TECHNISCHE HOCHSCHULE LÜBECK

Module Catalog

Biomedical Engineering, Master

State: 25.04.2025

Table of Contents

TECHNISCHE HOCHSCHULE LÜBECK

Biomedical Engineering, Master

1st Semester of Studies

Module: System Theory

Level	Master	**Short Name**	SYSTHEO
Responsible Lecturers	Prof. Dr. rer. nat. Thorsten M. Buzug (UzL) Prof. Henrik Botterweck		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	6
Semester of Studies	1	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	180
Frequency	WiSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	120
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering, Medical Microtechnology		
Remarks	None		

Module Course: Signals and Systems

(of Module: System Theory)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit	120	**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type	Oral Exam	**Exam Language**	English
Exam Length (minutes)	20	**Exam Grading System**	One-third Grades

Learning Outcomes	• Students can create an overview of the signal processing chain for medical imaging. • They can explain the mathematical background of the reconstruction of CT images. • They can explain the basics of the physical relationships regarding X-rays. • They can enumerate the different generations of computer tomographs and explain differences. • They can apply the Fourier transform. • They can reproduce and explain the mathematical principles of two-dimensional reconstruction of CT images. • They can apply the algebraic approach to solving a reconstruction problem. • They can apply the static approach to solving a reconstruction problem. • They can highlight the differences between two-dimensional reconstruction and three-dimensional reconstruction. • They can sketch the transition from two-dimensional reconstruction to three-dimensional reconstruction.
Participation Prerequisites	None

The previous section is filled only if there is a course-specific exam.

Contents	• 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)
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.
Remarks	None

Module Course: Numerical Methods

(of Module: System Theory)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades

Learning Outcomes	The students are aware of typical numerical effects when solving engineering problems. They can map reasonable complex real-world situations to a mathematical model. They know of typical approaches toward a solution. They may use basic mathematical techniques as working tools.
Participation Prerequisites	None

The previous section is filled only if there is a course-specific exam.

Contents	Numerical error propagation. Stability and condition. Linear systems. Basic differential equations. Eigenvector decomposition. Ill-posed problems. Basic statistical distributions. Maximum likelihood approaches.
Literature	*„Introduction to numerical methods“*, MIT OpenCourseWare 2019: Frank C. Hoppensteadt and Charles Peskin, *„Modeling and simulation in medicine and the life sciences“*, Springer, 1992.
Remarks	None

Module: Programming Workshop

Level	Master	**Short Name**	PRO
Responsible Lecturers	Prof. Dr. rer. nat. Tim Jürgens		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	4
Semester of Studies	1	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	120
Frequency	WiSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	60

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	• The students are able to solve basic programming exercises using MATLAB • The students know the syntax of the script language MATLAB • The students can apply a research-oriented task towards digital implementation with MATLAB • The students are able to use multiple ways of data visualization using MATLAB • The students understand basic concepts of signal processing with MATLAB-realized algorithms		
Participation Prerequisites	None		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering, Medical Microtechnology
Remarks	None

Module Course: Programming Workshop

(of Module: Programming Workshop)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	4
Participation Limit	25	**Semester Hours per Week**	2
Group Size	2	**Workload (hours)**	120
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Datatypes • Basic built-in MATLAB functions • Matrices and vectors • Basic and advanced plotting tools • Switch- and if-statements, for- and while-loops • Boolean operators • Cell and struct arrays
Literature	S. Eshkabilov, *„Beginning MATLAB and Simulink: From Novice to Professional “*, Apress publishing, 2019. T. Lyche, *„Exercises in Computational Mathematics with MATLAB (Problem Books in Mathematics)”*, Springer publishing, 2014. E. Tzvi, S. Oung, *„MATLAB introduction“*, electronic lecture manuscript, 2017.
Remarks	None

Module: Medicine

Level	Master	**Short Name**	
Responsible Lecturers	Prof. Dr. rer. nat. Dagmar Willkomm Prof. Dr. med. Dipl.-Ing. (FH) Hans-Jürgen Grein		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	8
Semester of Studies	1	**Semester Hours per Week**	8
Length (semesters)	1	**Workload (hours)**	240
Frequency	WiSe	**Presence Hours**	120
Teaching Language	English	**Self-Study Hours**	120
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering, Medical Microtechnology		
Remarks	None		

Module Course: Anatomy and Physiology

(of Module: Medicine)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	4
Participation Limit		**Semester Hours per Week**	4
Group Size		**Workload (hours)**	120
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	The students shall acquire a basic understanding of all tissues and organs structures and functions. They should get to know the commonly used terms, the basic principles of medical thinking, diagnostics and therapy. They shall be able to relate to the single tissues and organs productivities and to under what circumstances these can be limited. In addition, they shall learn about the principles to support and replace damaged tissues and organs. The students also acquire knowledge of the physiological regulation of the most important functions within the human body as well as the application of current technical diagnostic and therapy methods in clinical medicine		
Participation Prerequisites	None		

The previous section is filled only if there is a course-specific exam.

Contents

Basic knowledge in anatomy, cytology and histology

Overview on the main organ systems: Skeletal and muscle systems, respiratory tract, gastrointestinal tract, urogenital tract, central and peripheral nervous systems, blood and defense system

Examples are given concerning wide-spread diseases like infections, diabetes, malfunctions of heart, lungs and kidney and mechanical injuries:

1. The cardiovascular system
    1. Heart
    2. Circulation system
2. General neurophysiology and sensory system
    1. General neurophysiology
    2. Sensory system

	3. Brain function and regulation of hormonal feedback control systems
	   1. Brain function
	   2. Hormonal feedback control systems
	4. Motor system
	5. Respiration
	6. Kidneys
	7. Gastrointestinal tract and digestion
	8. Energy metabolism and nutrition

Literature	Waugh, A. Grant, *„Anatomy and Physiology in Health and Illness”*, Elsevier, 2018. R. Drake, A. Wayne Vogl, A. Mitchell, *„Gray's Anatomy for students”*, Churchill Livingstone, 2009.
Remarks	None

Module Course: Microbiology and Hygiene

(of Module: Medicine)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	4
Participation Limit		**Semester Hours per Week**	4
Group Size	25	**Workload (hours)**	120
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)	Presentation	**Self-Study Hours**	60
SL Length (minutes)	20	**SL Grading System**	One-third Grades

The following section is filled only if there is a course-specific exam.

Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades
Learning Outcomes	The students get acquainted with basic knowledge of microbiology and hygiene. A major focus is on medical microbiology and infections, which can occur when using medical technology products. In addition, students learn basics about sampling techniques, about the hygienically correct handling of potentially contaminated materials and about the avoidance of contamination by technical staff.		
Participation Prerequisites	None		

The previous section is filled only if there is a course-specific exam.

Contents	Basic knowledge of bacteriology, mycology, virology and immunology with an insight into diagnostics in medical microbiology and test systems used. A further focus is on transmission of disease, especially with regard to pathogens in hospitalized patients. In this context, also hygiene of air and water as well as methods of disinfection and sterilization are covered and experimentally explored.
Literature	Goering et al., *„Mims' Medical Microbiology"*, 5th ed. Elsevier, 2012.
Remarks	Study Achievenemts: A presentation has to be held

Module: Natural Science

Level	Master	**Short Name**	
Responsible Lecturers	Dr.-Ing. Robert Wendlandt (UKSH) Prof. Dr. sc. nat. Max Urban		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	4
Semester of Studies	1	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	120
Frequency	WiSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	60

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades

Learning Outcomes	• The students are able to analyze simplified models of the human musculoskeletal system for static joint loads. • The students are able to characterize different tissue types in the scope of orthopedic biomechanics. • The students are able to characterize the most important biomaterials used in joint arthroplasty for tissue reaction and wear properties. • Students are able to discuss the basics of the application of physical models and methods to biological/medical systems. • Students are able to explain how oxygen for metabolism comes to the cells, blood flow, lungs, alveoli's, gas law • Students understand concepts of electrical signals in nerve cells of human body • Students understand how to measure and use magnetic fields in the context of the human body
Participation Prerequisites	None

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering, Medical Microtechnology, Mechanical Engineering
Remarks	

Module Course: Biomechanics

(of Module: Natural Science)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	2
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	30
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Basic static mechanics and elasto-statics • Biomechanics of the human locomotive system • Properties of biomaterials in orthopedics • Artificial joints
Literature	Paul Brinckmann, W. Frobin, G. Leivseth (Hrsg.), „Orthopedic biomechanics", Thieme, 2015.
Remarks	None

Module Course: Biophysics

(of Module: Natural Science)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	2
Participation Limit	60	**Semester Hours per Week**	2
Group Size	10+	**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	30
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Application of physical models and methods to/for • Liquid and gas flow in the human body (e.g. transport of Oxygen to Mitochondria for ATP production) • Electrical and magnetic interactions in/with biological systems (concept of ATP to enable action potential in cells) • Diagnostic medical devices/ application as ECG, EMG, MEG and MRI
Literature	William C. Parke, „Biophysics: A Student's Guide to the Physics of Life Sciences and Medicine ", ISBN 978-3-030-44145-6, Springer, 2020. Paul A. Tipler, „Physics for Scientists and Engineers", ISBN 978-1-4292-0265-7, 2007.
Remarks	None

Module: Medical Technology

Level	Master	**Short Name**	MT
Responsible Lecturers	Prof. Dr.-Ing. Stefan Müller		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	8
Semester of Studies	1	**Semester Hours per Week**	6
Length (semesters)	1	**Workload (hours)**	240
Frequency	WiSe	**Presence Hours**	90
Teaching Language	English	**Self-Study Hours**	150

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades

Learning Outcomes	• Students have basic knowledge in medicine • They are able to communicate with physicians adequately • They have an overview about the most important physiological parameters and the according sensor principles to measure them • They are able to describe and analyze physiological systems in form of electrical equivalent circuits • They know the function and application of modern medical devices for diagnosis and therapy • Knowing of the function and practice of the main medical devices.
Participation Prerequisites	Basic knowledge in physics, mathematics and engineering sciences is advisable

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering, Medical Microtechnology, Mechanical Engineering
Remarks	None

Module Course: Medical Technology

(of Module: Medical Technology)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	6
Participation Limit		**Semester Hours per Week**	4
Group Size		**Workload (hours)**	180
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	120
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Medical Terminology, major organ systems, generation of bioelectrical potentials, a generalized medical instrument, system-transfer function • Measurement of flow, flow sensors, examples • Measurements of the respiratory system, physiology, instruments • Body temperature and temperature sensors • Bioelectrodes and biopotential • ECG (Eindhoven, Goldberger, Wilson), 3D Projection • Bioinstrumentation amplifiers, noise, electrical field, shielding, driven right leg concept • Pumps: Infusion, perfusion, insulin pumps, safety concepts • Cardiac pacemakers and defibrillators • Use of models and equivalent circuits • Exercises for the examination
Literature	John G. Webster, *„Medical Instrumentation"*, 3rd edition, Wiley and Sons, ISBN 978-0471153689, 1997.
Remarks	None

Module Course: Medical Technology - Lab

(of Module: Medical Technology)

Course Type	Practical Training	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	2
Participation Limit	25	**Semester Hours per Week**	2
Group Size	2	**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	Practical Training	**Self-Study Hours**	30
SL Length (minutes)	90	**SL Grading System**	One-third Grades

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Compulsory experiments • Lung function • ECG • Infusion and Perfusion
Literature	Hand-out, lab descriptions
Remarks	Study Achievements: Two lab reports have to be handed in

Module: Signal Processing

Level	Master	**Short Name**	SP
Responsible Lecturers	Prof. Dr. Alfred Mertins (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	4
Semester of Studies	1	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	120
Frequency	WiSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	60
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type	Oral Exam	**Exam Language**	English
Exam Length (minutes)	20	**Exam Grading System**	One-third Grades
Learning Outcomes	The students know about the basic operations of digital signal processing, they can adopt these operations to selected examples, and they can use them in the field of medical-technology. • Students are able to explain the fundamentals of linear system theory. • They are able to define and competently explain the essential elements of signal processing mathematically. • They will have a command of mathematical methods for the description and analysis of continuous-time and discrete-time signals and systems. • They are able to design digital filters and know various structures for their implementation. • They are able to apply the learned principles in practice • Analyse the digital signals using various digital transforms DFT, FFT etc. Design and develop the basic digital system. • Interpret the finite word length effects on functioning of digital filters.		
Participation Prerequisites	None		
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks			

Module Course: Signal Processing

(of Module: Signal Processing)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	2
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	30
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	•Basic signal processing knowledge •Elementary signals, LTI systems, Dirac pulse •Stability of systems •FIR and IIR filters: Impulse response and difference equation •Fourier transform and z-Transform •Pole-zero plots and the relationship to frequency responses •Discrete and fast Fourier transforms (DFT, FFT) •Sampling •Filter design for selected applications and Gibbs phenomenon
Literature	McClellan, J.H., Schafer, R.W., Yoder, M.A.: Signal Processing First. Prentice Hall Signal Processing Series, Englewood Cliffs (2003) Mertins, A.: Signaltheorie. 4. Ed., Springer, Wiesbaden (2020), in German Lecture notes
Remarks	None

Module Course: Signal Processing - Lab

(of Module: Signal Processing)

Course Type	Practical Training	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	2
Participation Limit	24	**Semester Hours per Week**	2
Group Size	2	**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	Practical Training	**Self-Study Hours**	30
SL Length (minutes)		**SL Grading System**	One-third Grades

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Introduction into Matlab • Scripts and functions • Plotting with annotations • Convolution • Fourier Transform • Sampling and discrete-time signals • FIR and IIR filter analysis • Filter design • FFT and Tasks from current research projects
Literature	see lecture
Remarks	Study Achievements: Around 5 page protocols on seven practical projects have to be handed in

Module: Electronics and Optics

Level	Master	**Short Name**	EO
Responsible Lecturers	Prof. Dr. Tim Jürgens Prof Dr. Gereon Hüttmann (UzL) Prof. Dr. Nino Karpf (UzL) Dr. Norbert Linz (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	8
Semester of Studies	1	**Semester Hours per Week**	6
Length (semesters)	1	**Workload (hours)**	240
Frequency	WiSe	**Presence Hours**	90
Teaching Language	English	**Self-Study Hours**	150
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✔ Target group specific adjustment of didactic methods ✔ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	The students shall acquire consolidated knowledge of physical, electrical, and mechanical principles of medical products. The students shall be enabled to contribute to the development of medical products according to relevant standards. The students shall know about development processes in medical technology and manage these processes according to their professional experience. The students shall be able to present results of their work adequately.		

TECHNISCHE HOCHSCHULE LÜBECK

Module Course: Medical Electronics

(of Module: Electronics and Optics)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	5
Participation Limit		**Semester Hours per Week**	4
Group Size		**Workload (hours)**	150
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	90
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	The students will have acquired a basic understanding of principles and tools applied in medical electronics. This includes the analogue circuits to measure bioelectric signals, aspect of electrical safety and the characteristics of bioelectric signal in comparison to their physiological origin.		
Participation Prerequisites	Basic knowledge in engineering sciences and analogue electronics is advisable – but not required		

The previous section is filled only if there is a course-specific exam.

Contents	•Some tools: Electrical Impedance, Transfer Function, Bode Diagram, Common Mode vs. Differential Mode Voltages •Electrical Safety of Medical Electronic Devices •Registration of Bioelectrical Signals •Potential Separation •Different forms of analog amplifiers •Measurement techniques of bioelectric signals • Power Supplies
Literature	Horowitz, P., Hill, W.: The Art of Electronics. Cambridge University Press, New York, 1999. ISBN: 0-521-37095-7 Webster, J. G.: Medical Instrumentation. Application and Design. John Wiley and Sons, Inc., New York, 1998. Mancini, R.: Op Amps For Everyone. Texas Instruments
Remarks	None

TECHNISCHE HOCHSCHULE LÜBECK

Module Course: Photonics I

(of Module: Electronics and Optics)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades

Learning Outcomes	The students will gain competence in the basic concepts of optics and photonics. They should be able to reproduce these concepts and apply them to concrete problems. Students will learn about the modern devices and their implementation. Upon successful completion of the module, students will be able to solve concrete problems in biomedical optics.
Participation Prerequisites	Basic knowledge in mathematics, physics are advisable: • Integral and differential calculus • Vector calculus • Linear algebra incl. matrix calculus • Fundamentals of classical and semiclassical physics incl. mechanics, thermodynamics, atomic physics, solid state physics, electrostatics and electrodynamics • Basic principles of optics (rays, lenses, mirrors, imaging

The previous section is filled only if there is a course-specific exam.

Contents	• Basics of optics (ray optics, wave optics, quantum optics) • Classical optical components (lenses, mirrors prisms) • Waveguides and optical fibres • Modern opto-electronic components incl. LEDs, photodiodes, CMOS-cameras, diode lasers • Radiation sources, detectors • Modern applications of photonics, especially in biomedical engineering • Knowledge about lecturer´s current research projects
Literature	Hecht, E.: Optics. München: Oldenbourg Young, M.: Optics and Lasers: Including Fibers and Optical Waveguides. Berlin: Springer

	Pedrotti, F.L., Pedrotti, L.M., Pedrotti, L.S.: Introduction to Optics. Upper Saddle River, NJ B. Saleh, Teich: Fundamentals of Photonics, Wiley
Remarks	None

Module: Design Engineering

Level	Master	**Short Name**	DE
Responsible Lecturers	Prof. Dr.-Ing. Stephan Klein Dr. Christian Damiani		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory elective	**ECTS Credit Points**	8
Semester of Studies	1	**Semester Hours per Week**	8
Length (semesters)	1	**Workload (hours)**	240
Frequency	WiSe	**Presence Hours**	120
Teaching Language	English	**Self-Study Hours**	120

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades

Learning Outcomes	**Basic Understanding of Materials:** Define and differentiate between various types of materials, including metals, polymers, ceramics, and composites. Understand the atomic and molecular structures of materials. **Material Properties:** Analyze and describe mechanical and microstructural properties of materials. Correlate material properties with their underlying atomic and molecular structures. **Material Processing:** Comprehend common material processing techniques such as casting, forging, rolling, and heat treatment. Evaluate how processing methods influence material properties. **Phase Diagrams:** Interpret phase diagrams and understand the relationships between temperature, composition, and phases in materials. **Mechanical Behavior:** Propose preventive measures to mitigate degradation. **Qualifications:** Upon completion of the course, students should be able to: Exhibit a solid understanding of the fundamental principles of material science.

	Apply material science concepts to solve engineering problems. Conduct basic material testing experiments and interpret results. Analyze and critically evaluate material choices for specific engineering applications. Effectively communicate material-related concepts and findings. Collaborate in teams to solve engineering challenges related to materials. Analyze stress and strain in materials and understand the principles of elasticity, plasticity, and fracture. **Corrosion and Degradation:** Identify common mechanisms of corrosion and wear The students know about the phases of product development considering the mechanical construction. They can structure a development process according to VDI guidelines and can apply the most important methods of problem solving. Knowledge about lecturer´s current research projects The activities and methods presented in the lecture shall be trained and applied to real research projects. The students can apply the presented methods and evaluate their benefits and limits
Participation Prerequisites	Students should have completed a bachelor's degree in engineering or a related field. Students should have a good understanding of introductory physics. Students should be comfortable with intermediate level Mathematics Knowledge in machine elements and mechanical design

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	The students shall acquire consolidated knowledge of physical, electrical, and mechanical principles of medical products. The students shall independently cope with a defined problem in medical technology. The students shall be enabled to contribute to the development of medical products according to relevant standards. The students shall know about development processes in medical technology and manage these processes according to their professional experience. The students shall be able to present results of their work adequately

Module Course: Material Science

(of Module: Design Engineering)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	4
Participation Limit		**Semester Hours per Week**	4
Group Size		**Workload (hours)**	120
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	•Introduction to materials and matter •Atomic bonds and structures •Defects in crystals •Diffusion in solids, solidification •Phase diagrams •Thermal treatments of materials •Mechanical Properties of solids •Fracture, fatigue, creep •Wear and abrasion, corrosion •Overview metals, metals in medical technology •Overview polymers, polymers in medical technology • Overview ceramics, ceramics in medical technology
Literature	W.D. Callister, Jr.: Material Science and Engineering, an Introduction. 7th edition, John Wiley and Sons, Inc. (2007). Askeland, D.: The Science and Engineering of Materials. Thomson Learning (2006)

	Schackelford, J., F.: Introduction to Material Science for Engineering, Prentice Hall (1996
Remarks	None

Module Course: Design Methodology

(of Module: Design Engineering)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	2
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	30
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Introduction (mechanical design in medical technology, importance of development for quality of products) •The design process (VDI-guideline 2221, phases in the process, methods of problem solving, development of concepts, selection and evaluation of solutions) •The designer (characteristics of good problem solvers, presenting, sketching) • Embodiment design (basic principles “simple, clear and save”, stiffness in design, design of bearings, design for primary shaping manufacturing, rapid prototyping • Tolerances (ISO-tolerancing system)
Literature	Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H.: Engineering Design: A systematic approach. 3rd ed. Springer 2007 Hales, Chr., Shayne, G.: Managing Engineering Design. 2nd ed. Springer 2004 Ullmann, D.: The Mechanical Design Process. 3rd ed. McGraw Hill Zenios, St., Makower, J., Yock, P.: Biodesign. Cambridge University Press 2010
Remarks	None

Module Course: Design Methodology - Lab

(of Module: Design Engineering)

Course Type	Practical Training	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	2
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	Practical Training	**Self-Study Hours**	30
SL Length (minutes)		**SL Grading System**	One-third Grades

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	The students work in groups of four to six on tasks coming from research projects in the lab. Other projects are formulated by external partners, usually companies. The students can use a CAD-System (solid works, solid edge) for doing the design. Tasks are taken from lecturer´s current research projects.
Literature	Hand-out from lecturer
Remarks	Study Achievements: Reports/Descriptions have to be handed in

Module: Control Systems

Level	Master	**Short Name**	CS
Responsible Lecturers	Prof. Dr. Erhardt Barth (UzL) Prof. Dr. Georg Schildbach (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory elective	**ECTS Credit Points**	8
Semester of Studies	1	**Semester Hours per Week**	6
Length (semesters)	1	**Workload (hours)**	240
Frequency	WiSe	**Presence Hours**	90
Teaching Language	English	**Self-Study Hours**	150
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	None		

Module Course: Machine Learning

(of Module: Control Systems)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	Exercise	**Self-Study Hours**	60
SL Length (minutes)	90	**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type	Oral Exam	**Exam Language**	English
Exam Length (minutes)	20	**Exam Grading System**	One-third Grades

Learning Outcomes	• Students can explain different learning problems. • You can explain different methods of machine learning and apply them exemplarily. • You can select and test a suitable learning method for a given problem. • You can recognize and explain the limits of automatic data analysis.
Participation Prerequisites	Basic knowledge in statistics

The previous section is filled only if there is a course-specific exam.

Contents	• Learning from representations • Statistical learning theory • VC dimension and support vector machines • Boosting • Deep learning • Limits of induction and weighting of the data
Literature	None
Remarks	None

Module Course: Machine Learning

(of Module: Control Systems)

Course Type	Exercise	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	1
Participation Limit		**Semester Hours per Week**	1
Group Size		**Workload (hours)**	30
Teaching Language	English	**Presence Hours**	15
Study Achievements ("Studienleistung", SL)	Exercise	**Self-Study Hours**	15
SL Length (minutes)	90	**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	

Learning Outcomes	• Students can explain different learning problems. • You can explain different methods of machine learning and apply them exemplarily. • You can select and test a suitable learning method for a given problem. • You can recognize and explain the limits of automatic data analysis.
Participation Prerequisites	None

The previous section is filled only if there is a course-specific exam.

Contents	• Learning from representations • Statistical learning theory • VC dimension and support vector machines • Boosting • Deep learning • Limits of induction and weighting of the data
Literature	None
Remarks	Study Achievements: Exercises take place every week with tutor support

Module Course: Model Predictive Control

(of Module: Control Systems)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades

Learning Outcomes	• The students have a comprehensive overview of optimal control procedures. • The students have an insight into the basics of numerical optimization. • The students can design model predictive controllers for linear and non-linear systems. • The students master various tools to implement model predictive controllers. • The students can establish system-theoretical properties of MPC controllers. • The students have insights into possible areas of application for model predictive control.
Participation Prerequisites	Participation in lecture

The previous section is filled only if there is a course-specific exam.

Contents	• Learning from representations • Statistical learning theory • VC dimension and support vector machines • Boosting • Deep learning • Limits of induction and weighting of the data
Literature	F. Borrelli, A. Bemporad, M. Morari: *Predictive Control for Linear and Hybrid Systems* - Cambridge University Press, 2017 (ISBN: 978-1107016880)
Remarks	None

TECHNISCHE HOCHSCHULE LÜBECK

Module Course: Model Predictive Control

(of Module: Control Systems)

Course Type	Exercise	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	1
Participation Limit		**Semester Hours per Week**	1
Group Size		**Workload (hours)**	30
Teaching Language	English	**Presence Hours**	15
Study Achievements ("Studienleistung", SL)	Exercise	**Self-Study Hours**	15
SL Length (minutes)	90	**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	

Learning Outcomes	• The students have a comprehensive overview of optimal control procedures. • The students have an insight into the basics of numerical optimization. • The students can design model predictive controllers for linear and non-linear systems. • The students master various tools to implement model predictive controllers. • The students can establish system-theoretical properties of MPC controllers. • The students have insights into possible areas of application for model predictive control.
Participation Prerequisites	None

The previous section is filled only if there is a course-specific exam.

Contents	• LQ optimal control and Kalman filter • Convex optimization • Invariant sets • Theory of model predictive control (MPC) • Numerical optimization methods • Explicit MPC • Practical aspects (robust MPC, offset-free tracking, etc.) • Applications of MPC
Literature	F. Borrelli, A. Bemporad, M. Morari: *Predictive Control for Linear and Hybrid Systems* - Cambridge University Press, 2017 (ISBN: 978-1107016880)

Remarks	Study Achievements: Exercises take place every week with tutor support

TECHNISCHE HOCHSCHULE LÜBECK

Biomedical Engineering, Master

2nd Semester of Studies

Module: Medical Imaging

Level	Master	**Short Name**	IM
Responsible Lecturers	Prof. Dr. Henrik Botterweck Dr. Mandy Ahlborg (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	8
Semester of Studies	2	**Semester Hours per Week**	6
Length (semesters)	1	**Workload (hours)**	240
Frequency	SuSe	**Presence Hours**	90
Teaching Language	English	**Self-Study Hours**	150

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades

Learning Outcomes	Students will be able to 'translate' the medical requirements of imaging diagnostics by users to technical terms for developers and engineers. They understand the physical principles, basic technical realizations and the general medical field of application of the most important medical imaging modalities. They know about the criteria for their development and engineering and how they are related to possible medical benefits. They have a first understanding of the relationship between physical/technical properties (e.g. pixel size, contrast…), necessary data processing (e.g. image reconstruction), possible artifacts and the final medical outcome (diagnostic value). Development of the basics of the 2D signal processing (colours spaces, image scanning, discretisation of two-dimensional signals, discrete geometry) Getting to know simple signal processing methods concerning feature extraction, filtering, and contrast adaption Getting to know different methods to restore an image Getting to know the basics of different image processing methods such as image segmentation and image registration Getting to know the mathematical description, numerical solutions, and algorithmic implementation in digital signal processing Knowledge about lecturer´s current research projects After getting to know the basic numerical approaches and methods in the lecture the students can learn and practise the concrete application to realistic medical problems in this lab. The students become aware

	of aspects and criteria of the implementation and improvement of an algorithm. Knowledge about lecturer´s current research projects
Participation Prerequisites	Numerical Methods in Medicine (lecture), Mathematics and Physics on a graduate (engineering bachelor) level are advisable Mathematical knowledge and knowledge in the field of signal-theory are advisable Lecture „Numerical Methods“

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	The students get a sound knowledge of the main imaging technologies concerning the applied principles and technologies. The students know about the great influence of mathematics on the result of computed images

Module Course: Imaging

(of Module: Medical Imaging)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Principles and classification of medical imaging, Optical Imaging, Sonography, Doppler, Diagnostic use of X-Rays, Transmission Tomography, Emission Tomography, Physical principles of nuclear magnetic resonance, typical MR imaging sequences, principles of maximum likelihood/a posteriori reconstruction, basic image processing.
Literature	Th. Buzug: Computed Tomography (Springer) O. Dössel: Bildgebende Verfahren in der Medizin (Springer)
Remarks	None

TECHNISCHE HOCHSCHULE LÜBECK

Module Course: Image Processing

(of Module: Medical Imaging)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents

Medical image processing is an active area of research. This lecture aims at developing a principle understanding for methods used in medical image processing and image analysis. The lecture will cover the mathematical description, the numerical solution as well as the algorithmic implementation of different methods used in medical image processing. Apart from the introduction into very general image processing methods this lecture will also provide some insight into state-of-the-art image processing algorithms.

This lecture is not thought as a brief overview of medical image processing and its applications. It is rather thought as a comprehensive discussion of some explicitly chosen methods in depth. Therefore, the students will not only learn how to process two dimensional signals but also gain a deep insight into applied mathematics and computer science.

The developed mathematical and numerical understanding will not only allow to understand the beauty of medical image processing but also supply the students with a basic understanding of mathematical methods, which indeed is of great value in many other fields.

In the very beginning of the lecture the students will be supplied with the basics of the representation of digital images. Subsequently several methods used for feature extraction, contrast enhancement and filtering in the spatial as well as the Fourier domain will be explained. These very lectures form the basis for the understanding of higher image processing methods such as image restauration, image segmentation and image

	registration, all of which to date still represent a highly active field of research with many unsolved problems. The lecture will not only focus on the theoretical background but will be accompanied with illustrative examples to further develop an understanding of the theoretically presented mathematical and numerical methods.
Literature	Gonzales, R. C.: Digital Image Processing, Prentice Hall, New Jersey, 2008. Jähne, B.: Digital Image Processing, Springer, Berlin Heidelberg, 2002. Lehmann, Th. et al.: Bildverarbeitung für die Medizin, Springer, Berlin Heidelberg, 1997. Pratt, W. K.: Digital Image Processing: PIKS Scientific Inside, John Wiley & Sons, 2007.
Remarks	None

Module Course: Numerical Methods - Lab

(of Module: Medical Imaging)

Course Type	Practical Training	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	2
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	Exercise	**Self-Study Hours**	30
SL Length (minutes)	90	**SL Grading System**	One-third Grades

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Simple, yet realistic problems in the fields of •medical image processing and visualization, •tomographic reconstruction, •statistical data evaluation, simulation (epidemics...), and medical -/bio-informatics (large data-sets) are posed together with example input data. The students apply given numerical tools (Matlab) and/or develop simple programs given numerical libraries in order to model, solve and analyse the tasks. A critical assessment of the results (Are the chosen methods adequate? Is the outcome realistic? What is the range of applicability? What could be improved?) is an important part of the work.
Literature	Computer (Programming/Simulation/Visualization tools), hand-outs, short presentation of results
Remarks	None

Module: Scientific Writing Project

Level	Master	**Short Name**	SW
Responsible Lecturers	Prof. Dr.-Ing. Stefan Müller and others		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	2
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	60
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	30

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Study Work	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	Pass
Learning Outcomes	• The students are able to plan and structure a research project • The students are able to execute a literature research • The students are able to write a paper according to the standards of a scientific publication		
Participation Prerequisites	None		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	The students shall be enabled to contribute to the development of medical products according to relevant standards. The students shall know about development processes in medical technology and manage these processes according to their professional experience. The students shall be able report and present results of their scientific project.

Module Course: Scientific Writing Project

(of Module: Scientific Writing Project)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	2
Participation Limit	25	**Semester Hours per Week**	2
Group Size	2	**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	Practical Training	**Self-Study Hours**	30
SL Length (minutes)		**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Systematic structure of a research project • Typical structures of scientific and technical manuscripts • Writing style and "good practices" • Literature research (methods, sources, databases) • Formatting / citation standards • Finding the right Journal for Publication • Peer review process • Writing, editing and peer review exercises in small group • Preparing a presentation
Literature	diverse
Remarks	Study Achievements: Workshop on different topics – with one review on paper or presentation

Module: Medical Electronics - Projects

Level	Master	**Short Name**	MEP
Responsible Lecturers	Prof. Dr. rer. nat. Tim Jürgens		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades

Learning Outcomes	The students shall get hands-on knowledge about different medical electronic devices and principles of measuring bioelectric signals as well as electric stimulation. The students shall be enabled to contribute to the development of medical electronic devices according to relevant standards. The students shall be able to document their results scientifically.
Participation Prerequisites	The following is advisable: Basic knowledge in engineering sciences and analogue electronics. Knowledge in programming using MATLAB Knowledge of signals and systems lecture Knowledge of the regulatory affairs for medical products and medical electronic lecture.

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	The students shall acquire consolidated knowledge of physical, electrical, and mechanical principles of medical products. The students shall be enabled to contribute to the development of medical products according to relevant standards.

	The students shall know about development processes in medical technology and manage these processes according to their professional experience. The students shall be able to present results of their work adequately

Module Course: Medical Electronics - Projects

(of Module: Medical Electronics - Projects)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size	2	**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Three projects cover a wide variety of aspects of medical electronic devices: • measurement of myocard activity • electric stimulation • measurement of evoked potentials
Literature	EN 60601-1 and related standards Specific literature about the different medical electronic devices E. Tzvi, S. Oung, *„MATLAB introduction“*, electronic lecture manuscript, 2017.
Remarks	None

Module: Regulatoy Affairs

Level	Master	**Short Name**	RA
Responsible Lecturers	Prof. Dr. sc. hum. Dipl.-Chem. Folker Spitzenberger		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	• Knowledge: The relevant legal requirements concerning registration and certification of medical devices in the US and EU, amongst other countries, in addition to the basics in quality and risk management for medical devices • Skills: Application of regulatory strategies to the development and production process of a medical device according to legislation and standards. Concepts of CE-marking. • Abilities: Application and implementation of the regulatory requirements during the life cycle of medical products. Dealing with risks in the market (declarations and regulatory actions risks).		
Participation Prerequisites	Basic knowledge in medical technology, application of medical products and quality management is advisable.		
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering and Medical Microtechnology		
Remarks	None		

Module Course: Regulatoy Affairs

(of Module: Regulatoy Affairs)

Course Type	Online Course	**Form of Learning**	Online unsupported
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Requirements and procedures concerning CE-marking and quality management system certification according to the EU-Legislation based on New Approach and New Legislative Framework concept. • Relevant EU harmonization legislation addressing medical devices including in vitro-diagnostics (IVD) and comparison with US approval schemes. • Third party auditing in the EU and corresponding requirements in the US and other markets. • Essential Requirements for safety and effectiveness, classification concepts and conformity assessment procedures for medical devices including IVD. • Basic aspects of clinical evaluation and investigation • Application of risk management requirements and procedures to medical devices. • Implementing adverse event reporting, recalls and corrective/ preventive actions in post market surveillance systems in the EU and in the US. • Technical files and the role and use of harmonized European standards for the certification and CE-marking. Requirements regarding Instructions for use and marking on the device.

Literature	Hand-out by presentation slides, Regulation (EU) 2017/745, Regulation (EU) 2017/746, EU MDCG and MEDDEV documents, 21 CFR 800 – 899, FDA databases and FDA guidelines
Remarks	None

TECHNISCHE HOCHSCHULE LÜBECK

Biomedical Engineering, Master

3rd Semester of Studies

Module: Forschungspraktikum (Research Internship)

Level	Master	**Short Name**	FPSK
Responsible Lecturers	Prof. Dr.-Ing. Stefan Müller and others		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	30
Semester of Studies	3	**Semester Hours per Week**	
Length (semesters)	1	**Workload (hours)**	900
Frequency	SuSe and WiSe	**Presence Hours**	700
Teaching Language	English	**Self-Study Hours**	200

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type		**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	Pass
Learning Outcomes	The students shall learn about the application of medical products in diagnosis as well as in therapy. The students shall experience the independent and self-reliant work on an own project. The students shall apply the methods taught in "scientific writing" Students learn how to write and submit a scientific paper. They also learn to be part of a review process.		
Participation Prerequisites	Completed Internship is necessary		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	None

Module Course: Forschungspraktikum (Research Internship)

(of Module: Forschungspraktikum (Research Internship))

Course Type	Practical Training	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	24
Participation Limit		**Semester Hours per Week**	
Group Size		**Workload (hours)**	720
Teaching Language	English	**Presence Hours**	640
Study Achievements ("Studienleistung", SL)	(Flexible)	**Self-Study Hours**	80
SL Length (minutes)		**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Students are working on their project. See detailed internship regulations.
Literature	None
Remarks	Study Achievements: Minimum 16 weeks' internship at university or in industry. A 20 to 30 page report has to be handed in.

Module Course: Studierendenkonferenz (Student Conference)

(of Module: Forschungspraktikum (Research Internship))

Course Type	Seminar	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	6
Participation Limit		**Semester Hours per Week**	
Group Size		**Workload (hours)**	180
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)	Presentation	**Self-Study Hours**	120
SL Length (minutes)		**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Students have to contribute the following to the conference: • Submission of a research paper • Submission of a poster • take part in the review-process At the conference they are supposed to • give a short presentation at the poster • present their paper in a talk
Literature	
Remarks	Study Achievements: Presentation of internship results at the annual student conference in March on campus. There will be a paper published and a poster and talk presented. Attendance is obligatory on all three days.

TECHNISCHE HOCHSCHULE LÜBECK

Biomedical Engineering, Master

4th Semester of Studies

Module: Abschluss (Master)

Level	Master	**Short Name**	A
Responsible Lecturers	Prof. Dr.-Ing. Stefan Müller and others		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	30
Semester of Studies	4	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	900
Frequency	SuSe and WiSe	**Presence Hours**	2
Teaching Language	English	**Self-Study Hours**	898
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	None		

Module Course: Abschlussarbeit (Master Thesis)

(of Module: Abschluss (Master))

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	26
Participation Limit		**Semester Hours per Week**	
Group Size		**Workload (hours)**	780
Teaching Language	English	**Presence Hours**	
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	780
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type	Thesis	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades

Learning Outcomes	• The students shall know about the application of current medical products in diagnosis and therapy and be able to critically evaluate data and draw conclusions. • The students shall acquire consolidated knowledge of physical, electrical, and mechanical principles applied in medical products. • The students shall independently cope with a defined problem in medical technology and be able to use creativity to develop new and original ideas and methods. • The students shall be enabled to independently develop medical products according to relevant standards. • The students shall be able to present results of their work and should have a knowledge of the non-technical implications of engineering practice. • The students shall be prepared for the international labour market and should have the ability to work and communicate effectively in national and international contexts. • The students shall apply research methods.
Participation Prerequisites	All credits from 1st semester and at least 20 credits from 2nd semester.

The previous section is filled only if there is a course-specific exam.

Contents	The students work on a defined task independently and present their work in writing.
Literature	None
Remarks	None

Module Course: Abschlusskolloquium (Final oral exam)

(of Module: Abschluss (Master))

Course Type	Seminar	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	4
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	120
Teaching Language	English	**Presence Hours**	2
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	118
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type	Colloquium	**Exam Language**	English
Exam Length (minutes)	60	**Exam Grading System**	One-third Grades

Learning Outcomes	• The students shall know about the application of current medical products in diagnosis and therapy and be able to critically evaluate data and draw conclusions. • The students shall acquire consolidated knowledge of physical, electrical, and mechanical principles applied in medical products. • The students shall independently cope with a defined problem in medical technology and be able to use creativity to develop new and original ideas and methods. • The students shall be enabled to independently develop medical products according to relevant standards. • The students shall be able to present results of their work and should have a knowledge of the non-technical implications of engineering practice. • The students shall be prepared for the international labour market and should have the ability to work and communicate effectively in national and international contexts. • The students shall apply research methods.
Participation Prerequisites	None

The previous section is filled only if there is a course-specific exam.

Contents	The students work on a defined task independently and present their work orally.
Literature	None
Remarks	None

TECHNISCHE HOCHSCHULE LÜBECK

Biomedical Engineering, Master

Elective Modules

Module: Anaesthesia and Artificial Ventilation

Level	Master	**Short Name**	AV
Responsible Lecturers	Prof. Dr.-Ing. Ulf Pilz		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	5
Semester of Studies	2	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	150
Frequency	SuSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	90

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	The students get to know the basics of breathing and lung mechanics The students get to know different ventilation modes and know which mode has to be applied for a specific disease The students gain knowledge in operating ventilation and anaesthesia devices The students get to know fundamental components of respiratory or anaesthetic workstations and get to know products currently used in the market The students get an overview on actual trends in ventilation and anaesthesia, e.g. green hospital, non-invasive diaphragm stimulation, new drugs for anaesthesia, device connectivity in medical context The students apply basic and sophisticated ventilation modes using anaesthesia and ventilation devices and lung simulators with adjustable lung mechanics The students learn the effects of specific diseases on lung mechanics and how to employ the optimal ventilation mode for a specific disease The students earn practical experience with different views for the user interface with anaesthesia and ventilation devices		
Participation Prerequisites	None		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods

	✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	None

Module Course: Anaesthesia and Artificial Ventilation

(of Module: Anaesthesia and Artificial Ventilation)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Lectures: Lung ventilation and the physiology of breathing, ventilation modes, anaesthetic machines, delivery of drugs in anaesthesia, actual trends in ventilation and anaesthesia, exercises and practical examples are included in the lectures: fundamentals of ventilation modes and anaesthesia devices and application on lung simulators Excursion to the Fraunhofer IMTE medical robotics and training laboratory
Literature	None
Remarks	None

Module Course: Anaesthesia and Artificial Ventilation

(of Module: Anaesthesia and Artificial Ventilation)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	2
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	Practical Training	**Self-Study Hours**	30
SL Length (minutes)		**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Practical Work: Basics of ventilation modes Sophisticated ventilation modes Anaesthesia devices and context sensitive half-times in anaesthesia
Literature	None
Remarks	Study Achievements: Active regular attendance

Module: Artificial Intelligence

Level	Master	**Short Name**	AI
Responsible Lecturers	Prof. Dr. rer. nat. habil. Floris Ernst (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	4
Semester of Studies	2	**Semester Hours per Week**	3
Length (semesters)	1	**Workload (hours)**	120
Frequency	SuSe	**Presence Hours**	45
Teaching Language	English	**Self-Study Hours**	75

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	The students are able to choose a method for machine learning for a given application amongst a variety of such methods. The chosen method can be customized to the needs of the application. The process of customization goes well beyond straightforward search of parameters and involves adjustments to the basic mathematical techniques. This leads to innovative applications for machine learning, designed and implemented by the students. The starting point are support vector machines. Skills: Self-study. Checking your own understanding after reading a scientific/mathematical text, without prior discussion in class.		
Participation Prerequisites			

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering, Robotics
Remarks	None

Module Course: Artificial Intelligence

(of Module: Artificial Intelligence)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Support Vector Machines and Dualisation • Classification • Regression • Time-Series Prediction • Lagrange Multipliers • Sequential Minimal Optimization • Geometric Reasoning
Literature	P. Norvig, S. Russell: Künstliche Intelligenz – München: Pearson 2004
Remarks	None

Module Course: Artificial Intelligence

(of Module: Artificial Intelligence)

Course Type	Exercise	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	1
Participation Limit		**Semester Hours per Week**	1
Group Size		**Workload (hours)**	30
Teaching Language	English	**Presence Hours**	15
Study Achievements ("Studienleistung", SL)	Exercise	**Self-Study Hours**	15
SL Length (minutes)	90	**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Support Vector Machines and Dualization • Classification • Regression • Time-Series Prediction • Lagrange Multipliers • Sequential Minimal Optimization • Geometric Reasoning
Literature	Given during lecture
Remarks	Study Achievements: Exercises are taking place every week with tutor support

Module: Biophysics Lab

Level	Master	**Short Name**	BPL
Responsible Lecturers	Prof. Dr. Max Urban		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type	Project Work	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades
Learning Outcomes	The students are able to successfully implement the theoretical biophysical skills from the lecture to practical problems. They learn how to write a report and work in groups to solve practical problems.		
Participation Prerequisites	None, preferably the BME biophysics lecture		
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	None		

Module Course: Biophysics Lab

(of Module: Biophysics Lab)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	3
Participation Limit	25	**Semester Hours per Week**	2
Group Size	2	**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	The students work on several tasks in the following fields: •Experiments testifying the Nernst-eq. and the Goldman-eq. •Experiments for understanding the electrophoresis and iontophoresis and the electrical behavior of different tissues •Experiments testifying the Law of Van`t Hoff (understanding the filtrations processes) Experiments for understanding MRI
Literature	See lecture
Remarks	None

Module: Clinical Application

Level	Master	**Short Name**	CA
Responsible Lecturers	Prof. Dr.-Ing. Stefan Müller and others (UzL, UKSH)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades
Learning Outcomes	The students shall acquire basic knowledge in medicine, learn to communicate with physicians adequately, and learn about the application of modern medical products. The students shall get consolidated knowledge of current medical products used for diagnosis and therapy. The students shall learn about the application of medical products in diagnosis as well as in therapy.		
Participation Prerequisites	None		
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	None		

Module Course: Clinical Application

(of Module: Clinical Application)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	3
Participation Limit	20	**Semester Hours per Week**	2
Group Size	2	**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	Test	**Self-Study Hours**	60
SL Length (minutes)	90	**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Lectures might vary from semester to semester. The numeration below lists some examples • Pediatric Medical Devices • Modern Techniques in Trauma/and Orthopedic Surgery • Nuclearmedicine • Advanced Technologies in Head and Neck Surgery • Minimal Invasive Surgery • Radiation Therapy Equipment Planning • Neurooncology • Heart valve prostheses / Mechanical circulatory support • Pathology • Anaesthesiology • Dermatology
Literature	Hand-outs and presentations from lecturers Board, transparencies, LCD-projector, visits in labs and clinics
Remarks	

Module: Computer Aided Techniques in Design

Level	Master	**Short Name**	CAD
Responsible Lecturers	Prof. Dr.-Ing. Dieter Warnack		
Department, Facility	Mechanical Engineering and Business Administration		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	5
Semester of Studies	2	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	150
Frequency	SuSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	90

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	The students should be able to understand the underlying physics of different computational methods as named under the contents of lecture below. They should be able to have a critical view on the applicability of the methods. These outcomes are achieved by attending the lecture and the practical training.		
Participation Prerequisites	Advisable knowledge • CAD •Fluid Mechanics •Mechanics of Solids • Mathematics		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering, Mechanical Engineering
Remarks	None

Module Course: Computer Aided Techniques in Design

(of Module: Computer Aided Techniques in Design)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	3
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	45
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	45
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• virtual design loop containing fluids and solids design virtual testing of flow features and structure with simplified models geometry definition with CAD virtual testing with 3D models - FEM, CFD outlook • further steps - rapid prototyping - experiments
Literature	Course packs and/ or literature as recommended in class Computer software in the laboratory
Remarks	None

Module Course: Computer Aided Techniques in Design

(of Module: Computer Aided Techniques in Design)

Course Type	Practical Training	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	2
Participation Limit		**Semester Hours per Week**	1
Group Size		**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	15
Study Achievements ("Studienleistung", SL)	Practical Training	**Self-Study Hours**	45
SL Length (minutes)		**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites	Attendance of lecture		

The previous section is filled only if there is a course-specific exam.

Contents	A virtual design is applied to a model wind turbine or an axial pump The underlying methods correspond to the methods as described in contents of lecture
Literature	as recommended in class
Remarks	Study Achievements: The practical training once a week has to be attended regularly. It needs to be passed in order to be allowed to take part in the exam

Module: Computer Vision

Level	Master	**Short Name**	CV
Responsible Lecturers	Prof. Dr. Erhardt Barth (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	4
Semester of Studies	2	**Semester Hours per Week**	3
Length (semesters)	1	**Workload (hours)**	120
Frequency	SuSe	**Presence Hours**	45
Teaching Language	English	**Self-Study Hours**	75

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Oral Exam	**Exam Language**	English
Exam Length (minutes)	20	**Exam Grading System**	One-third Grades
Learning Outcomes	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.		
Participation Prerequisites	Basic knowledge in signal processing is advisable		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	None

Module Course: Computer Vision

(of Module: Computer Vision)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• 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
Literature	Richard Szeliski: Computer Vision: Algorithms and Applications. Springer, Boston, 2011 l David Forsyth and Jean Ponce: Computer Vision: A Modern Approach. Prentice Hall, 2003 Hand-out from lecturer
Remarks	None

Module Course: Computer Vision

(of Module: Computer Vision)

Course Type	Exercise	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	1
Participation Limit		**Semester Hours per Week**	1
Group Size		**Workload (hours)**	30
Teaching Language	English	**Presence Hours**	15
Study Achievements ("Studienleistung", SL)	Exercise	**Self-Study Hours**	15
SL Length (minutes)	90	**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• 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
Literature	Richard Szeliski: Computer Vision: Algorithms and Applications. Springer, Boston, 2011 David Forsyth and Jean Ponce: Computer Vision: A Modern Approach. Prentice Hall, 2003 Hand-out from lecturer
Remarks	Study Achievements: Exercises take place every week with tutor support

Module: Health Technology Assessment

Level	Master	**Short Name**	HT
Responsible Lecturers	Dr. Dagmar Lühmann (UKE)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	The students know about the role of Health Technology Assessment HTA during decision-making-processes in the healthcare-system The students know structure, methods and typical contents of Health Technology Assessments. The students are able to judge about the scientific value of HTA reports. The students are enabled to design a record for a HTA		
Participation Prerequisites	None		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	None

Module Course: Health Technology Assessment

(of Module: Health Technology Assessment)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Introduction to Technology Assessment, History, International Developments and Collaborations, relation to industry and politics Basics of Epidemiology; prototypic description of diseases: severity, course, outcomes; determination of the "burden of illness"; examples Description of technologies: technical characteristics and functioning; requirements for its use; "Life cycle" of technologies (e.g. diffusion, patterns of use, regulatory status) Assessing safety, efficacy, effectiveness of diagnostic technologies – with a special focus on medical devices Assessing safety, efficacy, effectiveness of therapeutic and / or preventive interventions - with a special focus on medical devices, Basics of Health economics; Social and ethical implications of technology use Drawing conclusions, Information resources
Literature	Goodman CS. HTA 101: Introduction to Health Technology Assessment. Bethesda, MD: National Library of Medicine (US); 2014. https:// www.nlm.nih.gov/nichsr/hta101/HTA_101_FINAL_7-23- 14.pdf
Remarks	LCD-projector, guidelines, standards, board, databases

Module: Human Biochemistry

Level	Master	**Short Name**	HB
Responsible Lecturers	Dr. Mia Lahey-Rudolph		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	4
Semester of Studies	2	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	120
Frequency	SuSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	60

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades
Learning Outcomes	Biochemistry with related aspects of actual medical applications (Medical Biotechnology), Molecular aspects of *in vitro* Diagnostics. Students gain knowledge in lab work organization, learn important biochemical methods with practical and theoretical understanding. They can write comprehensive lab reports that ensure reproducibility of experimental results and can apply critical thinking with regard to technical limitations.		
Participation Prerequisites	Advisable: Introductory biochemistry and cell biology Introductory lab work in chemistry and/or biochemistry courses as bachelor preferable		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	None

Module Course: Human Biochemistry

(of Module: Human Biochemistry)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	4
Participation Limit	16	**Semester Hours per Week**	4
Group Size	2	**Workload (hours)**	120
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)	Practical Training	**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	One-third Grades

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Basic / Advanced Biochemistry lectures Main classes of biomolecules (proteins, carbohydrates, lipids, nucleic acids), gene expression, handling of micropipettes/analytical balance, buffer production, acid/base titration, immune biochemistry and ELISA, DNA methods incl. PCR, primer-design, electrophoresis, cytochemistry
Literature	Not fixed: journal articles, human metabolism: textbooks, Lab script
Remarks	Lectures using presentations and board, student´s talks/open discussions, interactive teamwork with lecturer/feedback Description/performance of lab experiments

Module: Implantable Hearing Devices

Level	Master	**Short Name**	IHD
Responsible Lecturers	Prof. Dr. Tim Jürgens		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	60	**Exam Grading System**	One-third Grades
Learning Outcomes	The students have acquired the necessary specialist knowledge to classify various hearing implants according to their respective technology and indication. The students understand the properties and restrictions of the electrode-nerve interface.The students know the background of the various adaptation strategies and rehabilitation measures and can evaluate them taking into account the individual requirements and psychosocial aspects of the hearing impaired.		
Participation Prerequisites	Advisable: Basic knowledge about anatomy and physiology Basic knowledge about medical electronics and medical technology Basic knowledge about signals and systems		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	None

Module Course: Implantable Hearing Devices

(of Module: Implantable Hearing Devices)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit	20	**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Candidacy for implantation • psychosocial development of deaf and implanted children and adults • Medical and surgical aspects of implantation • Design of implantable hearing devices • Physiological aspects of implantable hearing devices • Music perception, psychoacoustics, and speech understanding with cochlear implants • Fitting and rehabilitation aspects • Telemetry, technical and safety aspects of cochlear implants
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 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
Remarks	None

Module: Innovation Management and Marketing

Level	Master	**Short Name**	IMM
Responsible Lecturers	Prof. Dr. Dipl-Kfm. Marc Oliver Opresnik		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades

Learning Outcomes

Upon successful completion of this course, students will be able to:

Understand Key Concepts in Innovation and Marketing:

- Gain a comprehensive understanding of the fundamental principles of international marketing and innovation management, including how these two fields interrelate.
- Identify and explain critical terms, frameworks, and processes that drive marketing and innovation within organizations.

Analyze Strategic and Operational Challenges:

- Critically evaluate strategic and operational planning and decision-making processes relevant to innovation and marketing, using real-world examples and case studies.
- Develop the ability to identify key decision points and strategic challenges that organizations face when balancing innovation with marketing needs.

Develop Executive-Level Skills for Global Markets:

- Prepare for leadership roles by understanding the challenges of international management and marketing, equipping students with the tools needed to assume executive functions in a global business context.
- Apply best practices to lead marketing and innovation initiatives that drive organizational growth and competitive advantage.

Apply Innovation as an Integrated Management Process:

- Understand innovation not as a series of isolated activities but as an integrated and ongoing process within an organization
- Design and implement innovation strategies that align with overall business objectives and create sustainable competitive advantages.

	Solve Complex Problems Related to Innovation and Marketing: • Use critical thinking and problem-solving skills to tackle complex issues faced by companies when developing and marketing innovative products. • Analyze international case studies to understand the practical challenges companies encounter in today's globalized economy. **Contribute to Sustainable Business Development:** • Understand how innovation and marketing contribute to the long-term sustainability and competitiveness of firms, and how firms can innovate to meet emerging market trends. • Assess the social, economic, and political factors that influence innovation and marketing strategies at the firm level. **Engage with Gender and Diversity Issues in Innovation:** • Understand the importance of inclusive language and diverse perspectives in innovation management and marketing, ensuring gender and diversity considerations are integrated into business strategies.
Participation Prerequisites	None

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	None

Module Course: Innovation Management and Marketing

(of Module: Innovation Management and Marketing)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	This course provides an introduction to international marketing and innovation management: In addition to the discussion of basic terms and interdependencies of marketing and innovation management a special focus is on the identification and description of strategic and operational planning and decision problems. In order to facilitate an application of the discussed material, the participants will have the possibility to practice in the context of international case studies which will be presented and analysed in class. The subject of innovation management is often treated as a series of separate specialisms, rather than an integrated task. The main aim of this course, however, is to bring together the areas of innovation management and marketing and to keep a strong emphasis on innovation as an integrated management process. As innovation continues to be at the forefront of economic and political debate about how to improve the competitiveness of economies and firms, this course will provide some insight into the problems faced by firms as they try to develop and market innovative products that will help them to achieve sustainable development and competitive advantages.
Literature	Prime Reading: Hollensen, S. / Opresnik, M.: Marketing: Principles and Practice. A management-oriented approach, 5th ed., Opresnik Management Consulting, 2023

	Additional Literature: Kotler, P. / Keller, K. / Opresnik, M.: Marketing Management, 15th Edition, Pearson, 2023 Armstrong, G. / Kotler, P. / Opresnik, M.: Marketing: An Introduction, 15th Edition, Pearson, 2022
Remarks	None

Module: Medical Deep Learning

Level	Master	**Short Name**	MDL
Responsible Lecturers	Prof. Dr. Mattias Heinrich (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	6
Semester of Studies	2	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	180
Frequency	SuSe	**Presence Hours**	90
Teaching Language	English	**Self-Study Hours**	90

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades

Learning Outcomes	The students know the importance of data security, patient anonymization and ethics for clinical studies with sensitive data. They know methods and tools for collecting, pre-processing, storing and annotating large data sets for deep learning from medical data. You have a good understanding of deep / convolutional neural networks for general data processing (signals / text / images), their learning process and the assessment of their quality for new data. They understand the principles of weakly supervised learning, transfer learning, concept development and generative adversarial networks. You will know how to examine learned feature representations for the interpretation and visualization of high-dimensional abstract data. You can implement modern network architectures in DL frameworks and adapt and expand them to given problems in medicine. They have a broad overview of current applications of deep learning in medicine in research and clinical practice and can transfer their knowledge to future topics..
Participation Prerequisites	None

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering, Robotics

Remarks	None

Module Course: Medical Deep Learning

(of Module: Medical Deep Learning)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	4
Participation Limit	16	**Semester Hours per Week**	2
Group Size		**Workload (hours)**	120
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Heart disease health care: • ECG signal analysis for arrhythmia detection or sleep apnea and for mobile low-cost devices • MRI sequence analysis for anatomical segmentation and temporal modelling • Pathology and semantic image capture and localization • Analysis of text / natural language (radiology reports / study articles) for multimodal data mining in Electronic Health Records (EHR) • Computer-aided detection and classification of diseases: • CT lung nodule detection for cancer screening with transfer learning • Poorly monitored anomaly detection and biomarker detection • Interpretable and reliable deep learning systems • Human interaction and correction within deep learning models • Visualization of uncertainties and internally learned representations • Deep learning concepts, architectures and hardware • Convolutional Networks, Residual Learning, Deep Networks • Loss functions, derivatives, stochastic optimization • Cloud Computing, GPUs, Low Precision Computing, DL Frameworks

Literature	Ian Goodfellow, Yoshua Bengio und Aaron Courville: *Deep Learning* - The MIT Press
Remarks	None

Module Course: Medical Deep Learning

(of Module: Medical Deep Learning)

Course Type	Exercise	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	2
Participation Limit	16	**Semester Hours per Week**	2
Group Size		**Workload (hours)**	60
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	Exercise	**Self-Study Hours**	30
SL Length (minutes)	90	**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Heart disease health care: • ECG signal analysis for arrhythmia detection or sleep apnea and for mobile low-cost devices • MRI sequence analysis for anatomical segmentation and temporal modelling • Pathology and semantic image capture and localization • Analysis of text / natural language (radiology reports / study articles) for multimodal data mining in Electronic Health Records (EHR) • Computer-aided detection and classification of diseases: • CT lung nodule detection for cancer screening with transfer learning • Poorly monitored anomaly detection and biomarker detection • Interpretable and reliable deep learning systems • Human interaction and correction within deep learning models • Visualization of uncertainties and internally learned representations • Deep learning concepts, architectures and hardware • Convolutional Networks, Residual Learning, Deep Networks • Loss functions, derivatives, stochastic optimization • Cloud Computing, GPUs, Low Precision Computing, DL Frameworks

Literature	Ian Goodfellow, Yoshua Bengio und Aaron Courville: *Deep Learning* - The MIT Press
Remarks	Study Achievements: Exercises are taking place every week with tutor support

Module: Medical Robotics

Level	Master	**Short Name**	MEDROB
Responsible Lecturers	Prof. Dr. rer. nat. habil. Floris Ernst (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	4
Semester of Studies	2	**Semester Hours per Week**	3
Length (semesters)	1	**Workload (hours)**	120
Frequency	SuSe	**Presence Hours**	45
Teaching Language	English	**Self-Study Hours**	75

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	The participants are able to derive the inverse kinematic equation for a given robot construction with 6 degrees of freedom, and implant it in an application. Design goals for a robotic application can be formulated and reduced to a practical system. Mathematical methods for machine learning can be applied to motion learning, considering the dynamics of motion. The dynamics of motion in space can be mapped to learning techniques. Skills: Reading a scientific text on your own, without direct oral presentation. Answering questions about a scientific text, not having attended a class on this text.		
Participation Prerequisites	Basic knowledge in robotics is advisable		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering, Robotics
Remarks	None

Module Course: Medical Robotics

(of Module: Medical Robotics)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Kinematics, path planning of robot systems • Robot Programming • Medical Navigation • Sensors in medical applications • Surgery planningl Velocity kinematics after motion prediction • Motion planning
Literature	J. -C. Latombe: Robot Motion Planning –Dordrecht: Kluwer 1990 J.J. Craig: Introduction to Robotics - Pearson Prentice Hall 2002 Lecture notes (400 pages full text)
Remarks	None

Module Course: Medical Robotics

(of Module: Medical Robotics)

Course Type	Exercise	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	1
Participation Limit		**Semester Hours per Week**	1
Group Size		**Workload (hours)**	30
Teaching Language	English	**Presence Hours**	15
Study Achievements ("Studienleistung", SL)	Exercise	**Self-Study Hours**	15
SL Length (minutes)	90	**SL Grading System**	Pass

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Kinematics, path planning of robot systems • Robot Programming • Medical Navigation • Sensors in medical applications • Surgery planningl Velocity kinematics after motion prediction • Motion planning Sequential Minimal Optimizationl
Literature	J. -C. Latombe: Robot Motion Planning –Dordrecht: Kluwer 1990 J.J. Craig: Introduction to Robotics - Pearson Prentice Hall 2002 Lecture notes (400 pages full text)
Remarks	Study Achievements: Exercises take place every week with tutor support

TECHNISCHE HOCHSCHULE LÜBECK

Module: Medical Technology – Selected Topics

Level	Master	**Short Name**	MTST
Responsible Lecturers	Prof. Dr.-Ing. Stefan Müller. Prof. Dr. Max Urban		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	4
Semester of Studies	2	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	120
Frequency	SuSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	60

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Project Work	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades
Learning Outcomes	• Students are able to analyze a medical measurement task and can convert it into technical requirements • They are able to describe the function of a medical device in form of a block diagram and can separate it into technical sub-systems (filters, amplifiers, control-loops) • They are able to analyze and describe the functions of the sub-systems • They are able to simulate electronic circuits • They are able to design, populate and test simple printed circuit boards		
Participation Prerequisites			

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	None

Module Course: Medical Technology – Selected Topics

(of Module: Medical Technology – Selected Topics)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	4
Participation Limit	16	**Semester Hours per Week**	4
Group Size	2	**Workload (hours)**	120
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Lecture: • step by step discussion of the construction for a typical medical device (e.g. pulse oximeter, ECG amplifier) • theoretical background (origin of the signal, constraints for signal analysis) • technical requirements • block diagram, separation of the device into sub-systems • electronic circuit design • circuit simulation in LTSpice • design of printed circuit board Lab: building and test of the device discussed in the lecture
Literature	Hand-out John G. Webster „Medical Instrumentation“, 3rd edition, Wiley and Sons.
Remarks	None

Module: Nuclear Imaging

Level	Master	**Short Name**	NI
Responsible Lecturers	Prof. Dr. rer. nat. Magdalena Rafecas (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type	Oral Exam	**Exam Language**	English
Exam Length (minutes)	20	**Exam Grading System**	One-third Grades
Learning Outcomes	• instrumentation activities; • study of novel detector concepts; • development of radioactive phantoms; • Monte Carlo simulations; • development of models and algorithms for image reconstruction		
Participation Prerequisites	None		
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	None		

TECHNISCHE HOCHSCHULE LÜBECK

Module Course: Nuclear Imaging

(of Module: Nuclear Imaging)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	3
Participation Limit	16	**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Physical, biological and medical basics of nuclear imaging • Scintigraphy • Positron emission tomography (PET) • Single photon emission computed tomography (SPECT) • Clinical and preclinical applications
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
Remarks	None

Module: Photonics II

Level	Master	**Short Name**	PHOTII
Responsible Lecturers	Prof Dr. Gereon Hüttmann (UzL) Prof. Dr. Nino Karpf (UzL) Dr. Norbert Linz (UzL)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	4
Semester of Studies	2	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	120
Frequency	SuSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	60
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades
Learning Outcomes	Upon successful completion of the module, students should be able to • name, reproduce and apply the basic principles of modern optics. • specifically, name the special conditions for the use of lasers and modern optics in biology and medicine. • present a certain topic of modern photonics or biomedical optics to other students. The students should gain hands-on experience on the use of optical components. They should know who to conduct experiments and how to evaluate experimental results.		
Participation Prerequisites	Knowledge in optics and photonics, as it is part of the lecture Photonics I (1332) are advisable		
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	None		

Module Course: Photonics II

(of Module: Photonics II)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	4
Participation Limit		**Semester Hours per Week**	4
Group Size	6	**Workload (hours)**	120
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)	Practical Training	**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	One-third Grades

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Fourier optics • Laser, interferometry, and holography • Spectroscopy, nanophotonics • Laser-tissue interaction • Biomedical applications and laser medicine • Optical coherence tomography (OCT) • Modern microscopy
Literature	Lakowicz: Principles of Fluorescence Spectroscopy Demtröder: Laser Spectroscopy H.-P. Berlien, G.J.Müller, Applied Laser Medicine V. Tuchin, Handbook of Optical Biomedical ImagingT. Vo-Dinh, Biomedical Photonics Handbook P.N. Prasad, Introduction to Biophotonics
Remarks	Lecture with video projector/blackboard, and experimental work in labs

Module: Quality Management in Healthcare

Level	Master	**Short Name**	QMH
Responsible Lecturers	Prof. Dr.-Ing. Wen-Huan Wang		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)		**Exam Grading System**	One-third Grades
Learning Outcomes	Upon successful completion, the student will have acquired a solid understanding of quality management systems and will be proficient in utilizing various techniques to address issues related to product and process quality. Their competence in quality management will enable them to solve problems and ensure quality.		
Participation Prerequisites	None		
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✔ Target group specific adjustment of didactic methods ✔ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	None		

Module Course: Quality Management in Healthcare

(of Module: Quality Management in Healthcare)

Course Type	Project Work	**Form of Learning**	Online supported with presence hours
Mandatory Attendance	yes	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)	(Flexible)	**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	One-third Grades

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Lecture: • Requirements on products • Quality tools Q7 • Management tools M7 • Quality function deployment • Customer perceived quality • Process optimization • Capability analysis • Statistical process control • Standards for quality management systems • Audit and certification Project: • Analysis and improvement of medical devices by using quality management techniques such as House of Quality
Literature	ISO 9000 - Quality management systems - fundamentals and vocabulary ISO 9001 - Quality management systems - requirements

	ISO 9004 - Quality management systems - guidelines for performance improvements ISO 13485 - Medical devices – quality management systems – Requirements for regulatory purposes ISO 19011 - Guidelines for auditing management systems
Remarks	Study Achievements: In the practical part, there will be a presentation and a report

TECHNISCHE HOCHSCHULE LÜBECK

Module: Specialized Biomechanics

Level	Master	**Short Name**	SB
Responsible Lecturers	Dr.-Ing. Robert Wendlandt (UKSH)		
Department, Facility	(Unspecified)		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Written Exam	**Exam Language**	English
Exam Length (minutes)	90	**Exam Grading System**	One-third Grades
Learning Outcomes	The students are able to describe basic regulatory requirements for orthopaedic medical devices and describe applicable test methods. The students are able to characterize the relationship between motion analysis and rigid body simulations. The students are able to describe the theoretical principle of finite element analysis and are able to conduct and evaluate numerical simulations for biomechanical systems.		
Participation Prerequisites	Basic knowledge in orthopaedic biomechanics (static mechanics of the musculoskeletal system, properties of tissue), Elasto-static mechanics, Linear algebra is advisable		

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)
Applicability	Biomedical Engineering
Remarks	None

Module Course: Specialized Biomechanics

(of Module: Specialized Biomechanics)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	• Regulatory demands and strategies for mechanical testing of artificial joints and fracture implants • Motion analysis of the human body • Simulation of rigid body systems • Theory and application of finite element analysis for biomechanical problems
Literature	Hibbeler, R. Mechanics of Materials. Prentice Hall, 2010 Madenci, E., Guven, I.: The Finite Element Method and Applications in Engineering Using ANSYS. Springer, 2006
Remarks	Board, LCD-projector, models, Computer Lab

Module: Successful Negotiation and Communication

Level	Master	**Short Name**	SNC
Responsible Lecturers	Prof. Dr. Dipl-Kfm. Marc Oliver Opresnik		
Department, Facility	Applied Natural Sciences		
Course of Studies	Biomedical Engineering, Master		
Compulsory/elective	Elective	**ECTS Credit Points**	3
Semester of Studies	2	**Semester Hours per Week**	2
Length (semesters)	1	**Workload (hours)**	90
Frequency	SuSe	**Presence Hours**	30
Teaching Language	English	**Self-Study Hours**	60
The following section is filled only if there is **exactly one** module-concluding exam.			
Exam Type	Oral Exam	**Exam Language**	English
Exam Length (minutes)	20	**Exam Grading System**	One-third Grades
Learning Outcomes	The students know about to know the techniques, strategies and tactics of successful negotiations and apply them in a practical manner. The students are prepared for executive functions in their future career.		
Participation Prerequisites	None		
The previous section is filled only if there is **exactly one** module-concluding exam.			
Consideration of Gender and Diversity Issues	✔ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)		
Applicability	Biomedical Engineering		
Remarks	None		

Module Course: Successful Negotiation and Communication

(of Module: Successful Negotiation and Communication)

Course Type	Project Work	**Form of Learning**	Presence
Mandatory Attendance	yes	**ECTS Credit Points**	3
Participation Limit		**Semester Hours per Week**	2
Group Size		**Workload (hours)**	90
Teaching Language	English	**Presence Hours**	30
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	60
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents	Participants acquire successful negotiation techniques to better understand and lead negotiations in every situation. In addition, students will learn how to analyse negotiation partners and their motives thoroughly, interpret group processes and how to keep a cool head in difficult situations. The knowledge transfer in the seminar is supported by the integration of real-life examples and the application of practical cases. A leader constantly faces situations in which he needs to represent his own position and to achieve the best results for his business, his project, his strategy or his team. In this context, interdisciplinary negotiation, communication and reasoning skills are of decisive importance. Conversation, argumentation and negotiation skills is the ability to convincingly act and to meet the negotiation or dialogue partners - be they superiors, colleagues, customers or external stakeholders such as suppliers, politicians or investors - with a sophisticated negotiation technique in order to achieve the desired goals. The challenge is always to reach a constructive agreement and to lead the negotiation in such a way that a sustainable win-win strategy for all parties involved is generated.
Literature	Prime Reading: Opresnik, M.: Using the Force of Communicative Intelligence: Simply and intelligently explained strategies and tactics for successful negotiations, sales talks and presentations, Opresnik Management Consulting, Lübeck, 2020

	Opresnik: Opresnik, M.: The Hidden Rules of Successful Negotiation and Communication, Springer, Heidelberg/New York/London, 2014
Remarks	None