven, 2014
- S. A. Gelfand: Essentials of Audiology - Thieme Medical Publishers, 2009
- J. Blauert: Spatial Hearing: Psychophysics of Human Sound Localization - Mit University Press Group Ltd, 1996
- B. C. J. Moore: An introduction to the psychology of hearing - Cambridge University Press, 2014
- B. C. J. Moore: Cochlear hearing loss: physiological, psychological and technical issues - John Wiley & Sons, 2007
- J. Pickles: An introduction to the physiology of hearing - Brill, 2013
- E. Lehnhardt, R. Laszig: Praxis der Audiometrie - Thieme, 2009
- J. Eggermont, F. Zeng, A. Popper, R. R. Fay: Tinnitus - Springer, 2012
- D. J. Benson: Music: a mathematical offering - Cambridge University Press, 2007

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- AT4500-L1: Audiology, portfolio exam, 100% der Modulnote

The portfolio examination consists of the following three parts:
- presentation (max. 20 points)
- written report (max. 40 points)
- participation in exercises (max. 20 points)

The maximum possible total number of points is 80 points. The grade is calculated from the total number of points achieved for all three examination elements.

AT4510-KP03 - Psychoacoustics (PsyAku)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory module depending on previous knowledge), Auditory Technology, 2nd semester
- Master Auditory Technology 2017 (compulsory module depending on previous knowledge), Auditory Technology, 2nd semester

Classes and lectures:

- Psychoacoustics (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Basic concepts of psychophysics
- Methods and models of different dimensions of auditory perception in normal hearing, such as loudness, pitch and modulation perception
- Auditory filters
- Simultaneous and temporal masking

Qualification-goals/Competencies:

- The students should gain in-depth knowledge about psychoacoustic methods and models, and be able to rate them with respect to effective aural rehabilitation of hearing-impaired persons.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Tchorz

Teacher:

- Lübeck University of Applied Sciences
- Prof. Dr. rer. nat. Jürgen Tchorz

Literature:

- Fastl H., Zwicker E.: Psychoacoustics; Facts and Models - 3rd edition; Springer 2007
- Terhardt E.: Akustische Kommunikation - Berlin, Springer, 1998
- Blauert, J.: Räumliches Hören - Hirzel-Verlag, 1974

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- AT4510-L1:Psychoacoustics, written exam, 60 Min, 100% of modul grade

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 2023 (compulsory), computer science, 2nd semester
- Master Auditory Technology 2022 (optional subject), Auditory Technology, 2nd semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 2nd semester
- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master CLS 2016 (compulsory), computer science, 2nd semester
- Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master MES 2011 (optional subject), mathematics, 2nd semester
- Bachelor MES 2011 (optional subject), optional subject medical engineering science, 6th semester
- Master Computer Science 2012 (optional subject), advanced curriculum organic computing, 2nd or 3rd semester
- Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 2nd semester
- Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester
- Master Computer Science 2012 (compulsory), specialization field robotics and automation, 2nd semester
- Master Computer Science 2012 (compulsory), specialization field bioinformatics, 2nd semester
- Master CLS 2010 (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
- Unsupervised 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:

- 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

Notes:

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS4405-L1: Neuroinformatics, written exam, 90 min, 100% of module grade

According to the old version of the MES Bachelor Examination Regulations (until WS 2011/2012), an elective subject is scheduled for the 4th semester instead of the 6th semester.

CS5274-KP08 - Advanced Signal Processing (FortSign)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory), Auditory Technology, 2nd semester
- Master Auditory Technology 2017 (compulsory), Auditory Technology, 2nd semester

Classes and lectures:

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

Workload:

- 110 Hours private studies
- 90 Hours in-classroom work
- 40 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
- 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 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.
- 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:

- 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
- 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

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful processing of exercises as specified at the beginning of the semester (at least 50% of max. points).

Modul exam:
- CS5274-L1: Advanced Signal Processing, written exam, 120 Min, 100% of Modulgrade

(consists of CS5275 T, CS4220 T)

MA4030-KP08, MA4030 - Optimization (Opti)

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

Course of study, specific field and term:

- Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 8th semester
- Bachelor CLS 2023 (compulsory), mathematics, 4th semester
- Master Auditory Technology 2022 (optional subject), mathematics, 2nd semester
- Master MES 2020 (optional subject), mathematics / natural sciences, Arbitrary semester
- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary semester
- Master Robotics and Autonomous Systems 2019 (optional subject), Additionally recognized elective module, Arbitrary semester
- Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 8th semester
- Master Auditory Technology 2017 (optional subject), mathematics, 1st or 2nd semester
- Bachelor Computer Science 2016 (optional subject), advanced curriculum, Arbitrary semester
- Bachelor CLS 2016 (compulsory), mathematics, 4th semester
- Master MES 2014 (optional subject), mathematics / natural sciences, Arbitrary semester
- Master MES 2011 (optional subject), mathematics, 2nd semester
- Master Computer Science 2012 (optional subject), advanced curriculum numerical image processing, 2nd or 3rd semester
- Bachelor MES 2011 (optional subject), medical engineering science, 6th semester
- Master Computer Science 2012 (optional subject), advanced curriculum analysis, 2nd or 3rd semester
- Bachelor CLS 2010 (compulsory), mathematics, 4th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Linear optimization (simplex method)
- Unconstrained nonlinear optimization (gradient descent, conjugate gradients, Newton method, Quasi-Newton methods, globalization)
- Equality- and inquality-constrained nonlinear optimization (Lagrange multipliers, active set methods)
- Stochastic methods for machine learning

Qualification-goals/Competencies:

- Students can model real-life problems as optimization problems.
- They understand central optimization techniques.
- They can explain central optimization techniques.
- They can compare and assess central optimization techniques.
- They can implement central optimization techniques.
- They can assess numerical results.
- They can select suitable optimization techniques for practical problems.
- Interdisciplinary qualifications:
- Students can transfer theoretical concepts into practical solutions.
- They are experienced in implementation.
- They can think abstractly about practical problems.

Grading through:

- Written or oral exam as announced by the examiner

Is requisite for:

- Non-smooth Optimization and Analysis (MA5035-KP05)

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Analysis 2 (MA2500-KP09)
- 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:

- J. Nocedal, S. Wright: Numerical Optimization - Springer
- F. Jarre: Optimierung - Springer
- C. Geiger: Theorie und Numerik restringierter Optimierungsaufgaben - Springer

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None (Familiarity with the topics of the required modules is assumed, but the modules are not a formal prerequisite for attending the course).

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

Examination:
- MA4030-L1: Optimization, written examination (90 min) or oral examination (30 min) as decided by examiner, 100 % of final mark

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 Auditory Technology 2022 (optional subject), Auditory Technology, 2nd semester
- Master MES 2020 (optional subject), medical engineering science, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), medical image processing, 1st or 2nd semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 2nd semester
- Master MES 2014 (optional subject), medical engineering science, 1st or 2nd semester
- Master MES 2011 (optional subject), mathematics, 1st or 2nd semester
- Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science 2012 (optional subject), specialization field medical informatics, 3rd semester
- Master Computer Science 2012 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 1st or 2nd semester
- Master CLS 2010 (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

Notes:

Prerequisites for attending the module:
- None

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

PY2926-KP04 - Advanced Methods in Stimulus programming using Psychtoolbox (PTB) with Matlab (StimPTB2)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each summer semester	4	20

Course of study, specific field and term:

- Master Psychology - Cognitive Systems 2022 (optional subject), psychology, Arbitrary semester
- Master Psychology 2016 (optional subject), psychology, Arbitrary semester
- Bachelor Psychology 2016 (optional subject), psychology, Arbitrary semester
- Bachelor Psychology 2020 (optional subject), psychology, Arbitrary semester
- Master Auditory Technology 2022 (optional subject), psychology, 2nd semester

Classes and lectures:

- Advanced Methods in Stimulus programming using Psychtoolbox (PTB) with Matlab (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Refresh and extension of Matlab functions, essential for Psychtoolbox
- Optimization of Psychtoolbox configuration
- Advanced text usage (continuous text, text scrolling, etc.)
- Sound generation and accurate timing of playback
- Usage of response devices (e.g. Joystick, response buttons)
- Interaction with external systems (EEG, Eyetracking, MRI)
- Graphical user interface template
- Data management in experiments

Qualification-goals/Competencies:

- Extension of knowledge with Psychtoolbox using Matlab®
- Effective handling of stimulus sequences
- Operationalisation of research questions
- The students learn to create experiments so that the following evaluation steps (statistics) can be carried out optimally

Grading through:

- Exercises
- B-Certificate (not graded)

Responsible for this module:

- Dr. rer. hum. biol. Andreas Sprenger

Teacher:

- Department of Neurology

- Dr. rer. hum. biol. Andreas Sprenger
- PD Dr. rer. nat. Dipl.-Psych. Marcus Heldmann

Literature:

- Internet Documentation Psychtoobox: https://docs.psychtoolbox.org
- Internet Matlab Documentation: http://de.mathworks.com/help/matlab

Language:

- Will be offered using an audience-oriented mixture of German and English

Notes:

Prerequisites for attending the module:
- General knowledge in Matlab is a prerequisite, e.g. for bachelor students: PY2917, DawiPro or for master students: PY4880, FoDaMatlab. Alternatively, Matlab videos on getting started and tutorials should be worked through on your own (https://de.mathworks.com/support/learn-with-matlab-tutorials.html). The Matworks Onramp course shows how to use Matlab and the important Matlab commands. All tutorials on Mathworks.com are free of cost for students and personnel of the University of Lübeck; a Mathworks account is essential which can be obtained at Mathworks with a uni-luebeck.de or a student.uni-luebeck.de email address. Knowledge of the course StimPTB1 (PY2919) is preferable. Course-shifters should check out demos of Peter Scarfe (https://peterscarfe.com/ptbtutorials.html) as well as video tutorials in the internet. Please contact me via email if there are any questions.

Prerequisites for the exam:
- None

Exam:
- At least 80% of the exercises should be of a sufficient level. Bachelor- and master students get exercises on different levels.
General knowledge in Matlab is a prerequisite, e.g. for bachelor students: PY2917-KP04 or for master students: PY4880-KP04 or in general PY2919-KP04.

PY3001-KP06 - Cognitive and affective neurosciences (KogNeuroBA)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), psychology, 2nd semester
- Bachelor Psychology 2020 (compulsory), psychology, 4th semester

Classes and lectures:

- Cognitive and affective neurosciences (lecture, 2 SWS)
- Cognitive and affective neurosciences (seminar, 1 SWS)

Workload:

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

Contents of teaching:

- Teaching concepts, theories and paradigms of the cognitive-affective neurosciences
- Acquisition of basic knowledge of the cognitive-affective neurosciences in the fields of attention, memory, learning, cognition, language, motivation and emotion
- Learning methods for the planning and execution of cognitive-affective neuroscientific experiments
- Critical evaluation of neuroscientificconcepts and methods of perception, cognition and learning, motivation and emotion

Qualification-goals/Competencies:

- Students will be able to explain and apply neuroscientific concepts in the areas of perception, cognition, learning, motivation and emotion.
- They can translate psychological questions into empirical research.
- They can use your knowledge in neuroscientific research to scientifically judge, think and discuss.
- They have acquired social competence through discussion skills and knowledge transfer.
- They have extended their knowledge to include scientific research and working techniques.
- Theycan structure and communicate newly acquired knowledge yourself.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. rer. nat. Ulrike Krämer

Teacher:

- Institute of Medical Psychology
- Prof. Dr. rer. nat. Ulrike Krämer

Literature:

- Eysenck & Keane: Cognitive Psychology: A student s handbook - Taylor & Francis 2015
- Gazzaniga, Ivry und Mangun: Cognitive Neuroscience: The Biology of the Mind - W. W. Norton & Company
- Karnath & Thier: Kognitive Neurowissenschaften - Springer

Languages:

- offered only in German
- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Module Exam:
PY3001-L1: Portfolio examination Cognitive and Affective Neuroscience with a total of 100 points, divided as follows:
- 70 points for written exam (90 min)
- 30 points for processing seminar tasks

PY4860-KP04, PY4860 - Hands on EEG data (EEGdata)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	every summer semester	4	10

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), psychology, 2nd semester
- Master psychology 2013 (optional subject), psychology, 2nd or 4th semester
- Master Psychology 2016 (optional subject), psychology, 2nd or 4th semester
- Master Auditory Technology 2017 (optional subject), psychology, 2nd semester
- Master Psychology - Cognitive Systems 2022 (optional subject), psychology, 2nd or 4th semester

Classes and lectures:

- Seminar Hands on EEG data (seminar, 2 SWS)

Workload:

- 65 Hours private studies and exercises
- 30 Hours written report
- 25 Hours in-classroom work

Contents of teaching:

- Theoretical and practical knowledge to analyze EEG-data
- Introduction into EEG-signals: neural activity, signal generation, evoked potentials, oscillations
- Preprocessing: filtering, epoching, ICA, re-referencing, ERPs, time-frequency analysis
- Statistical Parametric Mapping (SPM)
- EEGlab

Qualification-goals/Competencies:

- Theoretical knowledge about EEG and data analysis
- Ability to analyze EEG data using SPM 8 and EEGlab in combination with Matlab
- Ability to create an SPM-based and ability to interpret the results of an EEG study and summarize in a scientific text

Grading through:

- Written report
- B-Certificate (not graded)

Responsible for this module:

- Prof. Dr. rer. nat. Nico Bunzeck

Teacher:

- Institute for Psychology I
- Dr. rer. biol.hum. Tineke Steiger

Literature:

- Present literature will be given in the course:

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- PY4860 Hands on EEG data, report, 100% of module grade

AT5210-KP12 - Internship Auditory Technology 1 (ProjPrakH1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	12 (Typ B)

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory), Auditory Technology, 3rd semester
- Master Auditory Technology 2017 (compulsory), Auditory Technology, 3rd semester

Classes and lectures:

- Internship I (September-November) (block practical course, 12 SWS)

Workload:

- 320 Hours work on project
- 40 Hours written report

Contents of teaching:

- Project task in a concrete application scenario
- Documentation, presentation, motivation in heterogeneous environments
- The project task is always embedded in heterogeneous and vivid environments with significant demands on communication integration, planning, interfaces, resources, etc.

Qualification-goals/Competencies:

- The students have a deep understanding of selected aspects of auditory technology.
- They are able to implement selected aspects of auditory technology.
- They are able to document and present project results.
- They are capacble of presenting to particular audiences or under time restrictions (eg elevator pitch etc.).
- They have project experience in concrete application scenarios.
- They have basic skills in the field of project management.

Grading through:

- B-Certificate (not graded)

Responsible for this module:

- Studiengangsleitung Hörakustik und Audiologische Technik

Teacher:

- All Institutes and Clinics of the Universität zu Lübeck
- Scientific facilities at the Universität zu Lübeck or abroad with mandatory supervision by an university lecturer

Literature:

- is selected individually:

Language:

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

Notes:

Prerequisites for attending the module:
- Before the internships begin the registration of the internships is obligatory for later recognition. The corresponding forms can be found in Moodle.

Prerequisites for the exam:
- Regular and successful participation in the internship

Modul exam:
- AT5210-L1: Internship, not graded, 0% of the modul grade, has to be passed

(Part of Technische Hochschule Lübeck of the internship is 50%)
(Part of LE Computer Science / electrical engineering of the internship is 50%)

The internships can be completed in auditorytechnology companies, medical institutions or clinics or in scientific facilities outside the

university as well. It is recommended to seek a place abroad.
Both internships can be merged into one large internship.

AT5220-KP12 - Internship Auditory Technology 2 (ProjPrakH2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	12 (Typ B)

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory), Auditory Technology, 3rd semester
- Master Auditory Technology 2017 (compulsory), Auditory Technology, 3rd semester

Classes and lectures:

- Internship II (December-February) (block practical course, 12 SWS)

Workload:

- 320 Hours work on project
- 40 Hours written report

Contents of teaching:

- Project task in a concrete application scenario
- Documentation, presentation, motivation in heterogeneous environments
- The project task is always embedded in heterogeneous and vivid environments with significant demands on communication integration, planning, interfaces, resources, etc.

Qualification-goals/Competencies:

- The students have a deep understanding of selected aspects of auditory technology.
- They are able to implement selected aspects of autitory technology.
- They are able to document and present project results.
- They are capacble of presenting to particular audiences or under time restrictions (eg elevator pitch etc.).
- They have project experience in concrete application scenarios.
- They have basic skills in the field of project management.

Grading through:

- B-Certificate (not graded)

Responsible for this module:

- Studiengangsleitung Hörakustik und Audiologische Technik

Teacher:

- All Institutes and Clinics of the Universität zu Lübeck
- Scientific facilities at the Universität zu Lübeck or abroad with mandatory supervision by an university lecturer

Literature:

- is selected individually:

Language:

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

Notes:

Prerequisites for attending the module:
- Before the internships begin the registration of the internships is obligatory for later recognition. The corresponding forms can be found in Moodle.

Prerequisites for the exam:
- Regular and successful participation in the internship

Modul exam:
- AT5220-L1: Internship, not graded, 0% of the modul grade, has to be passed

(Part of Technische Hochschule Lübeck of the internship is 50%)
(Part of LE Computer Science / electrical engineering of the internship is 50%)

The internships can be completed in auditorytechnology companies, medical institutions or clinics or in scientific facilities outside the

university as well. It is recommended to seek a place abroad.
Both internships can be merged into one large internship.

PS5000-KP06, PS5000 - Student Conference (ST)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	6 (Typ B)

Course of study, specific field and term:

- Master Psychology - Cognitive Systems 2022 (compulsory), psychology, 3rd semester
- Master Biophysics 2023 (compulsory), biophysics, 3rd semester
- Master Auditory Technology 2022 (compulsory), Auditory Technology, 3rd semester
- Master MES 2020 (compulsory), interdisciplinary competence, 3rd semester
- Master Medical Informatics 2019 (compulsory), interdisciplinary competence, 3rd semester
- Master Biophysics 2019 (compulsory), biophysics, 3rd semester
- Master Auditory Technology 2017 (compulsory), Auditory Technology, 3rd semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester
- Master Robotics and Autonomous Systems 2019 (compulsory), Compulsory courses, 3rd semester
- Master Medical Informatics 2014 (compulsory), interdisciplinary competence, 3rd semester
- Master MES 2014 (compulsory), interdisciplinary competence, 3rd semester

Classes and lectures:

- Student Conference (seminar, 4 SWS)

Workload:

- 155 Hours work on an individual topic (research and development) and written elaboration
- 25 Hours in-classroom work

Contents of teaching:

- Preparation of a scientific publication in English based on the results of at least one of the project internships
- Preparation of a scientific poster in English based on the results of at least one of the project internships
- Presentation of a scientific poster in German or English, based on the results of at least one of the project internships
- Talk in English based on the results of at least one of the project internships
- Active participation in scientific discussions
- Active participation in a scientific peer-review process

Qualification-goals/Competencies:

- Students have experience in a comprehensive review of a scientific topic
- They are able to get an extensive overview of a complex scientific area
- They have the experience and ability to take an active part in scientific discussions
- They are able to defend one's work successfully in a scientific discourse
- They have knowledge of the peer-review process of publications
- They are able to constructively criticize in a blind peer-review process
-

Grading through:

- continuous, successful participation in course

Responsible for this module:

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

Teacher:

- All Institutes and Clinics of the Universität zu Lübeck

Literature:

- is selected individually:

Language:

- offered only in English

Notes:

Admission requirements for the module:
- Successful completion of at least one project internship.
- Registration for at least one project internship is required.

Admission requirements for the examination:
- Regular and successful participation

Since the content of the presentation should reflect the results of at least one of the project internships, the students will be supervised by the same university lecturer that supervised the internships. Internships can be carried out at home or abroad in medical technology companies, audiology companies and IT companies in the healthcare industry as well as hospitals and scientific institutions. The supervision by an university lecturer is obligatory.

Students for whom this course is a compulsory module have priority.

(The share of the Institute of Medical Technology in all is 75%)
(Share of medical informatics in all is 25%)

AT5990-KP30 - Master Thesis Auditory Technology (HATMArbeit)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (compulsory), Auditory Technology, 4th semester
- Master Auditory Technology 2017 (compulsory), Auditory Technology, 4th semester

Classes and lectures:

- Authoring of the Master 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:

- Independent scientific work on a complex task of auditory technology and its applications
- Scientific presentation of the problem at hand and the solutions developed

Qualification-goals/Competencies:

- The students are able to solve a complex scientific problem with state of the art methods.
- They have the expertise to plan, organize and carry out a project work.
- They can present complex information in written and oral form.
- They have gained expert knowledge on a roughly defined topic.

Grading through:

- Written report

Responsible for this module:

- Studiengangsleitung Hörakustik und Audiologische Technik

Teacher:

- Lübeck University of Applied Sciences
- All institutes of the University of Lübeck
- Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges

Literature:

- is selected individually:

Language:

- thesis can be written in German or English

Notes:

Prerequisites for attending the module:
- see study programme regulations (e.g. at least 70 ECTS points have been acquired)

Prerequisites for attending the exam:
- Approval of the application for admission to the master's thesis by the chairman of the examination board and at least 70 ECTS points have been acquired

Modul exam:
- CS5990-L1: Master´s thesis of Auditory Technology, thesis with oral exam (colloquium), 100% of module grade

If the thesis is written outside of the university (at scientific institutions or at companies) in the field of hearing aid technology, it has to be supervised by professors from the University of Lübeck or the Technische Hochschule Lübeck.

MA3110-KP04, MA3110 - Numerics 1 (Num1KP04)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), Elective, Arbitrary semester
- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary semester
- Bachelor MES 2020 (optional subject), mathematics / natural sciences, 3rd semester at the earliest
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), mathematics, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), mathematics, 4th to 6th semester
- Bachelor IT-Security 2016 (optional subject), mathematics, Arbitrary semester
- Master Auditory Technology 2017 (optional subject), compulsory module depending on previous knowledge , 1st semester
- Bachelor Computer Science 2016 (optional subject), advanced curriculum, Arbitrary semester
- Bachelor Computer Science 2016 (optional subject), Canonical Specialization Web and Data Science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), mathematics, 5th or 6th semester
- Bachelor Medical Informatics 2014 (optional subject), mathematics, 5th or 6th semester
- Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd or 5th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester
- Master MES 2011 (optional subject), mathematics, 1st semester
- Bachelor MES 2011 (optional subject), mathematics, 3rd semester
- Bachelor Computer Science 2012 (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Round-off errors and condition
- Direct solvers for linear equations
- LR decomposition
- Perturbation theory
- Cholesky decomposition
- QR decomposition, least squares fit

Qualification-goals/Competencies:

- Students understand basic numerical tasks.
- They are proficient in the modern programming language MATLAB.
- They can implement theoretical algorithms.
- They can assess the quality of a method (accuracy, stability, complexity).

Grading through:

- written exam

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)
- Analysis 2 (MA2500-KP04, MA2500)
- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Rößler

Teacher:

- Institute for Mathematics
- Prof. Dr. rer. nat. Andreas Rößler

Literature:

- M. Bollhöfer, V. Mehrmann: Numerische Mathematik - Vieweg (2004)
- P. Deuflhard, A. Hohmann: Numerische Mathematik I - 4. Auflage, De Gruyter (2008)
- P. Deuflhard, F. Bornemann: Numerische Mathematik II - 3. Auflage, De Gruyter (2008)
- M. Hanke-Bourgeois: Grundlagen der Numerischen Mathematik und des Wissenschaftlichen Rechnens - 3. Aufl., Teubner (2009)
- H. R. Schwarz, N. Köckler: Numerische Mathematik - 6. Auflage, Teubner (2006)
- J. Stoer: Numerische Mathematik I - 10. Auflage, Springer (2007)
- J. Stoer, R. Bulirsch: Numerische Mathematik II - 5. Auflage, Springer (2005)
- A. M. Quarteroni, R. Sacco, F. Salieri: Numerical Mathematics - 2. Auflage, Springer (2006)

Language:

- offered only in German

Notes:

The lecture is identical to that in module MA3110-MML/Numerics 1.

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

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

XM2720-KP03 - Image and Multidimensional Signal Processing (ImProc)

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

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), Elective, Arbitrary semester
- Master Biomedical Engineering (compulsory), imaging systems, 2nd semester
- Master Auditory Technology 2017 (compulsory module depending on previous knowledge), Auditory Technology, 2nd semester

Classes and lectures:

- Image and Multidimensional Signal Processing (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Development of the fundamentals of 2D signal processing with respect to image processing
- Getting to know simple signal processing methods concerning feature extraction, filtering, and contrast adaption
- Getting to know the basics of different image processing methods such as pre- and post processing, image segmentation and image registration
- Getting to know the mathematical description, numerical Solutions, and algortihmic implementation in digital Signal processing
- Knowledge of the two- and higher-dimensional Fourier transform and their properties
- Knowledge of the sampling theorem for two- and higher-dimensional signals

Qualification-goals/Competencies:

- The students are able to explain the fundamentals of digital image processing.
- They can describe and apply the discretization of images (sampling and quantization).
- They can explain and apply image pre-processing procedures as denoising or interpolation of images.
- They know different image segmentation algorithms.
- They can explain the fundamentals of image registration.
- They can describe and apply necessary image post-processing steps.
- They are able to adopt learned contents application specific.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering
- Dr. Ing. Mandy Ahlborg

Literature:

- Rafael C. Gonzales: Digital Image Processing - Prentice Hall, New Jersey, 2008
- Bernd Jähne: Digital Image Processing - Springer, Berlin Hedelber, 2002
- Kristian Bredies; Dirk Lorenz: Mathematische Bildverarbeitung - Vieweg und Teuber, 2011
- Klaus D. Tönnis: Grundlagen der Bildverarbeitung - Pearson Studium, 2005

Language:

- offered only in English

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Modul exam:
- XM2720-L1: Image and Multidimensional Signal Processing, written exam, 90 Min, 100% of modul grade

Identical to module XM2120 of the University of Applied Sciences Lübeck