HAW HAMBURG

Faculty of Life Sciences

Module compendium

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Master degree program
HAW Hamburg

European Master of Medical Technology and Healthcare Business (EMMaH)

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Department Medizintechnik / Fakultät Life Sciences
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HAW HAMBURG

Module compendium

Master's degree program HAW Hamburg

European Master of Medical Technology and Healthcare Business (EMMaH)

Faculty of Life Sciences
Department of Biomedical Engineering

June 2024

Approved by the Faculty Council of the Faculty of Life Sciences on 20.06.2024

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Aims of the study program

This module description is valid for the master programme “European Master of Medical Technology and Healthcare Business” (EMMaH). This master ‘s programme is run jointly with three institutions:

- Hochschule für Angewandte Wissenschaften Hamburg (HAW)
- Instituto Politécnico do Porto (IPP), Escola superior de saúde (ESS)
- Université de Lille UFR3S - Faculté Ingénierie et Management de la Santé (ILIS)

They regulate the organization, execution of the studies and the examinations and are supplemented by the subject-related study and examination regulations for the specific master ’s programme at each institution. This module description refers to the modules taught at HAW Hamburg only.

Giving due regard to changes and requirements in the working world, the aim of the master’s Programme in EMMaH is to impart to students holding a relevant bachelor's degree the particular knowledge, skills and methods required in the medical technology and management field in a way that enables them to conduct scientific work, to critically assess and integrate scientific findings and knowledge, and to act responsibly. In order to achieve these objectives, the master’s programme in EMMaH strives to link research and instruction very closely with one another, inter alia through intensive lab courses conducted in collaboration with the three higher education institutions in Hamburg, Lille and Porto.

Master’s degree programmes are advanced courses and lead to a further and higher academic and vocational qualification. This module compendium describes the course of studies "European Master of Medical Technology and Healthcare Business (EMMaH)" of the HAW Hamburg.

The full-time study is designed for 4 semesters (2 years). The graduate-level courses in Hamburg part cover scientific and engineering knowledge focused on the field of biomedical engineering with emphasis on the processing, control and imaging of biomedical signals and physiological control loops including virtual reality applications. The course is completed by regulatory and technology assessment aspects. Most lectures are complemented by associated practical courses with up-to-date software tools and hardware, e.g., in our research labs or at the hospital sites of our collaboration partners. In a mandatory project seminar, the students are engaged in autonomous scientific studies in small groups with one person of each country. Enhanced soft skills are acquired in the seminars and during the lectures by intense discussions and small projects like preparation of presentations, posters and papers. In the master thesis, the students will demonstrate their ability for autonomous scientific work at graduate level. The courses are held in English language.

Graduates have the ability to independently acquire new fields of knowledge and to solve complex problems, even above the current state of knowledge, using scientific methods. Graduates are capable to isolate problems in a new area of expertise or such an area in development and to encircle the most probable solution approach. They have the continuing ability of composing new technical solutions and new process strategies in the field of biomedical engineering and to transfer these solutions into clinical use or in industrial production. Although the course is designed for students interested in designing biomedical applications, graduates can not only work in research & development, but also in a company’s

production division or in technical functions in a hospital or research institutes. Graduates are qualified to join a doctorate program subsequently.
The Study and Examination Regulation for this course (Studiengangsspezifische Prüfungs- und Studienordnung für den konsekutiven Masterstudiengang European Master of Medical Technology and Healthcare Business (EMMaH) (M.Sc.) an der Hochschule für Angewandte Wissenschaften Hamburg (HAW Hamburg) in Kooperation mit dem Instituto Politécnico do Porto — Escola Superior de Saúde do Porto (IPP) und der Université de Lille UFR3S - Faculté Ingénierie et Management de la Santé (ILIS)) as well as the General Study and Examination Regulation for Bachelor- and Master Courses of Studies in Engineering, Natural and Health Science as well as Informatics of the Hamburg University of Applied Sciences (Allgemeine Prüfungs- und Studienordnung für Bachelor- und Masterstudiengänge der Ingenieur-, Natur- und Gesundheitswissenschaften sowie der Informatik an der Hochschule für Angewandte Wissenschaften Hamburg (APSO-INGI)) are important applicable documents, too. These and more applicable regulations and further information are accessible at the HAW websites, at the sites of the Faculty of Life Sciences, Department Medizintechnik.

Module outcome matrix

1	2	General qualification goals							Fields of Activity						
Nr	**Module**	**Knowledge and Comprehension**	**Analysis objectives and tasks**	**Finding and use of knowledge in new**	**Problem solving, research and decision**	**Self-system**	**Reflection**	**Communication**	**Management**	**Research & Development**	**Production and Maintenance**	**Assembly and Commissioning**	**Technical Support**	**Project a. Productmanagement**	**Controlling**
1	Project Seminar in Engineering		**x**	**x**	**x**		**x**	**x**							
2	Health Technology Assessment /Regulatory Affairs		**x**		**x**										
3	Numerical Mathematics	**X**		**x**	**x**	**x**									
4	Simulation and Virtual Reality in Medicine	**x**		**x**	**x**	**x**									
5	Advanced Control Systems	**x**		**X**	**x**	**x**									
6	Modelling Medical Systems	**x**		**x**	**x**	**x**									
7	Master Thesis and Colloquium		**x**	**x**	**x**		**x**	**x**							

Module and course structure

Nr.	Modul	Credit Points	Semester*	lecture	Course Type	SHW	Achievement type	Examination Type	Group Size
1	Project Seminar in Engineering	5	W	Project Seminar in Engineering	PJ	4	PL	H, (K, R, M, THP)	20
2	Health Technology Assessment /Regulatory Affairs	5	W	Regulatory Affairs	SeU	2	PL	M, (H, R, THP)	20
			W	Health Technology Assessment	SeU	2			20
3	Numerical Mathematics	5	W	Numerical Mathematics	SeU	4	PL	K, (H, R, M, PP, THP)	20
4	Simulation and Virtual Reality in Medicine	5	W	Simulation and Virtual Reality in Medicine	SeU	2	PL	PP (THP)	20
			W	Simulation and Virtual Reality in Medicine, **Practical Work (SimLab**)	Üb	2			20
5	Advanced Control Systems	5	W	Advanced Control Systems Methods	SeU	2	PL	PP, (K, R, M, THP)	20
			W	Advanced Control Systems, Tools, **Practical Work**	SeU	2			
6	Modelling Medical Systems	5	W	Biomechanical modeling and validation	SeU	2	PL	H, (K, R, M, THP)	20
			W	Finite Element Analysis	SeU	2			
	Gesamt	**30**				**24**			

Legend:
SHW = Presence hours per week during semester
Achievement type: PL = examination, PVL = preliminary examination
Course type: ST = seminaristic teaching, PJ = Project, Sem = Seminar (>80% presence obligatory)
Achievement type: PL = Examination (graded)
Examination type: K = written examination, M = oral examination, R = paper or oral examination, H = Home project or term paper, PP = portfolio examination, THP = take home examination

Forms of examination

In accordance with § 14 APSO-INGI, as amended from time to time, the forms of examination for the subsequent module manual are defined as follows:

Home Project or Term Paper (HP)
A home project is a piece of written work, to be produced by the student on his or her own and outside class hours, in which the student is to prove that he or she is able to investigate and analyse a set question or subject independently. A maximum of three months is allowed for completion. If the home project constitutes an examination, the program-specific examination and study regulations may specify whether or not a colloquium is to be held once the written project has been submitted. Colloquia should last between 15 and 45 minutes and are generally to be held within one month of submission of the written work.

Written examination (WE)
A written examination is completed under supervision. Students must complete the set questions on their own, either without the use of study aids or with the use of specified study aids only. Written examinations last at least 60 and no longer than 240 minutes.

Oral examination (OE)
In an oral examination, a student must demonstrate in discussion with the examiner that he or she fully understands the material on which he or she is being examined. Oral examinations generally last at least 15 and no more than 45 minutes. Oral examinations may be conducted as individual or group examinations and are to be conducted by one examiner and one assessor in accordance with §13 (4) APSO-INGI. An oral examination may alternatively be conducted by two or more examiners instead of one, i.e., by a panel of examiners; in such a case, the student is to be examined by one examiner only in each of the various examination subjects. Oral examinations are always assessed and graded by one examiner only, no matter whether they are conducted by several examiners or by an examiner and an assessor. The examiner responsible for grading in each case must consider the views of the other examiners/the assessor before deciding on the grade to be awarded. The main aspects covered in and results of each oral examination are to be recorded. The record is signed by the examiners and assessor and is filed with the examination documents.

Paper or Oral Presentation (Pap)
A paper is a presentation lasting between 15 and 45 minutes based on written preparation by the student. A paper is followed by a discussion led by the student or tutor. Papers should not be read out from detailed notes; students should be able to speak spontaneously. Digital or hard copies of any presentations and graphics used are to be submitted to the examiner. The detailed written paper to be submitted to the examiner should summarize the key findings and conclusions.

Colloquium (Co)
A colloquium is an examination discussion in which students must demonstrate in free speech that they mastered the examination material. The colloquium is an examination discussion of at least 15 and at most 45 minutes duration, which also serves to determine whether the performance to be delivered is an independently delivered performance. Colloquia can be conducted as individual examinations or as group examinations. In the case of group

examinations, the size of the group shall be considered appropriately when determining the duration of the examination.

Portfolio examination (PP)
A portfolio examination is a form of examination consisting of a maximum of ten examination elements. At least two different forms of examination shall be used for the portfolio examination. The possible forms of examination that can be used result from the forms of examination listed in § 14 paragraph 3 APSO-INGI as well as semester-long exercises. At the beginning of the course, the lecturer determines which examination elements and with which weighting for the individual examination elements the portfolio examination should take place. In the case of an examination performance, the individual examination elements result in an overall grade for the respective portfolio examination according to their weighting. The total scope of the portfolio examination in terms of workload and degree of difficulty may not exceed the scope of the examination form if this were to be selected as the only examination element.

Take home examination (THP)
A take-home examination consists of the independent processing of one or more specified examination tasks, which is carried out by the student independently of location with the aid of approved aids within the specified processing time. The examination tasks are issued and the solutions are submitted in electronic form. The processing time is a minimum of 60 and a maximum of 300 minutes. The duration of the examination is made up of the processing time and the time allowed to students for the creation and downloading and uploading of the examination documents. The examination is conducted via the software, collaboration, video conferencing systems or learning platforms provided by the university. Students should be given the opportunity to become familiar with the software, collaboration, video conferencing systems or learning platforms prior to the exam as part of the course. When handing in the work, the student assures in writing or in electronic form that he/she has written the work independently, within the specified processing time and using no other than the specified approved aids.

Module descriptions:

Master degree program: European Master of Medical Technology and Healthcare Business	
Project Seminar in Engineering	
Module Code Digit	1
Module coordination/ responsible person	Prof. Dr. Bernd Flick
Semester/Period/Interval	1st semester / one semester / winter semester
ECTS Credits/ Presence hours per week	5CP / 4 SHW
Workload	150 h: laboratory work, private study
Status	Mandatory module
Requirements	Recommended: Appropriate knowledge from previous academic studies in a professionally associated field, bachelor's degree The projects must be individually supervised by a professor of the biomedical department (Department Medical Technologies/Faculty LS). The project regulations of the Department Medical Technologies apply.
Language	English
Competences/ Learning Outcomes	The students are able to develop a biomedical component, device, software or study. Therefore, they … • approach and handle complex problems, tasks and projects in the biomedical field. • understand and apply complex laboratory and biomedical equipment to solve the project tasks. • find and understand appropriate literature, assess and understand complex informations and apply them to the project (E.g. literature data bases, specialized publications). • autonomously design, develop and implement laboratory experiments / software / hardware. • autonomously design, keep records and interpret measurements using appropriate mathematical and scientific methods. • provide and track a project plan. • understand and define project goals and negotiate them with the project sponsors. • present the results to peers and sponsors. The students are able to…

	• handle projects responsible, with awareness to cost, risk and safety. • autonomously organize project groups, organize meetings and communication among the project participants and identify and solve all problems typical to scientific projects. • get in contact to experts, where necessary, discuss project and test plans with co-workers and project sponsors and defend their plans and results against critical objections.
Content	project skills in practice the scientific matters depend on the projects, which must be supervised / approved by a professor of the biomedical department the projects should address scientific level problems from any aspect of biomedical engineering and biomedical sciences
Applicability	• Methods and Analysis, Research and Development, Reflection and Communication • Project management
Course- and examination achievements	Regular form for the module examination: term paper (graded) Further possible examinations: written exam, oral examination, oral presentation, take home examination The type of examination will be announced by the lecturer at the beginning of the course.
Associated lectures/courses	• Project Seminar in Engineering
Teaching methods/ methods generally/ types of media	Typically: experimental laboratory work/hardware and software engineering/literature work/seminar/presentations/project meetings/project documentation/web-based cooperation
Literature/working materials	Scientific literature, depending on the project

Master degree program: European Master of Medical Technology and Healthcare Business	
Health Technology Assessment / Regulatory Affairs	
Module Code Digit	2
Module coordination/ responsible person	Prof. Dr. Udo van Stevendaal
Semester/Period/Interval	1st semester / one semester / winter semester
ECTS Credits/ Presence hours per week	5 CP / 4 SHW
Workload	150 h: 68 h course work, 82 h self-organized
Status	Mandatory module
Requirements	Recommended: appropriate knowledge from previous academic studies in a professionally associated field, bachelor's degree
Language	English
Competences/ Learning Outcomes	**Competence in facts (knowledge & understanding)** The students are able to… • investigate complex HTA and RA problems • use and apply international standards and laws of in the field of HTA and medical approvals **Competence in methods (knowledge application & development)** The students are able to… • solve challenging engineering specific and natural scientific problems • apply concepts of scientific work in the medical engineering field and use them conducive • use mathematical/physical and technical methods on problems in the field of biomedical engineering • to use their method-knowledge and to evaluate critical results from the literature and to express and transact them in their own words • have knowledges and abilities in project- and time management that allow them to work out large scientific results in the given period **Social competences (communication & cooperation)** The students are able to… • talk in trade public about correlative job definitions and methods

	• deal unaffiliated with technical and medical working materials • describe and deliver theoretical contexts in the biomedicine • present and protect their results in form of scientific publications and/or public presentations **Self-Competence (professionalism & self-regulation)** The students are able to… • critically read, understand and review original articles, laws, standards and working documents • present and discuss their concepts in a peer group
Content	• Medical Device Regulation (MDR) • In Vitro Diagnostic Regulation (IVDR) • Medical Device Directive (MDD) • Active Implantable Medical Device Directive (AIMDD) • In Vitro Diagnostic Directive (IVDD) • Medical Devices Implementation Act (MPDG) • QM & RA in the development process of medical devices • Usability of medical products • Medical device software • general approvals & worldwide approvals for medical devices • CE marking – approval procedure in Europe • approval procedure in the USA • Risk management for medical devices • Quality management systems for medical devices • International RA & QM norms / standards for medical devices • Basis and methodologies of evidence-based medicine • HTA as a prospective and retrospective tool of quality assurance in the development and evaluation of medical technologies • National and international health technology assessment organizations and their tasks
Applicability	The module conveys essential knowledge of Health Technology Assessment and Regulatory Affairs for medical devices. The practical Eligibility is also in the foreground, as is the scientific way of working and the engineering way of thinking. The module can be used in other study programs with a mathematical and scientific background e. g. as an optional subject.

Course- and examination achievements	Regular form for the module examination: oral examination (graded) Further possible examinations: oral presentation, term paper, take home examination The type of examination will be announced by the lecturer at the beginning of the course.
Associated lectures/courses	• Regulatory Affairs • Health Technology Assessment
Teaching methods/ methods generally/ types of media	• presentations • group work (internet retrieval, discussions) • excursions (“expert interviews”)
Literature/working materials	del Llano-Senaris J.E. and Campillo-Artero C., Health Technology Assessment and Health Policy Today: A Multifaceted View of their Unstable Crossroads, Springer International Publishing Switzerland 2015, ISBN 978-3-319-15003-1, Friedman L.M. and Furberg C.D. and DeMets D.L., Fundamentals of Clinical Trials, Fourth Edition, Springer Science + Business Media, LLC 2010, ISBN 978-1-4419-1585-6 Introduction to health technology assessment. CS Goodmann. HTA 101, 2004.Guyatt GH, Haynes RB, Jaeschke RZ, et al. Users’ guide to the medical literature, XXV: Evidence-based medicine: principles for applying the users’ guides to patient care. Evidence-Based Medicine Working Group. JAMA. 2000; 284:1290-6. international laws and standards acc. to approval procedures of medical devices scientific literature announced in the course

Master degree program: European Master of Medical Technology and Healthcare Business	
Numerical Mathematics	
Module Code Digit	3
Module coordination/ responsible person	Prof. Dr. Anna Rodenhausen
Semester/Period/Interval	Numerical Mathematics: 1st semester / one semester / winter semester
ECTS Credits/ Presence hours per week	5 CP/4 SHW
Workload	150 h: 68 h course work, 82 h self-organized
Status	Mandatory module
Requirements	Recommended: Basic skills in programming and mathematics (e.g. acquired in a bachelor degree program)
Language	English
Competences/ Learning Outcomes	The students are able to use the computer as an universal tool to solve practical problems. They can … • apply a wide range of numerical methods, • understand the fundamental principles of the discussed methods, • implement and visualize problems from numerical mathematics in the MATLAB environment, • judge about the quality of computational results. The students can solve curve and surface integrals and to interpret the resulting numbers. They can apply integral operators and to make use of Gauss' and Stokes' Theorems in selected applications. The students are able to • help each other to identify programming errors, • analyze advanced integration problems and solve them in teams, • discuss their results and judge about their quality and scientific relevance.
Content	Numerical Mathematics: • Introduction to MATLAB • Numerical solution of linear equation systems • Curve fitting and interpolation • Optimization

	• Numerical differentiation and integration • Numerical solution of ordinary differential equations (ODEs) and systems of ODEs • Examples of numerical solution of partial differential equations
Applicability	The module enables to perform advanced quantitative analysis in own responsibility. It can also be used in other master programs in various fields of studies.
Course- and examination achievements	Regular form for the module examination: written exam (graded). Further possible examinations: oral examination, oral presentation, term paper, portfolio exam, take home examination. The type of examination will be announced by the lecturer at the beginning of the course.
Associated lectures/courses	• Numerical Mathematics
Teaching methods/ methods generally/ types of media	Lectures, practical work in the computer lab, discussions, exercises, black board, movies, software examples, online materials,
Literature/working materials	Each in the current edition: Chapra, S.C.: Numerical Methods for Engineers, McGraw-Hill. Gilat, A., Subramaniam, V.: Numerical Methods – An Introduction with Applications Using MATLAB, Wiley. Mathews, J. H., Fink, K.D.: Numerical Methods using MATLAB, Pearson/Prentice Hall. Yang, W.Y., Cao, W., Chung, T.-S., Morris, J.: Applied Numerical Methods Using MATLAB, Wiley. Lecture notes and exercises edited by the Lecturers. *All books and materials are used in the latest edition.*

Master degree program: European Master of Medical Technology and Healthcare Business:	
Simulation and Virtual Reality in Medicine	
Module Code Digit	4
Module coordination/ responsible person	Prof. Dr. Boris Tolg
Semester/Period/Interval	1st semester / one semester / winter semester
ECTS Credits/ Presence hours per week	5 CP / 4 SHW
Workload	150 h: 68 h course work, 82 h self-organized
Status	Mandatory module
Requirements	
Language	English
Competences/ Learning Outcomes	The courses of this module enable the students to... • decide based on a given scenario which simulation technique fits best. • develop training scenarios for given situations. • evaluate and analyze training results. The students are able to… • critically read, understand and review original articles and working documents. • present and discuss their concepts in a peer group. develop solutions for simulation tasks.
Content	• 3D Simulation o Mathematical Background ▪ Transformation matrices ▪ Quaternions ▪ Kinematics ▪ Propagation Models ▪ … o Computer Graphics Background ▪ Lighting ▪ Data Structures ▪ … o Simulation Background

	▪ Main Loop ▪ Events ▪ Storing results with MySQL ▪ … • Other Simulation methods o Simulation Patients o Mass Casualty Incidents (MCI) o CAVE o 3D-Visual systems • Evaluation o Mathematical Background ▪ Statistics ▪ … o Methodical Background ▪ Questionnaires ▪ Physiological data o Psychological Background …
Applicability	The module conveys essential knowledge of simulation methods and technologies used in medicine. The focus is on practical applicability, scientific methods and engineering abilities. The module can be used in other study programs with a mathematical and scientific background.
Course- and examination achievements	Regular form of the module examination: portfolio-exam (graded) containing • Oral project presentation • Written project documentation • Project outcome, for example: o source code o literature research o other content o … Further possible examinations: take home examination The type of examination will be announced by the lecturer at the beginning of the course.
Associated lectures/courses	• Simulation and Virtual Reality in Medicine • Simulation and Virtual Reality in Medicine, Practical Work (SimLab)
Teaching methods/ methods generally/ types of media	The lecture is based on projects Projects contain • experimental laboratory work • hardware and software engineering

	• literature research • seminars • presentations • project meetings • project documentation web based cooperation
Literature/working materials	Scientific literature, depending on the project

Master degree program: European Master of Medical Technology and Healthcare Business:	
Advanced Control Systems	
Module Code Digit	05
Module coordination/ responsible person	Prof. Dr. Gerwald Lichtenberg
Semester/Period/Interval	1st semester/ one semester / winter semester
ECTS Credits/ Presence hours per week	5 CP / 4 SHW
Workload	150 h: 68 h course work, 82 h self-organized
Status	Mandatory module
Requirements	Recommended: Appropriate knowledge from previous academic studies on bachelor level: mathematics, physics, informatics, feedback systems, human biology.
Language	English
Competences/ Learning Outcomes	**Competence in facts (knowledge & understanding)** The students are able to … • understand model-based engineering methods • model dynamical systems - structured, by first principles (white box) - unstructured, from measurement data (black box) - semi-structured, by adapting model parameters (gray box) • design appropriate controllers - fix the control structure - choose the controller structure - optimize controller parameters **Competence in methods (knowledge application & development** The students are able to… • apply model-based methods for automation tasks - State feedback - Predictive and Learning Control - Adaptive Control - Supervisory Control • use block-oriented simulation tools (MATLAB/Simulink) - build models from basic equations (white box) - identify parameters from measurements (black/gray box) - validate a model - design controllers with model-based tools • decide which concepts are applicable, • guide the implementation process, • understand basics for later usage of engineering tools. **Social competence (communication & cooperation)**

	The students are able to … • discuss control concepts in a project team **Self-Competence (professionalism & self-regulation)** The students are able to … • reflect their ideas • evaluate their performance by objective measures
Content	**Modelling:** linear and nonlinear systems, continuous- and discrete-time systems, continuous- and discrete-variable systems, hybrid systems, state space models, block diagrams, parameter identification **Analysis:** stability, controllability, observability, performance, robustness **MATLAB:** matrix computing, linear models, MATLAB programming, data import and export, transfer functions, state space models **Simulink:** nonlinear models, modelling continuous-time, discrete-time and hybrid systems, solver settings, model hierarchies, modelling guidelines, controller design using Simulink **Design:** state feedback and observers, linear predictive control, learning and adaptive control, response optimization
Applicability	Module *Advanced Control Systems* in the Master‘s Program *Renewable Energy Systems* (RES)
Course- and examination achievements	Regular form for the module examination: portfolio exam (PL) Further possible examinations: written exam, oral presentation, oral examination, take home examination The content of the portfolio exam will be announced by the lecturer at the beginning of the course.
Associated lectures/courses	• Advanced Control Systems Methods • Advanced Control Systems Tools (Practical Work)
Teaching methods/ methods generally/ types of media	Lectures, computer labs, mini group projects, presentations in classroom and online.
Literature/working materials	Lecture notes Current research papers Each in current edition: Khalil *Nonlinear Systems*, Prentice-Hall. Skogestad & Postlethwaite *Multivariable feedback control: analysis and design*, Wiley. Ljung *System Identification*, Prentice-Hall. Maciejowski *Predictive Control with constraints*, Prentice-Hall.

Master degree program: European Master of Medical Technology and Healthcare Business:	
Modelling Medical Systems	
Module Code Digit	6
Module coordination/ responsible person	Prof. Dr. Nicholas Bishop
Semester/Period/Interval	1st semester / one semester / winter semester
ECTS Credits/ Presence hours per week	5 CP / 4 SHW
Workload	150 h: 68 h course work, 82 h self-organized
Status	Mandatory module
Requirements	Recommended: Students should have knowledge of technical mechanics, Excel and programming
Language	English
Competences/ Learning Outcomes	The courses of this module enable the student to... • understand model-based simulation methods • model continuum mechanics problems • discretisation of continuum problems • solution by numerical methods • use simulation tools, e.g., MATLAB • build a model from physical differential-algebraic equations • identify parameters from measurement data • validate a model • use finite element analysis software The students are able to … • discuss modelling concepts in a team. • decide which concepts are applicable. • guide the parameter identification process. • understand basics of engineering tools. • critically read, understand and review original articles and working documents. • present and discuss their concepts in a peer group.
Content	• Numerical Modelling of Structures • A particular simple mechanical problem will be addressed throughout this module in terms of deformation and strength of a structure. It will be analyzed using multiple modelling methods, allowing confidence in the results to be accumulated, demonstrating the synthesis of multiple approaches and highlighting comparisons between methods.

	• Semester 1: The Biomechanical modelling and validation course will concentrate on devising a 1-dimensional analytical solution to the problem, solved by hand, followed by a spread sheet solution, allowing a parametric analysis. The problem will then be discretized and solved using a spreadsheet. An experimental validation will be undertaken, potentially using custom 3D printed parts, mounted on a uniaxial mechanical testing machine. • Semester 2: In the Finite Element Analysis (FEA) course the problem will be analysed using FEA by hand and then using commercially available software in 2D. The outputs will be compared with modelling and experimental results and potential errors highlighted. Solution efficiency will be addressed by simulating symmetry planes using boundary conditions. • A biomechanical implant may then be analyzed using appropriate methods.
Applicability	The module conveys essential knowledge of modelling medical systems. The focus is on practical applicability, scientific methods and engineering abilities.
Course- and examination achievements	Regular form for the module examination: Term Project (PL) Further possible examinations: Oral or written examination, oral presentation, take home examination. The type of examination will be announced by the lecturer at the beginning of the course.
Associated lectures/courses	• Biomechanical modeling and validation • Finite Element Analysis
Teaching methods/ methods generally/ types of media	• Seminaristic lectures, practical courses, teamwork, PowerPoint-presentation, tutorials, private study, Blackboard, e-Learning
Literature/working materials	Hibbeler, R.C. Engineering Materials, Pearsons. (&similar / German) Müller, G & Groth, C (2007). FEM für Praktiker, I: Grundlagen: Basiswissen und Arbeitsbeispiele zur Finite-Element-Methode mit dem Programm ANSYS Expert Verlag. http://www.caewiki.info/wikiplus/index.php/Literatur Lee, H (2015) Finite Element Simulations with ANSYS Workbench: Theory, Applications, Case Studies. SDC Publishers. Bathe, K. (2007). Finite Element Procedures. Prentice Hall. Merkel, M & Öchsner, A, 2010, Eindimensionale Finite Elemente – Ein Einstieg in die Methode. Springer Verlag.

Master degree program: European Master of Medical Technology and Healthcare Business	
Masterthesis and Colloquium	
Module Code Digit	7
Module coordination/ responsible person	Prof. Dr. Bernd Flick
Semester/Period/Interval	4th semester/one semester/winter and summer semester
ECTS Credits/ Presence hours per week	30 CP / not applicable
Workload	900 h (autonomous private study)
Status	Mandatory module
Requirements	The Master's thesis may only be started when at least 80 CP of the first three semesters of study are available. Before the official start of the assignment the subject-matter and the supervisors must be approved by the board of examiners of the Department Biomedical Engineering / Faculty Life Sciences. The first examiner must be a professor of the Department Biomedical Engineering / Faculty Life Sciences.
Language	English
Competences/ Learning Outcomes	**Acquired competences / educational objectives** **Expertise and methodological competences** The students … • can solve challenging engineering specific and natural scientific problems. • are familiar with the concepts of scientific work in the medical engineering and use them conducive. • use mathematical / physical and technical methods on problems in the bioengineering. • have a scientific method-knowledge and are able to evaluate critical results from the literature and to express and transact them in their own words. • have knowledges and abilities in project- and time management that allow them to work out large scientific results in the given period. **Personal and interpersonal skills** The students … • are able to talk in trade public about correlative job definitions and methods. • are able to deal unaffiliated with technical and medical working materials. • can describe and transfer theoretical contexts into bio-medicine.

	• are specially invoked to present and defend their results in form of scientific publications and / or public presentations.
Content	The content of the Master's thesis depends on the task. The Master's thesis can be prepared at HAW Hamburg, other universities, research institutions or in public authorities and companies. The task is defined by the examiner and, if necessary, the external setup.
Applicability	Thesis in which the students independently work on a task from the professional field of activity of their course of study using scientific methods and findings. Students can submit thematic proposals and propose the examiners.
Course- and examination achievements	Regular form of examination for module examination (Master Thesis) (graded, weighting 20 CP): written elaboration, volume approx. 50 - 70 pages (without cover sheet, directories and appendix). Colloquium (graded, weighting 10 CP): oral presentation of the results achieved in the Master Thesis, duration: 30 to 45 minutes.
Associated lectures/courses	Not applicable
Teaching methods/ methods generally/ types of media	Self-employed written elaboration Personal discussion of interim results with supervisors and examiners.
Literature/working materials	Scientific literature, e.g. Society of Electromedical Engineering (IEEE)

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