Module Manual

Master of Science (M.Sc.)

Biomedical Engineering

Cohort: Winter Term 2020

Updated: 30th April 2020

Table of Contents

Table of Conte		2
Program descr		5
Core qualificat		7
	Business & Management	<u> </u>
	Non-technical Courses for Master	
	Applied Statistics	11
	Medical Imaging Systems Medical Basics and Pathology	14 16
	Practical Course Product Development, Materials and Production	19
	Case Studie and Clinical Internship	21
Module M1214:		23
	Implants and Endoprostheses	24
	Intelligent Systems in Medicine	24
	Selected Topics of Biomedical Engineering - Option A (6 LP)	27
Module M1241:	Selected Topics of Biomedical Engineering - Option B (12 LP)	37
	Intelligent Autonomous Agents and Cognitive Robotics	47
	Microsystem Engineering	
	Vibration Theory	54
	Finite Elements Methods Microsystems Technology in Theory and Practice	56
	Microsystems Technology in Theory and Practice Technology Management	58 61
	Control Systems Theory and Design	64
	Production Planning & Control and Digital Enterprise	68
	Electronic Circuits for Medical Applications	71
	Continuum Mechanics	75
	Material Modeling	77
Module M1199:	Advanced Functional Materials	79
	MED II: Introduction to Biochemistry and Molecular Biology	81
	BIO I: Implants and Fracture Healing	83
	BIO II: Biomaterials	86
Module M1342:	Regenerative Medicine	89 92
	Robotics and Navigation in Medicine	95
	Case Studies for Regenerative Medicine and Tissue Engineering	98
	Introduction into Medical Technology and Systems	99
	Nonlinear Dynamics	102
	Semiconductor Technology	104
Module M0835:	Humanoid Robotics	107
	Linear and Nonlinear System Identifikation	109
	Optimal and Robust Control	111
	Marketing (Sales and Services / Innovation Marketing)	114
	Bioprocess Engineering - Fundamentals Applied Design Methodology in Mechatronics	118 122
	MED II: Introduction to Physiology	124
	MED I: Introduction to Anatomy	126
	BIO I: Experimental Methods in Biomechanics	128
Module M1278:	MED I: Introduction to Radiology and Radiation Therapy	130
Module M1335:	BIO II: Artificial Joint Replacement	133
Module M0845:	Feedback Control in Medical Technology	135
Module M0832:	Advanced Topics in Control	137
	Bioelectromagnetics: Principles and Applications	140
	Artificial Organs and Regenerative Medicine	144
Module M0623:	Intelligent Systems in Medicine	144
Module M1241:	Selected Topics of Biomedical Engineering - Option B (12 LP) Selected Topics of Biomedical Engineering - Option A (6 LP)	147 157
	Intelligent Autonomous Agents and Cognitive Robotics	167
	Microsystem Fraincering	171
	Vibration Theory	174
Module M0814:	Technology Management	176
Module M0768:	Microsystems Technology in Theory and Practice	179
Module M0846:	Control Systems Theory and Design	182
	Production Planning & Control and Digital Enterprise	186
	Electronic Circuits for Medical Applications	189
	Continuum Mechanics	193
	Material Modeling Advanced Functional Materials	195 197
Module M1270	MED II: Introduction to Biochemistry and Molecular Biology	197
	BIO I: Implants and Fracture Healing	201
	BIO II: Biomaterials	204
Module M0808:	Finite Elements Methods	207
Module M1342:	Polymers	209

Module M0632:	: Regenerative Medicine	212
	: Robotics and Navigation in Medicine	215
	: Case Studies for Regenerative Medicine and Tissue Engineering	218
	: Introduction into Medical Technology and Systems	219
	: Nonlinear Dynamics	222
	: Semiconductor Technology	224
	: Humanoid Robotics	227
	: Linear and Nonlinear System Identifikation	229
	: Optimal and Robust Control	231
	: Marketing (Sales and Services / Innovation Marketing) : Applied Design Methodology in Mechatronics	234
	: Applied Design Methodology in Mechatronics : Bioprocess Engineering - Fundamentals	238 240
	: MED I: Introduction to Anatomy	240
	: MED I: Introduction to Radiology and Radiation Therapy	246
	: MED II: Introduction to Physiology	249
	: BIO I: Experimental Methods in Biomechanics	251
	: BIO II: Artificial Joint Replacement	253
	: Feedback Control in Medical Technology	255
	: Advanced Topics in Control	257
Module M0548:	: Bioelectromagnetics: Principles and Applications	260
Specialization	Management and Business Administration	264
Module M0623:	: Intelligent Systems in Medicine	264
	: Selected Topics of Biomedical Engineering - Option A (6 LP)	267
Module M1241:	: Selected Topics of Biomedical Engineering - Option B (12 LP)	277
	: Intelligent Autonomous Agents and Cognitive Robotics	287
	: Microsystem Engineering	291
	: Vibration Theory	294
	: Finite Elements Methods	296
	: Microsystems Technology in Theory and Practice	298
	: Technology Management	301
	: Control Systems Theory and Design : Production Planning & Control and Digital Enterprise	30 <u>4</u> 308
	: Electronic Circuits for Medical Applications	311
	: Continuum Mechanics	315
	: Material Modeling	317
	: Advanced Functional Materials	319
	: MED II: Introduction to Biochemistry and Molecular Biology	321
	: BIO I: Implants and Fracture Healing	323
Module M1334:	: BIO II: Biomaterials	326
Module M1342:	: Polymers	329
Module M0632:	: Regenerative Medicine	332
	: Robotics and Navigation in Medicine	335
	: Case Studies for Regenerative Medicine and Tissue Engineering	338
	Introduction into Medical Technology and Systems	339
	: Nonlinear Dynamics	342
	: Semiconductor Technology	344
	: Humanoid Robotics	347 349
	: Linear and Nonlinear System Identifikation : Optimal and Robust Control	349
	: Marketing (Sales and Services / Innovation Marketing)	354
	Pionrocoss Engineering Eundamentals	250
	: Applied Design Methodology in Mechatronics	362
Module M1277:	: MED I: Introduction to Anatomy	364
Module M1278:	: MED I: Introduction to Radiology and Radiation Therapy	366
	: MED II: Introduction to Physiology	200
Module M1332:	: BIO I: Experimental Methods in Biomechanics	371
Module M1335:	: BIO II: Artificial Joint Replacement	373
	: Feedback Control in Medical Technology	
	: Advanced Topics in Control	377
	Bioelectromagnetics: Principles and Applications	
	Medical Technology and Control Theory	384
	: Intelligent Systems in Medicine	384
	Selected Topics of Biomedical Engineering - Option A (6 LP)	
	: Selected Topics of Biomedical Engineering - Option B (12 LP)	397
	: Intelligent Autonomous Agents and Cognitive Robotics	407
	: Microsystem Engineering	411 414
	: Vibration Theory : Technology Management	116
Module M0769	: Necrificity Management: : Microsystems Technology in Theory and Practice	410
	: Control Systems Theory and Design	419
	: Production Planning & Control and Digital Enterprise	426
	: Electronic Circuits for Medical Applications	429
	: Continuum Mechanics	433
Module M1151:	: Material Modeling	435
Module M1199:	: Advanced Functional Materials	437

Module M1279: MED II: Introduction to Biochemistry and Molecular Biology	439
Module M1333: BIO I: Implants and Fracture Healing	441
Module M1334: BIO II: Biomaterials	444
Module M0808: Finite Elements Methods	447
Module M1342: Polymers	440
Module M0632: Regenerative Medicine	452
Module M0630: Robotics and Navigation in Medicine	455
Module M1384: Case Studies for Regenerative Medicine and Tissue Engineering	458
Module M0634: Introduction into Medical Technology and Systems	459
Module M0752: Nonlinear Dynamics	462
Module M0761: Semiconductor Technology	464
Module M0835: Humanoid Robotics	467
Module M0838: Linear and Nonlinear System Identifikation	469
Module M0840: Optimal and Robust Control	471
Module M0855: Marketing (Sales and Services / Innovation Marketing)	474
Module M1143: Applied Design Methodology in Mechatronics	478
Module M0938: Bioprocess Engineering - Fundamentals	480
Module M1277: MED I: Introduction to Anatomy	484
Module M1278: MED I: Introduction to Radiology and Radiation Therapy	486
Module M1280: MED II: Introduction to Physiology	489
Module M1332: BIO I: Experimental Methods in Biomechanics	491
Module M1335: BIO II: Artificial Joint Replacement	493
Module M0845: Feedback Control in Medical Technology	495
Module M0635: Medical Technology Lab	497
Module M0832: Advanced Topics in Control	499
Module M0548: Bioelectromagnetics: Principles and Applications	502
Thesis	506
Module M-002: Master Thesis	506

Program description

Content

Graduates have acquired in-depth and extensive skills in engineering, mathematics and sciences that enable them to work scientifically in the field of medical technology, medical device technology and neighboring fields. They have a critical awareness of recent knowledge of their discipline, based on which they can act responsibly in their profession and society.

Career prospects

The demands on the health care continue to rise due to aging and the increased life expectations of the population. Here, the mechanization is of great importance. This applies to both individual implants and instruments as well as to large appliances used for diagnosis and therapy. Medical and engineering science personnel of the future will have to work more closely together to meet the new requirements. However, this also means that these fundamentally different disciplines must be able to understand the basics of problems of the "other" discipline. For engineers, this means that they understand and influence specific engineering basics and additionally medical and business aspects of patient care, project management, and development and research may need.

Learning target

The above mentioned qualifications are acquired by graduates during the course of their studies. The contents of the three areas are mapped to specializations: 'implants and prostheses "," Artificial Organs and Regenerative Medicine " can be management and administration "or" Medical and Control ".

Graduates are able to:

- analyze and solve scientific problems, even if they are defined in an uncommon way or incompletely and have competing specifications;
- Apply innovative methods in basic research problem solving and develop new scientific methods;
- · identify information needs, find information and fundraising;
- theoretical and experimental investigation plan and perform;
- Evaluate data critically and draw conclusions;
- analyze and evaluate the use of new and emerging technologies.
- Concepts and solutions to basic research, partly unusual issues possibly involving other disciplines to develop;
- to create new products, processes and methods;
- apply their scientific engineering judgment to work with complex, possibly incomplete information to identify contradictions and deal with them;
- classify knowledge from different fields methodically and combine systematically and handle complexity;
- familiarize themselves systematically and in a short time with new tasks;

 \bullet To systematically reflect non-technical implications of engineering activity and responsibly integrate into their actions.

Core qualification

Module M0523	3: Business & Management
Module Responsible	Prof. Matthias Meyer
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	 Students are able to find their way around selected special areas of management within the scope of business management. Students are able to explain basic theories, categories, and models in selected special areas of business management. Students are able to interrelate technical and management knowledge.
Skills	 Students are able to apply basic methods in selected areas of business management. Students are able to explain and give reasons for decision proposals on practical issues in areas of business management.
Personal Competence	
Social Competence	 Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems
Autonomy	 Students are capable of acquiring necessary knowledge independently by means of research and preparation of material.
Workload in Hours	Depends on choice of courses
Credit points	6

Courses

Information regarding lectures and courses can be found in the corresponding module handbook published separately.

Module M0524: Non-technical Courses for Master						
Admission Requirements	None					
Recommended Previous Knowledge	None					
Educational Objectives	After taking part successfully, students have reached the following learning results					
Professional Competence						

The Nontechnical Academic Programms (NTA)

imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its **teaching architecture**, in its **teaching and learning arrangements**, in **teaching areas** and by means of teaching offerings in which students can qualify by opting for **specific competences** and a **competence level** at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.

The Learning Architecture

consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechnical academic programms follow the specific profiling of TUHH degree courses.

The learning architecture demands and trains independent educational planning as regards the individual development of competences. It also provides orientation knowledge in the form of "profiles".

The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in one to two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making the transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation to study these subjects in one or two specific semesters during the course of studies.

Teaching and Learning Arrangements

provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dealing with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are deliberately encouraged in specific courses.

Knowledge

Fields of Teaching

are based on research findings from the academic disciplines cultural studies, social studies, arts, historical studies, communication studies, migration studies and sustainability research, and from engineering didactics. In addition, from the winter semester 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start-ups in a goal-oriented way.

The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging goal-oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations.

The Competence Level

of the courses offered in this area is different as regards the basic training objective

in the Bachelor's and Master's fields. These differences are reflected in the practical examples used, in content topics that refer to different professional application contexts, and in the higher scientific and theoretical level of abstraction in the B.Sc.

This is also reflected in the different quality of soft skills, which relate to the different team positions and different group leadership functions of Bachelor's and Master's graduates in their future working life.

Specialized Competence (Knowledge)

Students can

- explain specialized areas in context of the relevant non-technical disciplines,
- outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area,
- different specialist disciplines relate to their own discipline and differentiate it as well as make connections,
- sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representation in the specialized sciences are subject to individual and socio-cultural interpretation and historicity,
- Can communicate in a foreign language in a manner appropriate to the subject.

Professional Competence (Skills)

In selected sub-areas students can

- apply basic and specific methods of the said scientific disciplines,
- aquestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline,
- to handle simple and advanced questions in aforementioned scientific disciplines in a sucsessful manner,
- justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.

Personal Competence

Skills

Personal Competences (Social Skills)

Students will be able

- to learn to collaborate in different manner,
- to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees,
- to express themselves competently, in a culturally appropriate and gendersensitive manner in the language of the country (as far as this study-focus would be chosen),
- to explain nontechnical items to auditorium with technical background knowledge.

Social Competence

Personal Competences (Self-reliance)

Students are able in selected areas

• to reflect on their own profession and professionalism in the context of reallife fields of application

Autonomy	 to organize themselves and their own learning processes to reflect and decide questions in front of a broad education background to communicate a nontechnical item in a competent way in writen form or verbaly to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)
Workload in Hours	Depends on choice of courses
Credit points	6

Courses

Information regarding lectures and courses can be found in the corresponding module handbook published separately.

Module M1173	3: Applied	l Statis	tics			
Courses						
Title	24)			Тур	Hrs/wk	СР
Applied Statistics (L15)				Lecture Project-/problem-	2	3
Applied Statistics (L15	36)			based Learning	2	2
Applied Statistics (L15	85)			Recitation Section (small)	ⁿ 1	1
Module Responsible	Prof. Michael	Morlock				
Admission Requirements	None					
Recommended Previous Knowledge	Basic knowle	dge of stat	cistical methods			
Educational Objectives	After taking p	oart succes	ssfully, students h	ave reached the follo	wing learn	ing results
Professional Competence						
Knowledge	Students can explain the statistical methods and the conditions of their use.					
Skills	Students are able to use the statistics program to solve statistics problems and to interpret and depict the results					
Personal Competence	'	·				
Social Competence	Team Work, joined presentation of results					
Autonomy	To understand and interpret the question and solve					
Workload in Hours	Independent	Study Tim	e 110, Study Time	e in Lecture 70		
Credit points	6					
Course achievement	Yes N	Bonus None	Form Written elaborati	Descript ion	tion	
Examination	Written exam	า				
Examination duration and scale	90 minutes, 2	28 questio	ns			
	Compulsory Mechatronics Mechatronics Biomedical E Product Dev Compulsory Theoretical I Compulsory	s: Specialis s: Specialis ngineering relopment, Mechanica Mechanica	ation System Des ation Intelligent S I: Core qualificatio Materials and	ent: Specialisation lign: Elective Compulsystems and Robotics on: Compulsory Production: Core echnical Complementecialisation Bio- and	sory : Elective (qualification tary Cours	Compulsory on: Elective se: Elective

Course L1584: Applied Statistics							
Тур	Lecture						
Hrs/wk							
СР	3						
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28						
Lecturer	Prof. Michael Morlock						
Language	DE/EN						
Cycle	WiSe						
	The goal is to introduce students to the basic statistical methods and their application to simple problems. The topics include:						
	Chi square test						
	Simple regression and correlation						
	Multiple regression and correlation						
Content	One way analysis of variance						
33113111	Two way analysis of variance						
	Discriminant analysis						
	Analysis of categorial data						
	Chossing the appropriate statistical method						
	Determining critical sample sizes						
Literature	Applied Regression Analysis and Multivariable Methods, 3rd Edition, David G. Kleinbaum Emory University, Lawrence L. Kupper University of North Carolina at Chapel Hill, Keith E. Muller University of North Carolina at Chapel Hill, Azhar Nizam Emory University, Published by Duxbury Press, CB © 1998, ISBN/ISSN: 0-534-20910-6						

Course L1586: Applied Statistics						
Тур	Project-/problem-based Learning					
Hrs/wk	2					
СР	2					
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28					
Lecturer	Prof. Michael Morlock					
Language	DE/EN					
Cycle	WiSe					
Content	The students receive a problem task, which they have to solve in small groups $(n=5)$. They do have to collect their own data and work with them. The results have to be presented in an executive summary at the end of the course.					
Literature	Selbst zu finden					

Course L1585: App	Course L1585: Applied Statistics					
Тур	Recitation Section (small)					
Hrs/wk	1					
СР	1					
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14					
Lecturer	Prof. Michael Morlock					
Language	DE/EN					
Cycle	WiSe					
Content	The different statistical tests are applied for the solution of realistic problems using actual data sets and the most common used commercial statistical software package (SPSS).					
Literature	Student Solutions Manual for Kleinbaum/Kupper/Muller/Nizam's Applied Regression Analysis and Multivariable Methods, 3rd Edition, David G. Kleinbaum Emory University Lawrence L. Kupper University of North Carolina at Chapel Hill, Keith E. Muller University of North Carolina at Chapel Hill, Azhar Nizam Emory University, Published by Duxbury Press, Paperbound © 1998, ISBN/ISSN: 0-534-20913-0					

Courses								
Title						Тур	Hrs/wk	СР
Medical Imaging Syste						Lecture	4	6
Module Responsible		chael G	rass					
Admission Requirements	None							
Recommended Previous Knowledge	none							
Educational Objectives	After	taking p	art succe	essfully,	students h	ave reached	the following lear	ning results
Professional Competence								
Knowledge	• • • • Descr	imagin Explair system Explair with th Name contras Explair charac Explair	pe the sign system in how the sign and appeared and dests; in how specification to the system of the system is the system of the	is; e systen n; oly the p nental pl scribe atial an e images mage rec	n compone hysical pro hysical equ the physic d tempora s generated constructio	nts and the cesses that neations; cal effects resolution od; neethods ar	ponents of the inverall system of make imaging postequired to general be influenced to general erent systems.	the imagir sible and us erate imag and how
Skills		mather o	matical of Calculate or physic Determir and tempe Explain to clinical a	r physic the par al equat he the in poral res he impo pplicatio	al equation rameters of cions; fluence of colution of interesting of cons;	is required; f imaging sys different syst maging syste	ssign to the syste stems using the r em components o ms; ging systems for	nathemation
Dowsonal	Select	. a suita	bie iiilag	ilig syste	eiii ioi aii a	іррпсацоп.		
Personal Competence								
Social Competence								
Autonomy	•		tand whi				nedical imaging; a measuring sy:	stem can I
Workload in Hours	Indep	endent :	Study Tir	ne 124,	Study Time	e in Lecture 5	6	
Credit points			·	·				
Course	None							

Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Biomedical Engineering: Core qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0819: Medical Imaging Systems		
Тур	Lecture	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Dr. Michael Grass, Dr. Tim Nielsen, Dr. Sven Prevrhal, Frank Michael Weber	
Language	DE	
Cycle	SoSe	
Content		
Literature	Primary book: 1. P. Suetens, "Fundamentals of Medical Imaging", Cambridge Press Secondary books: - A. Webb, "Introduction to Biomedical Imaging", IEEE Press 2003. - W.R. Hendee and E.R. Ritenour, "Medical Imaging Physics", Wiley-Liss, New York, 2002. - H. Morneburg (Edt), "Bildgebende Systeme für die medizinische Diagnostik", Erlangen: Siemens Publicis MCD Verlag, 1995. - O. Dössel, "Bildgebende Verfahren in der Medizin", Springer Verlag Berlin, 2000.	

Module M1179	9: Medical Basics a	nd Pathology		
Courses				
Title Medical Basics and Pat Medical Basics and Pat Medical Basics and Pat	hology II (L1600)	Typ Lecture Lecture Lecture	Hrs/wk 2 2 2	CP 2 2 2 2
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence Knowledge Skills				
Personal Competence Social Competence				
	· · · · · · · · · · · · · · · · · · ·	6, Study Time in Lecture 84		
Credit points Course achievement				
Examination	Written exam			
Examination duration and scale	120 minutes			
the Following	and Biotechnology: Elective	and Engineering: Specialisation e Compulsory Dre qualification: Compulsory	on II. Process	Engineering

Course L1599: Medical Basics and Pathology I	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Julian Schulze zur Wiesch
Language	DE
Cycle	SoSe
Content	Upon successful completion of the course, participants should be able to describe the foundations of the organization of the German health system and to describe different ways of treatment in the hospital. They should be able to describe the anatomy, physiology and basic diagnostic possibilities for the following organ system: heart / circulatory system, lungs, digestive tract, kidney, including the technical possibilities of monitoring heart-lung function, in the emergency department, in the monitoring stations and in intensive care and the basics of cardiopulmonary resuscitation. Furthermore, the anatomy and physiology of the nervous system will be explored. The importance and possibilities of preventive medicine of serious public health problems are described. Students prepare their own sub-themes in the form of small lectures and discuss various clinical cases on these topics interactively as problem-based learning. This course/Lecture by excursions into our emergency room, our endoscopy unit, mini-laparoscopy and our ICU as well as out patient clinics.
Literature	Wird in der Veranstaltung bekannt gegeben

Course L1600: Medical Basics and Pathology II		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Johannes Kluwe	
Language	DE	
Cycle	WiSe	
Content	 Major diseases of the gastrointestinal system and the liver, the hormone system, the kidneys. The lecture will focus on pathophysiology, symptoms, diagnostic and therapeutic principles of these diseases. I Gastrointestinal tract and liver: Gastrointestinal bleeding: causes, symptoms, endoscopic treatment options Colorectal cancer: basics, principle of prophylactic screening, therapy Liver diseases / liver cirrhosis: causes, symptoms, complications, therapeutic options II Hormones: Diabetes mellitus type 1 and 2: pathophysiology, complications, basics of glucose metabolism, therapeutic principles Thyreoid gland - hyper- and hypothyreoidism: causes, symptoms diagnostics, therapy III Kidneys Functions and failure, diagnostics, principles of renal replacement therapy 	
Literature	Wird in der Veranstaltung bekannt gegeben	

Course L1602: Medical Basics and Pathology III	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Dominic Wichmann
Language	DE
Cycle	WiSe
Content	 a) Basic understanding of the pathology/pathophysiology of cardiac diseases and their stage-adapted treatments: coronary heart disease, myocardial infarction, mitral valve insufficiencies, aortic valve stenosis b) Basic understanding of the pathology/pathophysiology of pulmonary diseases and their stage-adapted treatments: asthma, chronic obstructive pulmonary disease, pneumonia, bronchial cancer c) Basic understanding of infectious diseases, immune-system and autoimmune diseases
Literature	Skript zur Vorlesung.

Courses				
Γitle		Тур	Hrs/wk	СР
Practical Course Produ [L1566)	ct Development, Materials and Production	Practical Course	6	6
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
•	Product Development:			
	Lectures: Mechanics I-IIILectures: Integrated Product Deve	elopment I incl. CAD	practical tra	aining
	Materials:			
Recommended Previous Knowledge	Composites, Manufacturing of Pol	erials Testing es of Polymers, Str	ucture and F	
_	Production:			
	 Lecture: Production Engineering Lectures: Forming and Cutting 1 design Lectures: Machine Tools and Robo 		s of product	ion proces
Educational Objectives	After taking part successfully, students	have reached the fo	llowing learr	ning results
Professional Competence				
competence	Students can			
Knowledge	 represent more complex context describe functionality of mod machine technologies. 			tations an
	Students are capable of			
Skills	 applying theoretical knowledge for applying provided experimental if fields of study. analyzing and evaluating experimental applying modern measurement in 	methods for examin	ing contexts	
Personal Competence	Students can			
Social Competence	carry out and document experimepresent and discuss experimenta			rent fields (

Autonomy	 Students are able to carry out parts of experimental work independently guided by teachers. choose and apply suitable instruments. assess own strengths and weaknesses.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and scale	
Assignment for the Following Curricula	Biomedical Engineering: Core qualification: Compulsory Product Development, Materials and Production: Core qualification: Compulsory

Course L1566: Practical Course Product Development, Materials and Production		
Тур	Practical Course	
Hrs/wk	6	
СР	6	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	
Lecturer	Prof. Wolfgang Hintze, Prof. Josef Schlattmann, Prof. Dieter Krause, Prof. Claus Emmelmann, Prof. Uwe Weltin, Prof. Bodo Fiedler, Prof. Hermann Lödding, Prof. Michael Morlock, Prof. Gerold Schneider, Prof. Thorsten Schüppstuhl, Prof. Otto von Estorff, Prof. Jörg Weißmüller	
Language	DE	
Cycle	SoSe	
Content	 Modal analysis - experimental and computational Appropriate design in engineering Characterization of rubbery-elastic materials Stick-Slip-Analysis at friction and wear test station Materials: Property profiles of steel Actuators for modern fuel injection systems - synthesis and properties Processing, properties and structure of thermoplastic polymers and its composites Tribology in joints Production: Optimization of welding process parameters for hybrid plasma laser welding Evaluation of stock removal processes Analysis of basic laws in production logistics Analysis of positioning behaviour and trajectory accuracy of industrial robots 	
Literature	Nach Themenstellung / depending on topic	

Module M1180): Case Studie and Clinic	al Internship		
Courses				
Title Casestudies Surgery a Clinical Internship (L15	nd Internal Medicine (L1603) 587)	Typ Seminar Practical Course	Hrs/wk 5 1	CP 5 1
Kesponsible				
Admission Requirements	None			
	The lectures addressing medica Engineering in the respective BSc P		oncentration	Biomedical
Educational Objectives	After taking part successfully, stude	ents have reached the fo	ollowing learn	ing results
Professional Competence				
	The students learn the process of clinical practice regarding medical history, diagnosis and treatment decision with representative surgical and medical diseases in the various departments, and get an insight into the daily patient care through case studies in a hospital.			
Skills	Interpreting and explaining the medical history and medical records of a patient. Dealing with patients.			
Personal Competence Social Competence Autonomy	Dealing with patients.			
Workload in Hours	Independent Study Time 96, Study	Time in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	5 Pages (10 Case studies)			
Assignment for the Following Curricula	Biomedical Engineering: Core qualit	ication: Compulsory		

Course L1603: Casestudies Surgery and Internal Medicine		
Тур	Seminar	
Hrs/wk	5	
СР	5	
Workload in Hours	Independent Study Time 80, Study Time in Lecture 70	
Lecturer	Dr. Dominic Wichmann, Dr. Johannes Kluwe	
Language		
Cycle	WiSe/SoSe	
Content	Die Fallstudien werden in einem 2-wöchentlichen Blockkurs in der Innere und Chirurgie demonstriert. Alle 1-2 Tage wechseln die Stationen hierzu gehören: Notaufnahme Intensivstation Pneumologie Gastroenterologie Kardiologie Transfusionsmedizin Poliklinik/Ambulanz Dialyse Unfallchirugie	
Literature	keine spezifische	

Course L1587: Clinical Internship	
Тур	Practical Course
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Michael Morlock
Language	DE
Cycle	WiSe/SoSe
Content	The students complete a 1-week clinical internship in a hospital. The students organize the execution of the clinical internship in a hospital self-reliant. The choice of hospital has to be agreed with the program director.
Literature	keine

Module M1214	1: Study work
Courses	
Title	Typ Hrs/wk CP
	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous Knowledge	Subjects of the Master program and the specialisations.
Educational Objectives	IAHER TAKING NAH SHCCESSIHIV SHIGENIS NAVE TEACHED INE IGHOWING JEARNING TESHIIS
Professional Competence	
Knowledge	 Students can explain the project as well as their autonomously gained knowledge and relate it to current issues of their field of study. They can explain the basic scientific methods they have worked with.
Skills	The students are able to autonomously solve a limited scientific task under the guidance of an experienced researcher. They can justify and explain their approach for problem solving; they can draw conclusions from their results, and then can fine ways and methods for their work. Students are capable of comparing and assessing alternative approaches with their own with regard to given criteria.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work procedure and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to their peers and supervisors.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0
Credit points	12
Course achievement	INONO
Examination	Study work
Examination duration and scale	according to FSPO
Assignment for the Following Curricula	Biomedical Engineering: Core qualification: Compulsory

Specialization Implants and Endoprostheses

Module M0623	3: Intellig	gent Sys	stems in Me	dicine		
Courses						
Title Intelligent Systems in Medicine (L0331) Intelligent Systems in Medicine (L0334)				Typ Lecture Project Seminar Recitation Se	Hrs/wk 2 2 ection 1	CP 3 2
Intelligent Systems in	Medicine (L03	33)		(small)	1	1
Module Responsible	Prof. Alexan	der Schlaet	fer			
Admission Requirements	INIONA					
Recommended Previous Knowledge	principrinci	ples of stoo ples of pro	th (algebra, analys chastics gramming, Java/C amming skills			
Educational Objectives		part succe	ssfully, students h	ave reached the	following learr	ing results
Professional Competence						
Knowledge	The students are able to analyze and solve clinical treatment planning and decision support problems using methods for search, optimization, and planning. They are able to explain methods for classification and their respective advantages and disadvantages in clinical contexts. The students can compare different methods for representing medical knowledge. They can evaluate methods in the context of clinical data and explain challenges due to the clinical nature of the data and its acquisition and due to privacy and safety requirements.					
Skills	regression,	and predic	reasons for select tion. They can as implemented met	sess the method		
Personal Competence						
Social Competence			he results of othe into their work.	r groups, provide	helpful feedb	ack and car
Autonomy			ect their knowledg esults in an appro		the results o	f their work
Workload in Hours	Independent	t Study Tim	ne 110, Study Timo	e in Lecture 70		
Credit points	6					
Course achievement	Yes	Bonus 10 % 10 %	Form Written elaborati Presentation		ription	
Examination	Written exa	m				
Examination duration and scale						
	Electrical En	gineering:	ecialisation II: Intel Specialisation Med sation Intelligent S	dical Technology:	Elective Comp	oulsory

	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Assignment for	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
Curricula	Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective
	Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0331: Inte	lligent Systems in Medicine
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	WiSe
Content	 methods for search, optimization, planning, classification, regression and prediction in a clinical context representation of medical knowledge understanding challenges due to clinical and patient related data and data acquisition The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Russel & Norvig: Artificial Intelligence: a Modern Approach, 2012 Berner: Clinical Decision Support Systems: Theory and Practice, 2007 Greenes: Clinical Decision Support: The Road Ahead, 2007 Further literature will be given in the lecture

Course L0334: Intelligent Systems in Medicine		
Тур	Project Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0333: Intelligent Systems in Medicine		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP)

Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L1663)		Seminar	2	3
Introduction to Waveg Compatibility (L1669)	uides, Antennas, and Electromagnetic	Lecture	3	4
Introduction to Waveg Compatibility (L1877)	uides, Antennas, and Electromagnetic	Recitation (small)	Section 2	2
Development and Reg	ulatory Approval of Implants (L1588)	Lecture	2	3
•	for the Characterization of Materials (L1580)		2	3
	Biomechanics (L1583)	Seminar	2	3
Seminar Biomedical E	ngineering (L1890)	Seminar	2	3
Six Sigma (L1130)		Lecture	2	3
Fluid Mechanics II (L00		Lecture	2	4
System Simulation (L1	.820)	Lecture	2	2
System Simulation (L1	821)	Recitation (large)	Section 1	2
Ceramics Technology	(L0379)	Lecture	2	3
Module Responsible	I Prof. Milchael Moriock			
Admission Requirements	LNANA			
Recommended Previous Knowledge				
Educational Objectives	LATTER TAKING NART SUCCESSIUM STUGENTS N	ave reached	I the following learr	ning results
Professional Competence				
Knowledge				
Skills	<u>:</u>			
Personal	<u> </u>			
Competence				
Social Competence				
Autonomy	1			
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory			

Course L1663: Nati	ure's Hierarchical Materials		
Тур	Seminar		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Prof. Gerold Schneider		
Language	EN		
Cycle	WiSe		
Content	Biological materials are omnipresent in the world around us. They are the main constituents in plant and animal bodies and have a diversity of functions. A fundamental function is obviously mechanical providing protection and support for the body. But biological materials may also serve as ion reservoirs (bone is a typical example), as chemical barriers (like cell membranes), have catalytic function (such as enzymes), transfer chemical into kinetic energy (such as the muscle), etc. This lecture will focus on materials with a primarily (passive) mechanical function: cellulose tissues (such as wood), collagen tissues (such as tendon or cornea), mineralized tissues (such as bone, dentin and glass sponges). The main goal is to give an introduction to the current knowledge of the structure in these materials and how these structures relate to their (mostly mechanical) functions.		
Literature	Peter Fratzl, Richard Weinkamer, Nature's hierarchical materialsProgress, in Materials Science 52 (2007) 1263-1334 Journal publications		

Course L1669: Intro	oduction to Waveguides, Antennas, and Electromagnetic Compatibility
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency / high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation and Electromagnetic Compatibility will be introduced and discussed. Topics: - Fundamental properties and phenomena of electrical circuits - Steady-state sinusoidal analysis of electrical circuits - Steady-state sinusoidal description of electromagnetic fields and waves - Steady-state sinusoidal description of electromagnetic fields and waves - Useful microwave network parameters - Transmission lines and basic results from transmission line theory - Plane wave propagation, superposition, reflection and refraction - General theory of waveguides - Most important types of waveguides and their properties - Radiation and basic antenna parameters - Most important types of antennas and their properties - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques
Literature	 - Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999) - J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012) - D. M. Pozar, "Microwave Engineering", Wiley (2011) - Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008) - H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009) - A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)

Course L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1588: Dev	elopment and Regulatory Approval of Implants
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Dr. Roman Nassutt
Language	DE
Cycle	WiSe
Content	
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik - Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html

Course L1580: Exp	erimental Methods for the Characterization of Materials
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Patrick Huber
Language	DE
Cycle	WiSe
Content	 Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Course L1583: Nun	nerical Methods in Biomechanics
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	SoSe
Content	 Vorkenntnisse aus " Diskretisierungsmethoden der Mechanik" sind empfohlen Ein Überblick über die gängigsten numerischen Verfahren im Bereich der Biomechanik und Medizintechnik wird vermittelt. Grundkenntnissen aus verschiedenen Disziplinen (Mechanik, Mathematik, Programmierung) werden kombiniert um eine geschlossene Beispielfragestellung zu beantworten Die Vorlesung umfasst analytische Ansätze, rheologische Modelle und Finite Elemente Methoden Die vermittelten theoretischen Ansätze werden im Laufe der Vorlesung und im Rahmen von Hausaufgaben in praktische Übungen angewandt. Der kritische Blick auf die Möglichkeiten und Limitationen der Modellrechnung im Bereich humaner Anwendungen wird geschult.
Literature	Hauger W., Schnell W., Gross D., Technische Mechanik, Band 3: Kinetik, Springer-Verlag Berlin Heidelberg, 12. Auflage, 2012 Huber G., de Uhlenbrock A., Götzen N., Bishop N., Schwieger K., Morlock MM., Modellierung, Simulation und Optimierung, Handbuch Sportbiomechanik, Gollhofer A., Müller E., Hofmann Verlag, Schorndorf, 148-69, 2009

Course L1890: Seminar Biomedical Engineering				
Тур	Seminar			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Examination Form	Referat			
Examination duration and scale	schriftliche ausarbeitung und Vortrag (20 min)			
Lecturer	Prof. Michael Morlock			
Language	DE			
Cycle	WiSe			
Content				
Literature	Keine			

Course L1130: Six Sigma			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale	90 Minuten		
Lecturer	Prof. Claus Emmelmann		
Language	DE		
Cycle	WiSe		
Content	 Introduction and structuring Basic terms of quality management Measuring and inspection equipment Tools of quality management: FMEA, QFD, FTA, etc. Quality management methodology Six Sigma, DMAIC 		
Literature	Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008 Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996 Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008		

Course L0001: Fluid Mechanics II				
Typ	p Lecture			
Hrs/wk				
СР				
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28			
Examination Form				
Examination				
duration and				
scale				
Lecturer	Prof. Michael Schlüter			
Language	DE			
Cycle	WiSe			
Content	 Differential equations for momentum-, heat and mass transfer Examples for simplifications of the Navier-Stokes Equations Unsteady momentum transfer Free shear layer, turbulence and free jets Flow around particles - Solids Process Engineering Coupling of momentum and heat transfer - Thermal Process Engineering Rheology - Bioprocess Engineering Coupling of momentum- and mass transfer - Reactive mixing, Chemical Process Engineering Flow threw porous structures - heterogeneous catalysis Pumps and turbines - Energy- and Environmental Process Engineering Wind- and Wave-Turbines - Renewable Energy Introduction into Computational Fluid Dynamics 			
Literature	 Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008. Kuhlmann, H.C.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882. 			

Course L1820: System Simulation				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Examination Form	Mündliche Prüfung			
Examination duration and scale	30 min			
Lecturer	Dr. Stefan Wischhusen			
Language	DE			
Cycle	WiSe			
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems			
Literature	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011. 			

Course L1821: System Simulation		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Dr. Stefan Wischhusen	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0379: Ceramics Technology				
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Examination Form	Klausur			
Examination duration and scale	90 Minuten			
Lecturer	Dr. Rolf Janßen			
Language	DE/EN			
Cycle	WiSe			
	The course focus predomin metauurgical techniques and aspects of glass and cement sforming techniques of cerar Examples will be discussed in	sing with emphasis on advanced structural ceramics. atly on powder-based processing, e.g. "powder-sintering (soild state and liquid phase). Also, some science as well as new developments in powderless mics and ceramic composites will be addressed order to give engineering students an understanding d specific applications of ceramic components.		
	Content:	1. Introduction		
	Inhalt:	2. Raw materials		
Content		3. Powder fabrication		
		4. Powder processing		
		5. Shape-forming processes		
		6. Densification, sintering		
		7. Glass and Cement technology		
		8. Ceramic-metal joining techniques		
	W.D. Kingery, "Introduction to	Ceramics", John Wiley & Sons, New York, 1975		
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991			
Literature	D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992			
	Skript zur Vorlesung			

Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP)

(,				
Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical I	Materials (L1663)	Seminar	2	3
	uides, Antennas, and Electromagnetic		2	
Compatibility (L1669)		Lecture	3	4
Introduction to Waveg Compatibility (L1877)	uides, Antennas, and Electromagnetic	Recitation (small)	Section 2	2
Development and Reg	ulatory Approval of Implants (L1588)	Lecture	2	3
Experimental Methods	for the Characterization of Materials (L1580)	Lecture	2	3
	Biomechanics (L1583)	Seminar	2	3
Seminar Biomedical E	ngineering (L1890)	Seminar	2	3
Six Sigma (L1130)		Lecture	2	3
Fluid Mechanics II (L00		Lecture	2	4
System Simulation (L1	.820)	Lecture	2	2
System Simulation (L1	821)	Recitation (large)	Section 1	2
Ceramics Technology	(L0379)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	INONE			
Recommended Previous				
Knowledge				
Educational Objectives	LATTER TAKING DART SUCCESSIUM STUGENTS D	ave reached	the following learn	ning results
Professional				
Competence				
Knowledge				
Skills	j			
Personal	:			
Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	12			
Assignment for the Following Curricula	Riomodical Engineering: Specialisation	Implants a	and Endoprosthes	es: Elective trol Theory:

Course L1663: Nature's Hierarchical Materials		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Gerold Schneider	
Language	EN	
Cycle	WiSe	
Content	Biological materials are omnipresent in the world around us. They are the main constituents in plant and animal bodies and have a diversity of functions. A fundamental function is obviously mechanical providing protection and support for the body. But biological materials may also serve as ion reservoirs (bone is a typical example), as chemical barriers (like cell membranes), have catalytic function (such as enzymes), transfer chemical into kinetic energy (such as the muscle), etc. This lecture will focus on materials with a primarily (passive) mechanical function: cellulose tissues (such as wood), collagen tissues (such as tendon or cornea), mineralized tissues (such as bone, dentin and glass sponges). The main goal is to give an introduction to the current knowledge of the structure in these materials and how these structures relate to their (mostly mechanical) functions.	
Literature	Peter Fratzl, Richard Weinkamer, Nature's hierarchical materialsProgress, in Materials Science 52 (2007) 1263-1334 Journal publications	

Course L1669: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and scale		
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	SoSe	
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency / high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation and Electromagnetic Compatibility will be introduced and discussed. Topics: - Fundamental properties and phenomena of electrical circuits - Steady-state sinusoidal analysis of electrical circuits - Steady-state sinusoidal description of electromagnetic fields and waves - Steady-state sinusoidal description of electromagnetic fields and waves - Useful microwave network parameters - Transmission lines and basic results from transmission line theory - Plane wave propagation, superposition, reflection and refraction - General theory of waveguides - Most important types of waveguides and their properties - Radiation and basic antenna parameters - Most important types of antennas and their properties - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques	
Literature	 - Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999) - J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012) - D. M. Pozar, "Microwave Engineering", Wiley (2011) - Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008) - H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009) - A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007) 	

Course L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility	
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1588: Development and Regulatory Approval of Implants	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Roman Nassutt
Language	DE
Cycle	WiSe
Content	
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik – Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html

Course L1580: Experimental Methods for the Characterization of Materials	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Patrick Huber
Language	DE
Cycle	WiSe
Content	 Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Course L1583: Num	nerical Methods in Biomechanics
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	SoSe
Content	 Vorkenntnisse aus " Diskretisierungsmethoden der Mechanik" sind empfohlen Ein Überblick über die gängigsten numerischen Verfahren im Bereich der Biomechanik und Medizintechnik wird vermittelt. Grundkenntnissen aus verschiedenen Disziplinen (Mechanik, Mathematik, Programmierung) werden kombiniert um eine geschlossene Beispielfragestellung zu beantworten Die Vorlesung umfasst analytische Ansätze, rheologische Modelle und Finite Elemente Methoden Die vermittelten theoretischen Ansätze werden im Laufe der Vorlesung und im Rahmen von Hausaufgaben in praktische Übungen angewandt. Der kritische Blick auf die Möglichkeiten und Limitationen der Modellrechnung im Bereich humaner Anwendungen wird geschult.
Literature	Hauger W., Schnell W., Gross D., Technische Mechanik, Band 3: Kinetik, Springer-Verlag Berlin Heidelberg, 12. Auflage, 2012 Huber G., de Uhlenbrock A., Götzen N., Bishop N., Schwieger K., Morlock MM., Modellierung, Simulation und Optimierung, Handbuch Sportbiomechanik, Gollhofer A., Müller E., Hofmann Verlag, Schorndorf, 148-69, 2009

Course L1890: Seminar Biomedical Engineering	
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	schriftliche ausarbeitung und Vortrag (20 min)
Lecturer	Prof. Michael Morlock
Language	DE
Cycle	WiSe
Content	
Literature	Keine

Course L1130: Six Sigma		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Claus Emmelmann	
Language	DE	
Cycle	WiSe	
Content	 Introduction and structuring Basic terms of quality management Measuring and inspection equipment Tools of quality management: FMEA, QFD, FTA, etc. Quality management methodology Six Sigma, DMAIC 	
Literature	Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008 Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996 Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008	

Course L0001: Fluid	d Mechanics II
Typ	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination	
duration and	
scale	
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	WiSe
Content	 Differential equations for momentum-, heat and mass transfer Examples for simplifications of the Navier-Stokes Equations Unsteady momentum transfer Free shear layer, turbulence and free jets Flow around particles - Solids Process Engineering Coupling of momentum and heat transfer - Thermal Process Engineering Rheology - Bioprocess Engineering Coupling of momentum- and mass transfer - Reactive mixing, Chemical Process Engineering Flow threw porous structures - heterogeneous catalysis Pumps and turbines - Energy- and Environmental Process Engineering Wind- and Wave-Turbines - Renewable Energy Introduction into Computational Fluid Dynamics
Literature	 Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.

Course L1820: System Simulation		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Dr. Stefan Wischhusen	
Language	DE	
Cycle	WiSe	
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems	
Literature	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011. 	

Course L1821: System Simulation	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28	
Examination Form	Klausur		
Examination duration and scale	90 Minuten		
Lecturer	Dr. Rolf Janßen		
Language	DE/EN		
Cycle	WiSe		
	Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metauurgical techniques and sintering (soild state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.		
	Content:	1. Introduction	
	Inhalt:	2. Raw materials	
Content		3. Powder fabrication	
		4. Powder processing	
		5. Shape-forming processes	
		6. Densification, sintering	
		7. Glass and Cement technology	
		8. Ceramic-metal joining techniques	
	W.D. Kingery, "Introduction to	Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Har	dbook Vol.4 "Ceramics and Glasses", 1991	
Literature	re D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992		
	Skript zur Vorlesung		

Module M0629	9: Intelligent Autonomous Agents and Cognitive Robotics		
Courses			
_	Typ Hrs/wk CP s Agents and Cognitive Robotics (L0341) Lecture 2 4 s Agents and Cognitive Robotics (L0512) Recitation (small) 2 2		
Module Responsible	Rainer Marrone		
Admission Requirements	None		
Recommended Previous Knowledge	Vectors, matrices, Calculus		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Students can explain the agent abstraction, define intelligence in terms of rational behavior, and give details about agent design (goals, utilities, environments). They can describe the main features of environments. The notion of adversarial agent cooperation can be discussed in terms of decision problems and algorithms for solving these problems. For dealing with uncertainty in real-world scenarios students can summarize how Bayesian networks can be employed as a knowledge representation and reasoning formalism in static and dynamic settings. In addition students can define decision making procedures in simple and sequential settings with and with complete access to the state of the environment. In this context students can describe techniques for solving (partially observable) Markov decision problems, and they can recall techniques for measuring the value of information Students can identify techniques for simultaneous localization and mapping, and can explain planning techniques for achieving desired states. Students can explain coordination problems and decision making in a multi-agent setting in term of different types of equilibria, social choice functions, voting protocol, and mechanism design techniques.		
Skills	Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent application students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesian networks/dynamic Bayesian networks and apply bayesian reasoning for simple queries. Students can also name and apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situation students will apply techniques for finding different equilibria states, e.g., Nasl equilibria. For multi-agent decision making students will apply different voting protocols and compare and explain the results.		
Personal Competence			
Social Competence	Students are able to discuss their solutions to problems with others. They communicate in English		
Autonomy	Students are able of checking their understanding of complex concepts by solving varaints of concrete problems		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course			

achievement	None
Examination	Written exam
Examination duration and scale	
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Numerics and Computer Science: Elective Compulsory

Course L0341: Inte	lligent Autonomous Agents and Cognitive Robotics		
Тур	Lecture		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Rainer Marrone		
Language	EN		
Cycle	WiSe		
Content	 Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference by enumeration), typical-case complexity, pragmatics: reasoning from effect (that can be perceived by an agent) to cause (that cannot be directly perceived). Probabilistic reasoning over time: Environmental state may change even without the agent performing actions, dynamic Bayesian networks, Markov assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation, special cases: hidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decision networks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteration, MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks Simultaneous Localization and Mapping Planning Game theory (Golden Balls: Split or Share) Decisions with multiple agents, Nash equilibrium, Bayes-Nash equilibrium Social Choice Voting protocols, preferences, paradoxes, Arrow's Theorem, Mechanism Design Fundamentals, dominant strategy implementation, Revelation Principle, Gibbard-Satterthwaite Imp		
Literature	 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Norvig, Prentice Hall, 2010, Chapters 2-5, 10-11, 13-17 Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005 Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press, 2009 		

Course L0512: Intelligent Autonomous Agents and Cognitive Robotics		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Rainer Marrone	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0746	6: Microsystem I	Engineering			
Courses					
Title Microsystem Engineering (L0680)			Typ Lecture Project-/problem-	Hrs/wk 2	CP 4
Microsystem Engineeri	ing (L0682)		based Learning	2	2
1100 p 011011010					
Admission Requirements	None				
Recommended Previous Knowledge	Basic courses in physic	s, mathematics ar	nd electric engineeri	ng	
Educational Objectives	After taking part succe	ssfully, students h	ave reached the follo	owing learn	ing results
Professional Competence					CMEMO
Knowledge	The students know abo well as their application			nd materials	S OT MEMS as
Skills	Students are able to components and to eva			al behaviou	ır of MEMS
Personal Competence		olvo sposifis probl	ome alone or in a gr	roup and to	procent the
Social Competence	Students are able to so results accordingly.	oive specific probi	erris alorie or ili a gi	oup and to	present the
Autonomy	Students are able to ac integrate and associate			ialized liter	ature and to
	Independent Study Tim	ne 124, Study Timo	e in Lecture 56		
Credit points					
Course achievement	CompulsorBonus No 10 %	Form Presentation	Descrip	tion	
-	Written exam				
Examination duration and scale	2h				
	Electrical Engineering: International Managem Elective Compulsory International Managem Compulsory Mechanical Engineerin Compulsory Mechatronics: Specialis	nent and Engineer nent and Engineer ng and Managem	ing: Specialisation II. ing: Specialisation II. ent: Specialisation	. Mechatron	ics: Elective
Assignment for the Following Curricula	Biomedical Engineering Elective Compulsory Biomedical Engineerin	g: Specialisation Ang: Specialisation g: Specialisation g: Specialisation	rtificial Organs and Implants and End Medical Technology Management and B	Regenerative doprosthese and Contustiness Adi	es: Elective rol Theory: ministration:

Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0680: Mici	osystem Engineering	
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
	Prof. Manfred Kasper	
Language		
Cycle		
	Object and goal of MEMS	
	Scaling Rules	
	Lithography	
	Film deposition	
	Structuring and etching	
	Energy conversion and force generation	
	Electromagnetic Actuators	
	Reluctance motors	
Content	Piezoelectric actuators, bi-metal-actuator	
	Transducer principles	
	Signal detection and signal processing	
	Mechanical and physical sensors	
	Acceleration sensor, pressure sensor	
	Sensor arrays	
	System integration	
	Yield, test and reliability	
	M. Kasper: Mikrosystementwurf, Springer (2000)	
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press (1997)	

Course L0682: Microsystem Engineering		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Manfred Kasper	
Language	EN	
Cycle	WiSe	
	Examples of MEMS components	
	Layout consideration	
Content	Electric, thermal and mechanical behaviour	
	Design aspects	
Literature	Wird in der Veranstaltung bekannt gegeben	

Module M075	L: Vibration Theory
Courses	
Title Vibration Theory (L070)	Typ Hrs/wk CP Integrated Lecture 4 6
Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	Linear Algebra
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	tnem turtner.
	Students are able to denote methods of Vibration Theory and develop them further.
Personal Competence	
· ·	Students can reach working results also in groups.
	Students are able to approach individually research tasks in Vibration Theory.
	Independent Study Time 124, Study Time in Lecture 56
Credit points Course	
achievement	None
Examination	Written exam
Examination duration and scale	
the Following	Energy Systems: Core qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core qualification: Compulsory Naval Architecture and Ocean Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L0701: Vibr	Course L0701: Vibration Theory		
Тур	Integrated Lecture		
Hrs/wk	4		
СР	6		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Norbert Hoffmann		
Language	DE/EN		
Cycle	WiSe		
Content	Linear and Nonlinear Single and Multiple Degree of Freedom Oscillations and Waves.		
Literature	K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen. Springer Verlag, 2013.		

Module M0808	3: Finite Element	ts Methods			
Courses					
Title Finite Element Method Finite Element Method			Typ Lecture Recitation	Hrs/wk 2 Section 2	CP 3
Time Element Method	3 (10004)		(large)		
Module Responsible	Prof. Otto von Estorii				
Admission Requirements	none				
Recommended Previous Knowledge	Mechanics I (Statics, Kinematics, Dynamics) Mathematics I, II, III (in				lydrostatics,
Educational Objectives	After taking part succes	ssfully, students h	ave reached th	ne following learn	ing results
Professional Competence					
Knowledge	The students possess a element method and an basis of the method.				
Skills	The students are capa finite elements, assem resulting system of equ	bling the corresp			
Personal Competence Social Competence	Students can work in sr	mall groups on spe	ecific problems	s to arrive at joint	solutions.
Autonomy	The students are able and develop own finite are critically scrutinized	element routines.			
Workload in Hours	Independent Study Tim	e 124. Study Time	in Lecture 56		
Credit points		, 2 2 2 3 7			
	CompulsorBonus	Form Midterm	De	escription	
Examination	Written exam				
Examination duration and scale					
	Civil Engineering: Core Energy Systems: Core of Aircraft Systems Engine Aircraft Systems Engine	qualification: Elect eering: Specialisat	ive Compulsor ion Aircraft Sy	stems: Elective C	

Assignment for the Following Curricula	Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Product Development, Materials and Production: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Compulsory
--	--

Course L0291: Finite Element Methods			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Otto von Estorff		
Language	EN		
Cycle	WiSe		
Content	- General overview on modern engineering - Displacement method - Hybrid formulation - Isoparametric elements - Numerical integration - Solving systems of equations (statics, dynamics) - Eigenvalue problems - Non-linear systems - Applications - Programming of elements (Matlab, hands-on sessions) - Applications		
Literature	Bathe, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin		

Course L0804: Fini	Course L0804: Finite Element Methods		
Тур	Typ Recitation Section (large)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Otto von Estorff		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0768	8: Microsystems	Technolog	y in Theory an	d Practi	ice	
Courses						
Title Microsystems Technolo Microsystems Technolo			Typ Lecture Project-/problem-	Hrs/wk 2 2	CP 4	
			based Learning		2	
Кезропзівіс	Prof. Hoc Khiem Trieu					
Admission Requirements	INODE					
Recommended Previous Knowledge	Basics in physics, chem	nistry, mechanics	and semiconductor	technology		
Educational Objectives	LATTER TAKING NART SLICCE	ssfully, students	have reached the fol	lowing lear	ning results	
Professional						
Competence	Students are able					
	• to present and to e especially methods for					
Knowledge	to explain in details operation principles of microsensors and microactuator and				croactuator	
	·	ential and limitati	on of microsystems i	n applicatio	n.	
	Students are capable	-11-111	-t			
	to analyze the feas					
		s flows for the fab	orication of microstru	ctures and		
Skills	• to apply them.					
Personal Competence						
Social Competence	Students are able to possible well as to present and o				eam work a	
Autonomy	None					
Workload in Hours	Independent Study Tim	ne 124, Study Tin	ne in Lecture 56			
Credit points	i					
	Compulsor ÿ onus	Form	Descri Studier Kleingru	enden f	ühren ir eir	

Course achievement		NIANA	Subject practical		Gr dis Erg	borpraktiku uppe pr kutiert die gebniise ihr r dem gesa	äsentiert Theorie so er Labortä	und wie die tigkeit.
Examination	Oral exam							
Examination duration and scale	30 min							
Assignment for the Following Curricula	Technology: Electrical Er Internationa Compulsory Biomedical	Engineering: npulsory Engineering Engineering npulsory Engineering npulsory	mpulsory pecialisate ent and Er Specialis g: Special : Special	cion Medical ngineering: sation Artific lisation Im isation Med sation Mana	Technolog Specialisate cial Organs plants and dical Technologe agement a	gy: Elective tion II. Mech and Regen d Endopro nology and and Busines	Compulsor natronics: E erative Me stheses: E Control T es Adminis	Elective dicine: Elective Theory:

Course L0724: Micr	osystems Technology
Тур	Lecture
Hrs/wk	
СР	4
	Independent Study Time 92, Study Time in Lecture 28
	Prof. Hoc Khiem Trieu
Language	
Cycle	WiSe
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication photolithography, improving resolution, next-generation lithography, nancimprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVE techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD PECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropi etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH theory, corner undercutting, measures for compensation and etch-sto techniques; plasma processes, dry etching: back sputtering, plasma etching RIE, Bosch process, cryo process, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Eppoly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor Pt-100, spreading resistance sensor, pn junction, NTC and PTC; therma anemometer, mass flow sensor, photometry, radiometry, IR sensor thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: pellistor and thermal and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal

conductivity	sensor; metal	oxide	semiconductor	gas	sensor,	organic
semiconductor	r gas sensor, La	mbda p	robe, MOSFET ga	as ser	sor, pH-F	ET, SAW
sensor, princip	ole of biosensor,	Clark e	lectrode, enzyme	elect	rode, DN	A chip)

- Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics)
- MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration)
- Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship)
- System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)

M. Madou: Fundamentals of Microfabrication, CRC Press, 2002

N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009

Literature

T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010

G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L0725: Mic	ourse L0725: Microsystems Technology		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	2		
Workload in Hours	Vorkload in Hours Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Lecturer Prof. Hoc Khiem Trieu		
Language	EN		
Cycle	WiSe		
Content	Content See interlocking course		
Literature	See interlocking course		

Courses				
Γitle		Тур	Hrs/wk	СР
echnology Manageme	ent (L0849)	Project-/problem- based Learning	3	3
echnology Manageme	ent Seminar (L0850)	Project-/problem- based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements				
Recommended Previous Knowledge	Bachelor knowledge in business ma	nagement		
Educational Objectives	LATTER TAKING DART SUCCESSIUM STUG	ents have reached the fol	lowing learn	ing results
Professional Competence		D:		
Knowledge	Technology Intelligence Tochnology Portfolio Manage	s and Lifecycle Manageme e and Planning ment Methodology n and Exploitation lopment ion & Management	ent (I/II)	
Skills	 Develop an understanding of a national as well as internal Equip students with an und Management (strategic, of aspects) Foster a strategic oriental process as well as Technolog strategy Clarify activities of Technomaintenance and exploitatio Strengthen essential commanagerial, organizational Innovation- and R&D-manag Basic concepts, models 	ional level erstanding of important operational, organization ution to problem-solving by Management and its in ology Management (e.g on) onunication skills and a and financial issues comment. Further topics to	elements of lal and prowithin the mportance for technolog basic under oncerning to the discussed to the disc	Technologicess-related innovation corporated y sourcing standing fechnology include:
Personal Competence	technology, R&D and innova • Innovation as a process (ste			
Social Competence	 Interact within a team 			

Autonomy	 Discuss recent research debates in the context of Technology and Innovation Management Develop presentation skills Discussion of international cases in R&D-Management
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	90 minutes
the Following	Global Innovation Management: Core qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory

Course L0849: Tecl	Course L0849: Technology Management				
Тур	Project-/problem-based Learning				
Hrs/wk	3				
СР	3				
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42				
Lecturer	Prof. Cornelius Herstatt				
Language	EN				
Cycle	WiSe				
Content	The role of technology for the competitive advantage of the firm and industries; Basic concepts, models and tools for the management of technology; managerial decision making regarding the identification, selection and protection of technology (make or buy, keep or sell, current and future technologies). Theories, practical examples (cases), lectures, interactive sessions and group study. This lecture is part of the Module Technology Management and can not separately choosen.				
Literature	Leiblein, M./Ziedonis, A.: Technology Strategy and Inoovation Management, Elgar Research Collection, Northhampton (MA) 2011				

Course L0850: Tecl	hnology Management Seminar
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Beside the written exam at the end of the module, students have to give one presentation (RE) on a research paper and two presentations as part of a group discussion (GD) in the seminar in order to pass. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.
Literature	see lecture Technology Management.

Courses				
Title Control Systems Theor	ry and Design (L0656)	Typ Lecture	Hrs/wk	CP 4
Control Systems Theor	ry and Design (L0657)	Recitation (small)	Section 2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	INONE			
Recommended Previous Knowledge	Introduction to Control Systems			
Educational Objectives		nts have reached	the following lear	ning results
Professional Competence				
Knowledge	 Students can explain how list space models; they can intexternal excitation as traject. They can explain the system their relationship to state feet. They can explain the signification. They can explain observer-beachieve tracking and disturbed achieve tracking and disturbed. They can explain the z-transform. They can explain state space time systems. They can explain the experification systems, and how the identification. They can explain how a state of the systems. They can explain the experification. They can explain how a state of the systems. 	erpret the system ories in state space properties controlled back and state eance of a minimal ased state feedback ance rejection ove to multi-input nsform and its models and transmental identification problem tate space mode	n response to inite e ollability and obsestimation, respective realisation to the call and how it call and how it call and how it call and how it call to the call	ervability, and tively and the used to the Laplace and the Laplace are the Lap
Skills	 Students can transform transvice versa They can assess controllabrealisations They can design LQG control They can carry out a controtime domain, and decide whi They can identify transfer dynamic systems from expering they can carry out all these Control Toolbox, System Iden 	ers for multivarial ler design both in the is appropriate function models imental data e tasks using sta	ability and const ole plants continuous-time for a given sampl and state spac	and discrete ling rate e models o
Personal Competence				
Social Competence	Students can work in small groups of	on specific problen	ns to arrive at joir	nt solutions.
	Students can obtain information f documentation, experiment guides)			

Autonomy	They can assess their knowledge in weekly on-line tests and thereby control their learning progress.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 min		
Assignment for the Following Curricula	Electrical Engineering: Core qualification: Compulsory Energy Systems: Core qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Compulsory Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory Computational Science and Engineering: Specialisation II. Engineering Science: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Compulsory		

Course L0656: Con	trol Systems Theory and Design
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	State space methods (single-input single-output) State space models and transfer functions, state feedback Coordinate basis, similarity transformations Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem Controllability and pole placement State estimation, observability, Kalman decomposition Observer-based state feedback control, reference tracking Transmission zeros Optimal pole placement, symmetric root locus Multi-input multi-output systems Transfer function matrices, state space models of multivariable systems, Gilbert realization Poles and zeros of multivariable systems, minimal realization Closed-loop stability Pole placement for multivariable systems, LQR design, Kalman filter Digital Control Discrete-time systems: difference equations and z-transform Discrete-time state space models, sampled data systems, poles and zeros Frequency response of sampled data systems, choice of sampling rate System identification and model order reduction Least squares estimation, ARX models, persistent excitation Identification of state space models, subspace identification Balanced realization and model order reduction Case study Modelling and multivariable control of a process evaporator using Matlab and Simulink
Literature	 Software tools Matlab/Simulink Werner, H., Lecture Notes "Control Systems Theory and Design" T. Kailath "Linear Systems", Prentice Hall, 1980 K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997 L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999

Course L0657: Control Systems Theory and Design		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
		T	Hara facilis	CD
Title The Digital Enterprise	(1.0932)	Typ Lecture	Hrs/wk 2	CP 2
Production Planning ar		Lecture	2	2
Production Planning ar		Recitation	Section ₁	1
r roddetion r ianning ar	ia Control (20930)	(small)	-	1
Exercise: The Digital E	nterprise (L0933)	Recitation (small)	Section 1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	INONA			
Recommended				
	Fundamentals of Production and	Quality Management	t	
Knowledge				
Educational Objectives		dents have reached	the following learn	ing results
Professional				
Competence				
Knowledge	Students can explain the centent	s of the module in d	etail and take a crit	tical positio
Skills	Students are capable of choosi module to industrial problems.	ng and applying m	nodels and method	ds from th
Personal Competence	İ			
-	Students can develop joint solution	ons in mixed teams a	and present them t	o others.
Autonomy	<u> </u>		•	
Workload in Hours	Independent Study Time 96, Stud	ly Time in Lecture 84	4	
Credit points		•		
Course	N			
achievement	None			
Examination	Written exam			
Examination duration and scale	180 Minuten			
544.10	International Management and E	ngineering: Speciali	sation II. Product C)evelonmei
	and Production: Elective Compuls	ory		•
	Logistics, Infrastructure and M	obility: Specialisati	on Production an	d Logistic
	Elective Compulsory Biomedical Engineering: Specialis	sation Artificial Orga	ns and Regenerativ	ve Medicine
	Elective Compulsory	acion / weinelar orga	ns and negenerativ	ve i-rearent
	Biomedical Engineering: Specia	lisation Implants a	and Endoprosthes	es: Electiv
	Compulsory Biomedical Engineering: Special	ication Modical Too	hadaay and Cont	tral Theory
	Elective Compulsory	isation Medical lec	innology and Com	troi meory
Assignment for	Biomedical Engineering: Speciali	sation Management	and Business Ad	ministratio
the Following				ъ
Carricula	Product Development, Mater Development: Elective Compulso		tion: Specialisation	on Produ
	Product Development, Materia		n: Specialisation	Productio
	Compulsory		·	
	Product Development, Materials	and Production: Sp	ecialisation Materi	als: Electiv
	I Compulcory			
	Compulsory Theoretical Mechanical Enginee	ering: Specialisation	n Product Develo	pment ar

Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0929: Production Planning and Control		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Hermann Lödding	
Language	DE	
Cycle	WiSe	
Content	 Models of Production and Inventory Management Production Programme Planning and Lot Sizing Order and Capacity Scheduling Selected Strategies of PPC Manufacturing Control Production Controlling Supply Chain Management 	
Literature	 Vorlesungsskript Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002 	

Course L0930: Production Planning and Control		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Hermann Lödding	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0933: Exercise: The Digital Enterprise		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Axel Friedewald	
Language	DE	
Cycle		
Content	See interlocking course	
Literature	Siehe korrespondierende Vorlesung See interlocking course	

Module M092:	1: Electronic Circuits for	Medical Appli	cations	
Courses				
Title Electronic Circuits for I	Medical Applications (L0696)	Typ Lecture	Hrs/wk	CP 3
Electronic Circuits for I	Medical Applications (L1056)	Recitation ((small)	Section 1	2
Electronic Circuits for I	Medical Applications (L1408)	Practical Course	1	1
Responsible	4			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of electrical enginee	ering		
Educational Objectives	After taking part successfully, stud	ents have reached the	e following lear	ning results
Professional Competence				
Knowledge	 Students can explain the barcentral nervous system Students are able to explain propagation along an axon Students can exemplify the devices Students can describe the spapplications Students can explain the fur Students are able to discuss and artificial eyes 	communication between the communication between the communication between the communications of prostheses,	an action pote veen neurons a -noise amplifier e. g. an artificia	ntial and indicated and electron some second and the second all hand and the second
Skills	 Students can calculate the potential Students can give scenarios power signal acquisition. Students can develop the biology Students can define the buileye. 	s for further improve	ment of low-no	ise and lov
Personal Competence				
Social Competence	 Students are trained to solve teams together with experts Students are able to recogn for assistance to the right tire. Students can document their results in a way that others of 	s with different profes: ize their specific limit me. ir work in a clear mar	sional backgrou ations, so that nner and comm	nd. they can as unicate the
	 Students are able to realistic define actions for improvement Students can break down 	ents when necessary.		

Autonomy	 schedule their work in a realistic way. Students can handle the complex data structures of bioelectrical experiments without needing support. Students are able to act in a responsible manner in all cases and situations of experimental work. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
	CompulsorBonus Form Description		
Course achievement	res None practical work		
	No None Excercises		
Examination	Written exam		
Examination duration and scale			
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Microelectronics and Microsystems: Specialisation Microelectronics Complements: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory		

Course L0696: Electronic Circuits for Medical Applications			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Matthias Kuhl		
Language	EN		
Cycle	WiSe		
Content	 Market for medical instruments Membrane potential, action potential, sodium-potassium pump Information transfer by the central nervous system Interface tissue - electrode Amplifiers for medical applications, analog-digital converters Examples for electronic implants Artificial eye, cochlea implant 		
Literature	Kim E. Barret, Susan M. Barman, Scott Boitano and Heddwen L. Brooks Ganong's Review of Medical Physiology, 24nd Edition, McGraw Hill Lange, 2010 Tier- und Humanphysiologie: Eine Einführung von Werner A. Müller (Author), Stephan Frings (Author), 657 p., 4. editions, Springer, 2009 Robert F. Schmidt (Editor), Hans-Georg Schaible (Editor) Neuro- und Sinnesphysiologie (Springer-Lehrbuch) (Paper back), 488 p., Springer, 2006, 5. Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springer, 4th ed., 616 p., 2007 Vorlesungen der Universität Heidelberg zur Tier- und Humanphysiologie: http://www.sinnesphysiologie.de/gruvo03/gruvoin.htm Internet: http://butler.cc.tut.fi/~malmivuo/bem/bembook/		

Course L1056: Electronic Circuits for Medical Applications		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Matthias Kuhl	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1408: Elec	tronic Circuits for Medical Applications
Тур	Practical Course
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Matthias Kuhl
Language	EN
Cycle	WiSe
Content	 Market for medical instruments Membrane potential, action potential, sodium-potassium pump Information transfer by the central nervous system Interface tissue - electrode Amplifiers for medical applications, analog-digital converters Examples for electronic implants Artificial eye, cochlea implant
Literature	Kim E. Barret, Susan M. Barman, Scott Boitano and Heddwen L. Brooks Ganong's Review of Medical Physiology, 24nd Edition, McGraw Hill Lange, 2010 Tier- und Humanphysiologie: Eine Einführung von Werner A. Müller (Author), Stephan Frings (Author), 657 p., 4. editions, Springer, 2009 Robert F. Schmidt (Editor), Hans-Georg Schaible (Editor) Neuro- und Sinnesphysiologie (Springer-Lehrbuch) (Paper back), 488 p., Springer, 2006, 5. Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springer, 4th ed., 616 p., 2007 Vorlesungen der Universität Heidelberg zur Tier- und Humanphysiologie: http://www.sinnesphysiologie.de/gruvo03/gruvoin.htm Internet: http://butler.cc.tut.fi/~malmivuo/bem/bembook/

Module M1150	D: Continuum Mechanics			
Courses				
Title Continuum Mechanics Continuum Mechanics		Typ Lecture Recitation	Hrs/wk 2 Section 2	CP 3
Module	Prof. Christian Cyron	(small)		
Responsible Admission Requirements	None			
Recommended Previous Knowledge	Basics of linear continuum mechanics a (forces and moments, stress, linear constitutive laws, strain energy).			
Educational Objectives	After taking part successfully, students h	ave reached t	he following learr	ing results
Professional Competence				
Knowledge	The students can explain the fundame behavior of materials.	ntal concepts	to calculate the	mechanical
Skills	The students can set up balance laws a specific aspects, both in applied contexts			on theory to
Personal Competence Social Competence	The students are able to develop solution form and to develop ideas further.	ns, to present	them to specialis	sts in written
Autonomy	The students are able to assess their independently and on their own iden continuum mechanics and acquire the kr	ntify and solv	ve problems in	
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 50	5	
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	45 min			
	Materials Science: Specialisation Modelin Mechanical Engineering and Manage Compulsory Mechatronics: Technical Complementary Biomedical Engineering: Specialisation A Elective Compulsory Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation	ement: Special Course: Elect artificial Organ Implants ar Medical Tech	alisation Materia ive Compulsory s and Regeneration and Endoprosthes anology and Conf	ve Medicine: es: Elective trol Theory:

Elective (Product	Compulsory Development,	Materials	and	Production:	Core	qualification:	Elective
Compulse						·	
Theoretic	al Mechanical	Engineerir	ıg: Te	chnical Com	plemei	ntary Course:	Elective
Compulse	ory						
Theoretic	al Mechanical E	naineerina	: Core	gualification	: Electi	ve Compulsory	,

Course L1533: Con	tinuum Mechanics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	 kinematics of undeformed and deformed bodies balance equations (balance of mass, balance of energy,) stress states material modelling
	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Course L1534: Con	tinuum Mechanics Exercise
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	 kinematics of undeformed and deformed bodies balance equations (balance of mass, balance of energy,) stress states material modelling
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Module M115	L: Material Modeling			
Courses				
Title		Тур	Hrs/wk	СР
Material Modeling (L15	35)	Lecture	2	3
Material Modeling (L15	36)	Recitation (small)	Section 2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of linear and nonlinear conting Mechanics II and Continuum Mechanonlinear strain, free-body principle energy)	nics (forces and	moments, stress	, linear and
Educational Objectives	After taking part successfully, studen	ts have reached	the following learn	ing results
Professional Competence				
Knowledge	The students can explain the fundam laws	entals of multidi	mensional consitut	ive material
Skills	The students can implement their of particular, the students can apply the science and evaluate the correspond	eir knowledge to	various problems	
Personal Competence				
Social Competence	The students are able to develop so develop ideas further.	plutions, to prese	ent them to specia	alists and to
Autonomy	The students are able to assess th independently and on their own iden modeling and acquire the knowledge	tify and solve pro	blems in the area	
Workload in Hours	Independent Study Time 124, Study	Time in Lecture 5	6	
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following		agement: Spec on Artificial Orgar tion Implants a ion Medical Tecl	ialisation Materians and Regeneration and Endoprosthese anology and Cont	ve Medicine: es: Elective rol Theory:

Product Development, Materials and Production: Core qualification: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L1535: Mat	erial Modeling
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
	One of the most important questions when modeling mechanical systems in practice is how to model the behavior of the materials of their different components. In addition to simple isotropic elasticity in particular the following phenomena play key roles - anisotropy (material behavior depending on direction, e.g., in fiber-reinforced materials) - plasticity (permanent deformation due to one-time overload, e.g., in metal forming) - viscoelasticity (absorption of energy, e.g., in dampers) - creep (slow deformation under permanent load, e.g., in pipes) This lecture briefly introduces the theoretical foundations and mathematical modeling of the above phenomena. It is complemented by exercises where simple examples problems are solved by calculations and where the implementation of the content of the lecture in computer simulations is explained. It will also briefly discussed how important material parameters can be determined from experimental data.
Literature	

Course L1536: Material Modeling			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Christian Cyron		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M1199	9: Advanced Function	al Materials		
Courses				
TitleTypHAdvanced Functional Materials (L1625)Seminar2				CP 6
itesponsible	Prof. Patrick Huber			
Admission Requirements	None			
Recommended Previous Knowledge		ience, e.g. Materials Scie	nce I/II	
Educational Objectives	LATTER TAKING NART SLICCESSTILLIV ST	udents have reached the	following learn	ing results
Professional Competence				
Knowledge	The students will be able to exp their applications in techno semiconductor, modern compos	logy, in particular met	allic, ceramic,	polymeric,
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.			
Personal Competence				
Social Competence	The students are able to presfurther.	sent solutions to special	ists and to de	velop ideas
Autonomy	The students are able to assess their own strength gather new necessary ex			
Workload in Hours	Independent Study Time 152, S	tudy Time in Lecture 28		
Credit points				
Course achievement	None			
Examination				
Examination duration and scale	30 min			
Assignment for the Following Curricula	Blomedical Engineering: Specia	Management: Specialistical Organs a sialisation Implants and alisation Medical Technolisation Management an	end Regenerative Endoprosthese Blogy and Cont d Business Adi	ve Medicine: es: Elective rol Theory: ministration:

Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L1625: Adv	anced Functional Materials
Тур	Seminar
Hrs/wk	2
СР	6
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	 Porous Solids - Preparation, Characterization and Functionalities Fluidics with nanoporous membranes Thermoplastic elastomers Optimization of polymer properties by nanoparticles Fiber composites in automotive Modeling of materials based on quantum mechanics Biomaterials
Literature	Aktuelle Publikationen aus der Fachliteratur werden während der Veranstaltung bekanntgegeben.

	9: MED II: Introduction	to Biochemist	ry and M	lolecular
Biology				
Courses				
		T	Har bee	CP
Title Introduction to Biocher	mistry and Molecular Biology (L0386)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, stude	nts have reached the	following lear	ning results
Professional				
Competence				
Knowledge	 The students can describe basic biomolecules; explain how genetic informat explain the connection between 		A;	
Skills	 The students can recognize the importance disease; describe selected molecular-companies explain the relevance of these 	diagnostic procedures	;	course of a
Personal				
Competence				
Social Competence	The students can participate in disc level.	ussions in research a	nd medicine o	n a technical
Autonomy	The students can develop understa literature, by themselves.	nding of topics from t	he course, us	ing technical
Workload in Hours	Independent Study Time 62, Study	Time in Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	60 minutes			
the Following	General Engineering Science (General Engineering: Compulsory General Engineering Science (General Engineering, Focus Biom Data Science: Specialisation Medicing Electrical Engineering: Specialisation Engineering Science: Specialisation General Engineering Science (Engineering Engineering: Compulsory General Engineering: Compulsory General Engineering Science (Engineering Engineering: Focus Biom Mechanical Engineering: Specialisation Mechanical	y erman program, 7 nechanics: Compulsory ne: Compulsory n Medical Technology: Biomedical Engineerir nglish program, 7 y nglish program, 7 nechanics: Compulsory	semester): S Elective Com ng: Compulsor semester): S semester): S	Specialisation pulsory y Specialisation

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Module M1333	3: BIO I: Implants a	and Fracture Healing	
Courses			
Title Implants and Fracture	Healing (L0376)	Typ Lecture	Hrs/wk CP 2 3
Module Responsible	Prof. Michael Morlock		
Admission Requirements	None		
	"Implants and Fracture Hea	ticipate in "Introduction into Ar aling".	natomie" before attending
Educational Objectives	After taking part successfu	lly, students have reached the	following learning results
Professional Competence			
Knowledge	for their existence.	the different ways how bones h fferent treatments for the spin es.	·
Skills	The students can determing static situations under spec	ne the forces acting within the cific assumptions.	human body under quasi-
Personal Competence			
Social Competence	The students can, in gr calculation of internal force	roups, solve basic numerical es.	modeling tasks for the
Autonomy	The students can, in gr calculation of internal force	roups, solve basic numerical es.	modeling tasks for the
Workload in Hours	Independent Study Time 6	2, Study Time in Lecture 28	
Credit points			
Course achievement	None		
	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	Mechanical Engineering, For General Engineering Scial Biomedical Engineering: Congineering Scial Engineering Scial Engineering Scial Engineering Scial Engineering: Congeneral Engineering Scial Engineering: Compulsory Biomedical Engineering: Scial Engineering:	ialisation Biomedical Engineerin ence (English program, 7	semester): Specialisation g: Compulsory semester): Specialisation semester): Specialisation npulsory nd Regenerative Medicine: Endoprostheses: Elective ogy and Control Theory:

Orientierungsstudium: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0376: Imp	lants and Fracture Healing		
Тур	Lecture		
Hrs/wk	2		
СР			
	Independent Study Time 62, Study Time in Lecture 28		
	Prof. Michael Morlock		
Language Cycle			
3,010	Topics to be covered include:		
	Introduction (history, definitions, background importance)		
	2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)		
	3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)		
	3.1 The spine in its entirety		
	3.2 Cervical spine		
	3.3 Thoracic spine		
	3.4 Lumbar spine		
	3.5 Injuries and diseases		
Content	4. Pelvis (anatomy, biomechanics, fracture treatment)		
Content	5 Fracture Healing		
	5.1 Basics and biology of fracture repair		
	5.2 Clinical principals and terminology of fracture treatment		
	5.3 Biomechanics of fracture treatment		
	5.3.1 Screws		
	5.3.2 Plates		
	5.3.3 Nails		
	5.3.4 External fixation devices		
	5.3.5 Spine implants		
	6.0 New Implants		
	o.o new implants		
	Cochran V.B.: Orthopädische Biomechanik		
	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics		
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine		
	Nigg, B.: Biomechanics of the musculo-skeletal system		
Literature	Schiebler T.H., Schmidt W.: Anatomie		
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat		

Module M1334	4: BIO II: Biomaterials
Courses	
Title Biomaterials (L0593)	Typ Hrs/wk CP Lecture 2 3
	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of orthopedic and surgical techniques is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional	
Competence Knowledge	The students can describe the materials of the human body and the materials being used in medical engineering, and their fields of use.
Skills	The students can explain the advantages and disadvantages of different kinds of biomaterials.
Personal Competence	
Social Competence	The students are able to discuss issues related to materials being present or being used for replacements with student mates and the teachers.
Autonomy	The students are able to acquire information on their own. They can also judge the information with respect to its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Elective Compulsory

Course L0593: Biomaterials	
Тур	Lecture
Hrs/wk	2

CP Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
	Prof. Michael Morlock		
Language	EN		
Cycle			
	Topics to be covered include:		
	Introduction (Importance, nomenclature, relations)		
	2. Biological materials		
	2.1 Basics (components, testing methods)		
	2.2 Bone (composition, development, properties, influencing factors)		
	2.3 Cartilage (composition, development, structure, properties, influencing factors)		
	2.4 Fluids (blood, synovial fluid)		
	3 Biological structures		
	3.1 Menisci of the knee joint		
	3.2 Intervertebral discs		
	3.3 Teeth		
	3.4 Ligaments		
	3.5 Tendons		
Content	3.6 Skin		
	3.7 Nervs		
	3.8 Muscles		
	4. Replacement materials		
	4.1 Basics (history, requirements, norms)		
	4.2 Steel (alloys, properties, reaction of the body)		
	4.3 Titan (alloys, properties, reaction of the body)		
	4.4 Ceramics and glas (properties, reaction of the body)		
	4.5 Plastics (properties of PMMA, HDPE, PET, reaction of the body)		
	4.6 Natural replacement materials		
	Knowledge of composition, structure, properties, function and changes/adaptations of biological and technical materials (which are used for replacements in-vivo) Acquisition of basics for theses work in the area of biomechanics.		
	Hastings G and Ducheyne P.: Natural and living biomaterials. Boca Raton: CRC		
	Press, 1984.		
	Williams D.: Definitions in biomaterials. Oxford: Elsevier, 1987.		
	Hastings G.: Mechanical properties of biomaterials: proceedings held at Keele University, September 1978. New York: Wiley, 1998.		
Literature	Black J.: Orthopaedic biomaterials in research and practice. New York: Churchill Livingstone, 1988.		
	Park J. Biomaterials: an introduction. New York: Plenum Press, 1980.		
'			

Wintermantel, E. und Ha, SW : Biokompatible Werkstoffe und Bauweisen. Berli Springer, 1996.	١,

Module M1342	2: Polymers				
Courses					
Title		Тур	Hrs/wk	СР	
Structure and Propertie Processing and design	es of Polymers (L0389) with polymers (L1892)	Lecture Lecture	2 2	3 3	
Module			<u>-</u>		
Responsible	Dr. Hans Wittich				
Admission Requirements	None				
Recommended Previous Knowledge	Basics: chemistry / physics / mate	erial science			
Educational Objectives	After taking part successfully, stu-	dents have reached the	e following learn	ing results	
Professional Competence					
Competence	Students can use the knowledge analysis.	of plastics and define	the necessary	testing and	
Knowledge	They can explain the complex rela	ationships structure-pro	perty relationsh	nip and	
	the interactions of chemical sineighboring contexts (e.g. sustain			to explain	
	Students are capable of				
Skills	- using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials.				
	- selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.				
Personal					
Competence	Students can				
		notorogonius groups an	d document the	nm.	
Carial Camaratan	- arrive at funded work results in heterogenius groups and document them provide appropriate feedback and handle feedback on their own performance				
Social Competence	- provide appropriate feedback constructively.	and nandle feedback	on their own p	регтогтапсе	
	Students are able to				
	- assess their own strengths and v	weaknesses.			
Autonomy	- assess their own state of learn steps on this basis.	ning in specific terms	and to define f	urther work	
	- assess possible consequences of	f their professional activ	vity.		
Workload in Hours	Independent Study Time 124, Stu	dy Time in Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	180 min				

scale	
Assignment for the Following Curricula	

Course L0389: Stru	cture and Properties of Polymers
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Hans Wittich
Language	DE
Cycle	WiSe
	- Structure and properties of polymers
	- Structure of macromolecules
	Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution
	- Morphology
	amorph, crystalline, blends
Content	- Properties
	Elasticity, plasticity, viscoelacity
	- Thermal properties
	- Electrical properties
	- Theoretical modelling
	- Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag

Course L1892: Processing and design with polymers		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bodo Fiedler, Dr. Hans Wittich	
Language	DE/EN	
Cycle	WiSe	
Content	Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining Designing with Polymers: Materials Selection; Structural Design; Dimensioning	
Literature	Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag Crawford: Plastics engineering, Pergamon Press Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag Konstruieren mit Kunststoffen, Gunter Erhard, Hanser Verlag	

Module M0632	2: Regenerative	Medicine			
Courses					
Title			Тур	Hrs/wk	СР
Regenerative Medicine			Seminar	2	3
	ering - Regenerative Medi	cine (L1664)	Seminar	2	3
Module Responsible	Prof. Raif Portner				
Admission Requirements	None				
Recommended Previous	None				
Knowledge					
Educational Objectives	After taking part succe	ssfully, students h	ave reached the	following learn	ing results
Professional					
Competence	After successful comp	lation of the man	dula studanta wil	l he able to s	lescribe the
Knowledge	basic methods of reger different methods of ti methods for the cultiva	nerative medicine issue engineering	and to explain th They are able to	e use of the tis	sue cells for
	The students can o regenerative medicine discussed topics.				
	After successful comple	etion of the modul	le students are		
Skills	 able to use medical databases for acquirierung and presentation of relevant up-to-date data independently able to present their work results in the form of presentations able to carry out basic cell culture methods and the corresponding analysis independently able to analyse and evaluate current research topics for Tissue Engineering and regenerative medicine. 				
Personal					
Competence					
	Students are able to we and discuss their result				given tasks
Social Competence	Students are able to re teachers.	eflect their work o	rally and discuss	it with other s	tudents and
Autonomy	After completion of the problem in teams of all the results.	pprox. 2-4 person	s independently i		
	Independent Study Tim	ne 124, Study Tim	e in Lecture 56		
Credit points					
Course achievement	Compulsor B onus Yes 20 %	Form Written elaborat	ion Ausa	ription rbeitung zu Rir ocol for lecture	
Examination	Presentation		, μισι	.oco. for iccture	50,105

Examination duration and scale	Oral presentation + discussion (30 min)
the Following	Riomodical Engineering: Specialisation Management and Rusiness Administration:

Course L0347: Regenerative Medicine		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ralf Pörtner, Dr. Frank Feyerabend	
Language	DE	
Cycle	WiSe	
	The course deals with the application of biotechnological engineering principles for re-generation of human tissues. The main topics are "tissue engineering" for the generation of "artificial organs" such as cartilage, liver, blood vessel etc., and their applications: • Introduction (historical development, examples for medical and technical applications, commercial aspets)	
Content	 Cell specific fundamentals (cell physiology, biochemistry, metabolism, special requirements for cell cultivation "in vitro") Process specific fundamentals (requirements for culture systems, examples for reactor design, mathematical modelling, process and control strategies) Examples for applications for clinical applications, drug testing and material testing 	
	The fundamentals will be presented by the lecturers. The "state of the art" of specific applications will be exploited by the students based on selected papers and presented during the course.	
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Academic Pr Inc; ISBN-10: 0123693713, ISBN-13: 978-0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-3540777540	

Course L1664: Lecture Tissue Engineering - Regenerative Medicine		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ralf Pörtner, Prof. Michael Morlock	
Language	DE	
Cycle	WiSe	
Content	Discussion of current research topics for tissue engineering and regenerative medicine by invited experts	
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Academic Pr Inc; ISBN-10: 0123693713, ISBN-13: 978-0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-3540777540	

Module M0630	0: Robotics and	Navigation i	n Medicine		
_					
Courses					
Title	on in Madiaina (LOZZE)		Typ	Hrs/wk	CP
_	on in Medicine (L0335) on in Medicine (L0338)		Lecture Project Seminar	2	3 2
_	on in Medicine (L0336)		Recitation Sectio (small)	ⁿ 1	1
Module Responsible	TPINI DIEXANNEI SCHIAF	efer			
Admission Requirements	None				
Recommended Previous Knowledge	 principles of pro 	ath (algebra, analys ogramming, e.g., in b skills			
Educational Objectives	After taking part succe	essfully, students h	ave reached the follo	owing learn	ing results
Professional					
Competence	<u> </u>			12. 2. 1	
Knowledge	The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.				
Skills	The students are able to design and evaluate navigation systems and robotic systems for medical applications.				
Personal Competence					
Social Competence	The students discuss incoorporate feedback		r groups, provide he	lpful feedb	ack and car
Autonomy	The students can refl They can present the			e results o	f their work
Workload in Hours	Independent Study Tir	ne 110, Study Time	e in Lecture 70		
Credit points	6				
Course achievement	10 %	Form Written elaborati Presentation	Descrip tion	tion	
Examination	Written exam				
Examination duration and scale	90 minutes				
	Computer Science: Sp Electrical Engineering: International Manager Elective Compulsory International Manager and Biotechnology: Ele Mechatronics: Special Biomedical Engineerin Elective Compulsory Biomedical Engineeri	E Specialisation Med ment and Engineeri ment and Engineer ective Compulsory isation Intelligent S ag: Specialisation A	dical Technology: Ele ng: Specialisation II. ring: Specialisation I ystems and Robotics rtificial Organs and F	ctive Comp Electrical I I. Process :: Elective C Regenerativ	oulsory Engineering Engineering Compulsory ve Medicine:

the Following	Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
Curricula	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory Product Development Materials and Production, Specialisation Product
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0335: Robotics and Navigation in Medicine		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	SoSe	
Content	 kinematics calibration tracking systems navigation and image guidance motion compensation The seminar extends and complements the contents of the lecture with respect to recent research results. 	
Literature	Spong et al.: Robot Modeling and Control, 2005 Troccaz: Medical Robotics, 2012 Further literature will be given in the lecture.	

Course L0338: Robotics and Navigation in Medicine		
Тур	Project Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0336: Robotics and Navigation in Medicine		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M138 Engineering	4: Case Studies for Reger	nerative M	edicine and	d Tissue
Courses				
Title Case Studies for Reger (L1963)	nerative Medicine and Tissue Engineering	Typ Seminar	Hrs/wk 3	CP 6
Module Responsible	Prof. Ralf Pörtner			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students	have reached th	ne following learn	ing results
Professional Competence				
Knowledge Skills				
Personal Competence				
Social Competence Autonomy				
	Independent Study Time 138, Study Tin	ne in Lecture 42		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and scale				
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisatio Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Elective Compulsory	n Implants and	d Endoprosthese	es: Elective

Course L1963: Case Studies for Regenerative Medicine and Tissue Engineering		
Тур	Seminar	
Hrs/wk	3	
СР	6	
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42	
Lecturer	Prof. Ralf Pörtner, Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content		
Literature		

Introduction into Medi Introduction into Medi Module Responsible	ical Technology and Syster ical Technology and Syster ical Technology and Syster		Тур	, .	
Module Responsible			Lecture Project Seminar	Hrs/wk 2 2	CP 3 2
поэропына		ms (L1876)	Recitation Section (large)	1	1
	Prof. Alexander Schlae	fer			
Admission Requirements					
Recommended Previous Knowledge	principles of stochastic	CS	ulus)		
Educationa Objectives	TATTOL TAKING NALL SHEED	ssfully, students h	ave reached the follo	wing learn	ing results
Professional Competence					
Knowledge	The students can explain principles of medical technology, including imaging systems, computer aided surgery, and medical information systems. They are able to give an overview of regulatory affairs and standards in medical technology.				
Skills	The students are able clinical applications.	to evaluate syste	ems and medical dev	ices in the	e context (
Personal Competence					
Social Competence	The students describe a problem in medical technology as a project, and define tasks that are solved in a joint effort.				
Autonomy	The students can refle They can present the r			results of	their wor
Workload in Hours	Independent Study Tim	ne 110, Study Time	e in Lecture 70		
Credit points	s 6				
Course achievement	1 Voc 10 %	Form Written elaborati Presentation	Descript on	ion	
Examination	Written exam				
Examination duration and	90 minutes				
scale	1	Science (Germaı g: Compulsory	n program, 7 sem		pecialisatio ng: Electiv

Curricula	Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory
	Computational Science and Engineering: Specialisation Engineering Sciences:
	Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
	Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
	Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory:
	Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0342: Intro	oduction into Medical Technology and Systems
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	 imaging systems computer aided surgery medical sensor systems medical information systems regulatory affairs standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Wird in der Veranstaltung bekannt gegeben.

Course L0343: Introduction into Medical Technology and Systems		
Тур	Project Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1876: Introduction into Medical Technology and Systems				
Тур	Recitation Section (large)			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Alexander Schlaefer			
Language	DE			
Cycle	SoSe			
Content	 imaging systems computer aided surgery medical sensor systems medical information systems regulatory affairs standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning. 			
Literature	Wird in der Veranstaltung bekannt gegeben.			

Module M0752	2: Nonlinear Dynamics
Courses	
Title Nonlinear Dynamics (L	Typ Hrs/wk CP .0702) Integrated Lecture 4 6
Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	
Recommended Previous Knowledge	Linear Algebra
Educational Objectives	LATTER TAKING DART SUCCESSIUM STUGENTS DAVE REACTION THE TOMOWING JEARNING RESULTS
Professional Competence	
Knowledge	to develop and research new terms and concepts.
Skills _	Dynamics and to develop novel methods and procedures.
Personal Competence	
Social Competence	Students can reach working results also in groups.
Autonomy	Students are able to approach given research tasks individually and to identify and follow up novel research tasks by themselves.
-	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
Examination	Written exam
Examination duration and scale	2 Hours
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L0702: Nonlinear Dynamics				
Тур	Integrated Lecture			
Hrs/wk	4			
СР	6			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Lecturer	Prof. Norbert Hoffmann			
Language	DE/EN			
Cycle	SoSe			
Content	Fundamentals of Nonlinear Dynamics.			
Literature	S. Strogatz: Nonlinear Dynamics and Chaos. Perseus, 2013.			

Module M076	1: Semiconductor Tec	hnology		
Courses				
Title Semiconductor Technol Semiconductor Technol		Typ Lecture Practical Course	Hrs/wk 4 2	CP 4 2
Module Responsible	Prof. Hoc Khiem Trieu			
Admission Requirements	LNODA			
Recommended Previous Knowledge	Basics in physics, chemistry, m	aterial science and semicond	ductor device	es
Educational Objectives	After taking part successfully, s	students have reached the fo	llowing learr	ning results
Professional Competence				
Knowledge	substrates,		s, process fl	ows and the
Skills	to select and to evaluate p	rocess parameters on the pro rocesses and or the fabrication of semicond	-	
Personal Competence				
Social Competence	Students are able to prepare well as to present and discuss t			eam work a
Autonomy	None			
-	Independent Study Time 96, St	udy Time in Lecture 84		
Credit points	· · · · · · · · · · · · · · · · · · ·	,		
Course achievement	None			
Examination	Oral exam			
Examination				

duration and scale	
	Electrical Engineering: Specialisation Nanoelectronics and Microsystems Technology: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
	Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
Curricula	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Microelectronics and Microsystems: Core qualification: Elective Compulsory

	Microelectronics and Microsystems. Core qualification. Elective Compulsory
Course 0722; Com	sissandustan Tashualami
	niconductor Technology
	Lecture
Hrs/wk	
СР	
	Independent Study Time 64, Study Time in Lecture 56
	Prof. Hoc Khiem Trieu
Language	
Cycle	SoSe
	 Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski, Bridgeman and float zone process) Wafer fabrication (process flow, specification, SOI) Fabrication processes
Content	 Doping (energy band diagram, doping, doping by diffusion: transport processes, doping profile, higher order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation damage, annealing and equipment)
	 Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions, kinetics, influences on growth rate, process technology and equipment, anodic oxidation, plasma oxidation, thermal oxidation of GaAs)
	 Deposition techniques (theory: nucleation, film growth and structure zone model, film growth process, reaction kinetics, temperature dependence and equipment; epitaxy: gas phase, liquid phase, molecular beam epitaxy; CVD techniques: APCVD, LPCVD, deposition of metal silicide, PECVD and LECVD; basics of plasma, equipment, PVD techniques: high vacuum evaporation, sputtering)
	 Structuring techniques (subtractive methods, photolithography: resist properties, printing techniques: contact, proximity and projection printing, resolution limit, practical issues and equipment, additive methods: liftoff technique and electroplating, improving resolution: excimer laser light source, immersion lithography and phase shift lithography, electron beam lithography, X-ray lithography, EUV lithography, ion beam lithography, wet chemical etching: isotropic and anisotropic, corner undercutting, compensation masks and etch stop techniques; dry etching: plasma enhanced etching, backsputtering, ion milling, chemical dry etching, RIE, sidewall passivation)
	Process integration (CMOS process, bipolar process)
ı	 Assembly and packaging technology (hierarchy of integration, packages, chip-on-board, chip assembly, electrical contact: wire bonding, TAB and flip

	chip, wafer level package, 3D stacking)
	S.K. Ghandi: VLSI Fabrication principles - Silicon and Gallium Arsenide, John Wiley & Sons
	S.M. Sze: Semiconductor Devices - Physics and Technology, John Wiley & Sons
	U. Hilleringmann: Silizium-Halbleitertechnologie, Teubner Verlag
Literature	H. Beneking: Halbleitertechnologie - Eine Einführung in die Prozeßtechnik von Silizium und III-V-Verbindungen, Teubner Verlag
	K. Schade: Mikroelektroniktechnologie, Verlag Technik Berlin
	S. Campbell: The Science and Engineering of Microelectronic Fabrication, Oxford University Press
	P. van Zant: Microchip Fabrication - A Practical Guide to Semiconductor Processing, McGraw-Hill

Course L0723: Semiconductor Technology			
Тур	Practical Course		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Hoc Khiem Trieu		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M083!	5։ Hւ	ımano	oid Rol	botics	5				
Courses									
Title Humanoid Robotics (LO	0663)					Typ Seminar		Hrs/wk 2	CP 2
Module Responsible	Patric	k Göttsc	h						
Admission Requirements	LINIONE								
Recommended Previous Knowledge	•		ction to c theory a						
Educational Objectives	LATION	taking pa	art succes	ssfully, :	students l	have reached	the follo	wing learn	ing results
Professional Competence									
Knowledge	l .		ts learn to		ımanoid ro basic con	obots. trol concepts f	for differ	rent tasks i	n humanoid
Skills	•	based of Student	on specific ts genera	ed litera Ilize dev	ature veloped re	out selected a sults and pres give a present	ent ther		
Personal Competence									
Social Competence		present They a	them	to prov	∕ide appr	ing solutions opriate feedb			
Autonomy		present Student	ation for ts familia low prese	specific	tasks and mselves v	and drawbod select the best with a scientific r students, su	est soluti c field, a	ion are able of	introduce it
Workload in Hours	 	endent S	Study Tim	ne 32, St	tudy Time	in Lecture 28			
Credit points									
Course achievement	<u> </u>								
Examination Examination duration and scale	30 mi								
	Mecha Bioma Electi Bioma	atronics: edical En ve Comp	Specialis gineering ulsory	sation Sy g: Specia	ystem Des alisation <i>I</i>	Systems and R sign: Elective (Artificial Orgar n Implants a	Compuls ns and R	sory egenerativ	ve Medicine:

Assignment for	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
the Following	Elective Compulsory
Curricula	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective
	Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science:
	Elective Compulsory

Course L0663: Hun	nanoid Robotics
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Patrick Göttsch
Language	DE
Cycle	SoSe
Content	 Grundlagen der Regelungstechnik Control systems theory and design
Literature	- B. Siciliano, O. Khatib. "Handbook of Robotics. Part A: Robotics Foundations", Springer (2008).

Courses				
Title Linear and Nonlinear S	system Identification (L0660)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	Discrete-time systems			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	 Students can explain the general framework of the prediction error method and its application to a variety of linear and nonlinear model structures They can explain how multilayer perceptron networks are used to mode nonlinear dynamics They can explain how an approximate predictive control scheme can be based on neural network models They can explain the idea of subspace identification and its relation to Kalmai realisation theory 			
Skills	 Students are capable of applying the predicition error method to the experimental identification of linear and nonlinear models for dynamic systems They are capable of implementing a nonlinear predictive control scheme based on a neural network model They are capable of applying subspace algorithms to the experimental identification of linear models for dynamic systems They can do the above using standard software tools (including the Matla System Identification Toolbox) 			
Personal Competence				
Social Competence	Students can work in mixed grou	ups on specific problems	to arrive at join	t solutions.
Autonomy	Students are able to find required information in sources provided (lecture notes literature, software documentation) and use it to solve given problems.			
Workload in Hours	I Independent Study Time 62, Stu	dy Time in Lecture 28		
Credit points	· · · · · · · · · · · · · · · · · · ·			
Course achievement	None			
Examination	Oral exam			
Examination duration and scale				
	Electrical Engineering: Speciali Elective Compulsory Mechatronics: Specialisation Inte		-	_

	Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:		
	Elective Compulsory		
Assignment for	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective		
the Following	· ·		
Curricula	Biomedical Engineering: Specialisation Medical Technology and Control Theory:		
	Compulsory		
	Biomedical Engineering: Specialisation Management and Business Administration:		
	Elective Compulsory		
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective		
	Compulsory		
	Theoretical Mechanical Engineering: Core qualification: Elective Compulsory		

Course L0660: Linear and Nonlinear System Identification				
Тур	ecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Herbert Werner			
Language	EN			
Cycle	SoSe			
Content	 Prediction error method Linear and nonlinear model structures Nonlinear model structure based on multilayer perceptron network Approximate predictive control based on multilayer perceptron network model Subspace identification 			
Literature	 Lennart Ljung, System Identification - Theory for the User, Prentice Hall 1999 M. Norgaard, O. Ravn, N.K. Poulsen and L.K. Hansen, Neural Networks for Modeling and Control of Dynamic Systems, Springer Verlag, London 2003 T. Kailath, A.H. Sayed and B. Hassibi, Linear Estimation, Prentice Hall 2000 			

Courses				
Title Optimal and Robust Co Optimal and Robust Co		Typ Lecture Recitation	Hrs/wk 2 Section 2	CP 3
•		(small)		
поорононо				
Admission Requirements				
Recommended Previous Knowledge	 State space methods 		5)	
Educational Objectives	I ATTOR TAKING NAME CHARACTHING C	tudents have reached t	the following learr	ning results
Professional Competence				
Knowledge	 Students can explain the solution of LQ problems. They can explain the distate estimation. They can explain how the stability and performance. They can explain how an case of an H2 design promotes the can explain how an lends itself to robust con. They can explain how an can guarantee stability and can be represented as line. 	uality between optima the H2 and H-infinity e constraints. n LQG design problem blem. model uncertainty can troller design based on the small gair and performance for an nalysis and synthesis	I state feedback norms are used to can be formulate be represented in theorem - a robuuncertain plant. conditions on fee	and optime to represe ed as specental way thoust
Skills	 Students are capable multivariable plant mode They are capable of repform of a generalized plait. They are capable of trancontrol loops into consicarrying out a mixed-sen They are capable of consystem, and of designing They are capable of formatrix inequalities (LMI), They can carry out all crobust control toolbox). 	els. presenting a H2 or H-i ant, and of using stand slating time and freque traints on closed-loop asitivity design. structing an LFT uncer y a mixed-objective rob mulating analysis and and of using standard	nfinity design prolated software tool ency domain spectors sensitivity function tainty model for sust controller. Synthesis condition LMI-solvers for so	oblem in the last for solving ifications of the last formula in th
Personal Competence				
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.			
Autonomy	Students are able to find required information in sources provided (lecture notes literature, software documentation) and use it to solve given problems.			

Course L0658: Optimal and Robust Control				
Тур	Typ Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Herbert Werner			
Language	EN			
Cycle	SoSe			
Content	 Optimal regulator problem with finite time horizon, Riccati differential equation Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system Kalman's identity, phase margin of LQR controllers, spectral factorization Optimal state estimation, Kalman filter, LQG control Generalized plant, review of LQG control Signal and system norms, computing H2 and H∞ norms Singular value plots, input and output directions Mixed sensitivity design, H∞ loop shaping, choice of weighting filters Case study: design example flight control Linear matrix inequalities, design specifications as LMI constraints (H2, H∞ and pole region) Controller synthesis by solving LMI problems, multi-objective design Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty 			
Literature	 Werner, H., Lecture Notes: "Optimale und Robuste Regelung" Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 Skogestad, S. and I. Postlewhaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998 			

Course L0659: Optimal and Robust Control		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Fitle Marketing of Innovation		Typ Lecture Project-/problem-	Hrs/wk 4	CP 4
BL Marketing of Innov	rations (L0862)	based Learning	1	2
	Prof. Christian Lüthje			
Admission Requirements	None			
Recommended Previous Knowledge	 Module International Busin Basic understanding of busin decision theory, project material business of the important /li>	siness administration prince anagement, international b Knowledge (Marketing In sics of Buying Behavior) ses beweetn B2B and B2C r ortance of managing innov	ousiness) estruments, marketing	Market an
Educational Objectives	After taking part successfully, stu	dents have reached the fo	llowing learr	ing results
Professional Competence	Students will have gained a deep	o understanding of		
Knowledge	 Specific characteristics in the Approaches for analyzing adevelopment The gathering of information in the product and approached product and service development Approaches and tools for of new products and innover in the products and innover in the products and challenged pricing methods for new products and challenged pricing methods for new products and complete communication concepts and concepts are producted in the product of the product	on about future customer rest to integrate lead user opment processes ensuring customer-oriental ative services sthat take into considers of innovative products aroducts and services ex sales forces and personal	needs and rest and their tion in the disideration to the selling	uture marke quirements needs in levelopmer the specif
Skills	 Design and to evaluate strategies Analyze markets by applyi Conduct forecasts and deplanning Translate customer needs and successfully apply adviservice development Use adequate methods to services Choose suitable pricing innovations Make strategic sales decisales channels) Apply methods of sales for 	decisions regarding many market and technology welop compelling scenarios into concepts, prototypes wanced methods for custon foster efficient diffusion of strategies and commensions for products and second secon	portfolios s as a basis s and marke ner-oriented innovative punication are ervices (i.e.	for strateg stable offer product an products an ctivities for selection
		ce management me. cusic		IIQIVƏIƏI

Competence					
	The students will be able to				
Social Competence	 have fruitful discussions and exchange arguments develop original results in a group present results in a clear and concise way carry out respectful team work 				
Autonomy	 Acquire knowledge independently in the specific context and to map this knowledge on other new complex problem fields. Consider proposed business actions in the field of marketing and reflect on them. 				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points					
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and scale	Written elaboration, excercises, presentation, oral participation				
Assignment for the Following Curricula	Global Technology and Innovation Management & Entrepreneurship: Core qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory				

Course L2009: Mar	keting of Innovations		
Тур	Lecture		
Hrs/wk	4		
СР	4		
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56		
Lecturer	Prof. Christian Lüthje		
Language			
Cycle			
Content	 Introduction Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing) II. Methods and approaches of strategic marketing planning patterns of industrial development, patent and technology portfolios III. Strategic foresight and scenario analysis objectives and challenges of strategic foresight, scenario analysis, Delphi method IV. User innovations Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Customer Visits 		
	IX. Communications • Diffusion of Innovations, Communication Objectives, Communication Instruments		
	Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technology products and innovations, third edition, Pearson education. ISBN-10: 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (352-365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition,		
	McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Cause		
Literature	Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,pp. 3-24.		
	Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boston et al., McGraw Hill		
	Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		
	Von Hippel, E.(2005). Democratizing Innovation, Cambridge: MIT Press		

Course L0862: PBL	Marketing of Innovations
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	SoSe
Content	This PBL course is seggregated into two afternoon sessions. This cours aims at enhancing the students' practical skills in (1) forecasting the future development of markets and (2) making appropriate market-related decisions (particularly segmentation, managing the marketing mix). The students will be prompted to use the knowledge gathered in the lecture of this module and will be invited to (1) Conduct a scenario analysis for an innovative product category and (2) Engage in decision making within a market simulation game.
Literature	

Module M0938	B: Bioprocess Engineering -	Fundamentals		
Courses				
Title		Тур	Hrs/wk	СР
	g - Fundamentals (L0841)	Lecture	2	3
Bioprocess Engineering	g- Fundamentals (L0842)	Recitation Section (large)	¹ 2	1
Bioprocess Engineering	g - Fundamental Practical Course (L0843)	Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
Recommended Previous Knowledge	none, module "organic chemistry", modu	ule "fundamentals for	process er	ngineering"
Educational Objectives	After taking part successfully, students h	nave reached the follo	wing learn	ing results
Professional Competence				
Knowledge	Students are able to describe the basic concepts of bioprocess engineering. They are able to classify different types of kinetics for enzymes and microorganisms, as well as to differentiate different types of inhibition. The parameters of stoichiometry and rheology can be named and mass transport processes in bioreactors can be explained. The students are capable to explain fundamental bioprocess management, sterilization technology and downstream processing in detail.			
Skills	 After successful completion of this module, students should be able to describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parameters predict qualitatively the influence of energy generation, regeneration of redox equivalents and growth inhibition on the fermentation process analyze bioprocesses on basis of stoichiometry and to set up / solve metabolic flux equations distinguish between scale-up criteria for different bioreactors and bioprocesses (anaerobic, aerobic as well as microaerobic) to compare them as well as to apply them to current biotechnical problem propose solutions to complicated biotechnological problems and to deduce the corresponding models to explore new knowledge resources and to apply the newly gained contents identify scientific problems with concrete industrial use and to formulate solutions. to document and discuss their procedures as well as results in a scientific manner 			
Personal Competence Social Competence	After completion of this module participants should be able to debate technical questions in small teams to enhance the ability to take position to their own opinions and increase their capacity for teamwork in engineering and scientific environments.			
Autonomy	After completion of this module participants will be able to solve a technical problem in a team independently by organizing their workflow and to present their results in a plenum.			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		

Credit points	6		
Course	Compulsor B onus	Form Subject theoretical	Description
achievement	Yes 5 %	practical work	unu
Examination	Written exam		
Examination duration and scale			
the Following	Engineering: Compulsor General Engineering Bioprocess Engineering Bioprocess Engineering General Engineering Bioprocess Engineering General Engineering General Engineering Compulsor Biomedical Engineering Compulsory Biomedical Engineering Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory Technomathematics: Sp	Science (German prog : Compulsory : Core qualification: Com Science (English prog : Compulsory :ience (English program, ry :: Specialisation Artificial g: Specialisation Impla g: Specialisation Medica	ram, 7 semester): Specialisation 7 semester): Specialisation Process Organs and Regenerative Medicine: ants and Endoprostheses: Elective al Technology and Control Theory: ement and Business Administration: ring Science: Elective Compulsory

Course L0841: Biop	process Engineering - Fundamentals			
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng			
Language	DE			
Cycle	SoSe			
Content	 Introduction: state-of-the-art and development trends in the biotechnology, introduction to the lecture Enzyme kinetics: Michaelis-Menten, differnt types of enzyme inhibition, linearization, conversion, yield, selectivity (Prof. Liese) Stoichiometry: coefficient of respiration, electron balance, degree of reduction, coefficient of yield, theoretical oxygen demand (Prof. Liese) Microbial growth kinetic: batch- and chemostat culture (Prof. Zeng) Kinetic of subtrate consumption and product formation (Prof. Zeng) Rheology: non-newtonian fluids, viscosity, agitators, energy input (Prof. Liese) Transport process in a bioreactor (Prof. Zeng) Technology of sterilization (Prof. Zeng) Fundamentals of bioprocess management: bioreactors and calculation of batch, fed-batch and continuouse bioprocesses (Prof. Zeng/Prof. Liese) Downstream technology in biotechnology: cell breakdown, zentrifugation, filtration, aqueous two phase systems (Prof. Liese) 			
Literature	 K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012 H. Chmiel: Bioprozeßtechnik, Elsevier, 2006 R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010 H.W. Blanch, D. Clark: Biochemical Engineering, Taylor & Francis, 1997 			
	P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013			

Course L0842: Bioprocess Engineering- Fundamentals			
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	1		
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28		
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng		
Language			
Cycle	SoSe		
	1. Introduction (Prof. Liese, Prof. Zeng)		
	2. Enzymatic kinetics (Prof. Liese)		
	3. Stoichiometry I + II (Prof. Liese)		
	4. Microbial Kinetics I+II (Prof. Zeng)		
Content	5. Rheology (Prof. Liese)		
Content	6. Mass transfer in bioprocess (Prof. Zeng)		
	7. Continuous culture (Chemostat) (Prof. Zeng)		
	8. Sterilisation (Prof. Zeng)		
	9. Downstream processing (Prof. Liese)		
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)		
Literature	siehe Vorlesung		

Course L0843: Biop	process Engineering - Fundamental Practical Course
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng
Language	DE
Cycle	SoSe
Content	In this course fermentation and downstream technologies on the example of the production of an enzyme by means of a recombinant microorganism is learned. Detailed characterization and simulation of enzyme kinetics as well as application of the enzyme in a bioreactor is carried out. The students document their experiments and results in a protocol.
Literature	Skript

Module M1143	3: Applied Design Metho	odology in Mecha	atronics		
Courses					
Title Typ Applied Design Methodology in Mechatronics (L1523) Applied Design Methodology in Mechatronics (L1524) Project-/pro			Hrs/wk 2 3	CP 2	
	Prof. Thorsten Kern	based Learning			
Responsible Admission					
Requirements					
Recommended Previous Knowledge	Basics of mechanical design, elect	rical design or computer	-sciences		
Educational Objectives	After taking part successfully, stud	lents have reached the f	ollowing learn	ing results	
Professional Competence					
Knowledge	Science-based working on interd application of specific product des		ign consideri	ng targete	
Skills	Creative handling of processes used for scientific preparation and formulation o complex product design problems / Application of various product design techniques following theoretical aspects.				
Personal Competence					
Social Competence	In small design-teams with application of common, creative methodologies.				
Autonomy	the target and topic of the design				
	Independent Study Time 110, Stud	dy Time in Lecture 70			
Credit points					
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and scale	30 min Presentation for a group design-work				
Assignment for the Following Curricula	Biomedical Engineering: Specialisation implants and Endoprostheses: Elective Compulsory				

Compulsory

Course L1523: App	lied Design Methodology in Mechatronics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Kern
Language	EN
Cycle	SoSe
Content	 Systematic analysis and planning of the design process for products combining a multitude of disciplines Structure of the engineering process with focus on engineering steps (task-definition, functional decomposition, physical principles, elements for solution, combination to systems and products, execution of design, component-tests, system-tests, product-testing and qualification/validation) Creative methods (Basics, methods like lead-user-method, 6-3-5, BrainStorming, Intergalactic Thinking, Applications in examples al around mechatronics topics) Several design-supporting methods and tools (functional strcutures, GALFMOS, AEIOU-method, GAMPFT, simulation and its application, TRIZ design for SixSigma, continous integration and testing,) Evaluation and final selection of solution (technical and business-considerations, preference-matrix, pair-comparision), dealing with uncertainties, decision-making Value-analysis Derivation of architectures and architectural management Project-tracking and -guidance (project-lead, guiding of employees organization of multidisciplinary R&D departments, idea-identification responsibilities and communication) Project-execution methods (Scrum, Kanbaan,) Presentation-skills Questions of aesthetic product design and design for subjective requirements (industrial design, color, haptic/optic/acoustic interfaces) Evaluation of selected methods at practical examples in small teams
Literature	 Definition folgt Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, KH.: Konstruktionslehre: Grundlage erfolgreicher Produktentwicklung, Methoden und Anwendung, 7. Auflage Springer Verlag, Berlin 2007 VDI-Richtlinien: 2206; 2221ff

Course L1524: Applied Design Methodology in Mechatronics			
Тур	Project-/problem-based Learning		
Hrs/wk	3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Thorsten Kern		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M1280	D: MED II: Introduction	on to Physiology		
Courses				
Title Introduction to Physiol	ogy (L0385)	Typ Lecture	Hrs/wk CP 2 3	
Module Responsible	Dr. Roger Zimmermann			
Admission Requirements				
Recommended Previous	None			
Knowledge Educational Objectives		, students have reached the	e following learning results	
Professional Competence				
Knowledge	 the students can describe the basics of the describe physiological neuro- and sensory physiological neuro- 	relations in selected fields	of muscle, heart/circulation,	
Skills	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, development of forces and vital functions) and relate them to similar technical systems.			
Personal Competence				
Social Competence	The students can conduct dis The students can find solu analytical and metrological.			
Autonomy	The students can derive an physiological areas, using tec			
Workload in Hours	Independent Study Time 62,	Study Time in Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following	General Engineering Science Biomedical Engineering: Com General Engineering Science Mechanical Engineering, Focus Data Science: Specialisation I Electrical Engineering: Special Engineering Science: Speciali General Engineering Science Mechanical Engineering, Focus General Engineering: Com General Engineering: Com General Engineering: Com General Engineering: Science Biomedical Engineering: Specialise Mechanical Engineering: Specialise Biomedical Engineering: Specialise Biomedical Engineering: Specialise	pulsory ce (German program, 7 us Biomechanics: Compulsory dedicine: Compulsory disation Medical Technology sation Biomedical Engineer ce (English program, 7 us Biomechanics: Compulsor ce (English program, 7 pulsory ce (English program, 7 cive Compulsory cialisation Biomechanics: Co	semester): Specialisation ry y: Elective Compulsory ing: Elective Compulsory semester): Specialisation ry semester): Specialisation semester): Specialisation ompulsory	

Biomedical En Elective Comp		lanagement and Business Ad	dministration:
Biomedical Eng	gineering: Specialisation Art	tificial Organs and Regenerat	ive Medicine:
Elective Comp Biomedical Er		Implants and Endoprosthe	ses: Elective
Compulsory Technomathen	natics: Specialisation III. End	gineering Science: Elective Co	ompulsory

Course L0385: Introduction to Physiology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Gerhard Engler, Dr. Gerhard Engler		
Language	DE		
Cycle	SoSe		
Content			
Literature	Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier		

Courses				
Title		Тур	Hrs/wk	СР
Introduction to Anatom	ny (L0384)	Lecture	2	3
	Prof. Udo Schumacher			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, s	tudents have reached the	following learr	ning results
Professional Competence				
Knowledge	The students can describe basal structures and functions of internal organs and the musculoskeletal system. The students can describe the basic macroscopy and microscopy of those systems.			
Skills	The students can recognize the relationship between given anatomical facts and the development of some common diseases; they can explain the relevance of structures and their functions in the context of widespread diseases.			
Personal Competence				
•	The students can participate medicine on a professional leve		biomedical r	esearch an
Autonomy	The students are able to access anatomical knowledge by themselves, car participate in conversations on the topic and acquire the relevant knowledge themselves.			
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
	General Engineering Science Biomedical Engineering: Compu General Engineering Science Mechanical Engineering, Focus Data Science: Specialisation Me Electrical Engineering: Specialisa Engineering Science: Specialisa General Engineering Science	Ilsory (German program, 7 Biomechanics: Compulsory dicine: Compulsory sation Medical Technology: tion Biomedical Engineerir	semester): S / Elective Compose: Compose: Compose Com	pecialisatio pulsory y
the Following	Mechanical Engineering, Focus General Engineering Science Biomedical Engineering: Compu General Engineering Science Biomedical Engineering: Compu Mechanical Engineering: Special Biomedical Engineering: Special Elective Compulsory Biomedical Engineering: Special	Biomechanics: Compulsory (English program, 7 Ilsory (English program, 7 Ilsory Ilisation Biomechanics: Cor alisation Medical Technol	y semester): S semester): S mpulsory ogy and Con	pecialisation pecialisation pecialisation trol Theory

Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0384: Introduction to Anatomy			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study	Time 62, Study Time in Lecture 28	
	Prof. Tobias Lange		
Language			
Cycle			
	General Anatomy 1 st week:	The Eucaryote Cell	
	2 nd week: 3 rd week:	The Tissues Cell Cycle, Basics in Development	
	4 th week:	Musculoskeletal System	
	5 th week:	Cardiovascular System	
	6 th week:	Respiratory System	
	7 th week:	Genito-urinary System	
Content	8 th week:	Immune system	
	9 th week:	Digestive System I	
	10 th week:	Digestive System II	
	11 th week:	Endocrine System	
	12 th week:	Nervous System	
	13 th week:	Exam	
Literature	Adolf Faller/Michae Stuttgart, 2016	l Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag	

Module M1332	2: BIO I: Experimental Mo	ethods in Biom	echanics		
Courses					
Title Experimental Methods	in Biomechanics (L0377)	Typ Lecture	Hrs/wk	CP 3	
·	Prof Michael Morlock				
Admission Requirements					
Recommended	It is recommended to participat attending "Experimentelle Methode		ıd Frakturheili	ung" before	
	After taking part successfully, stude	ents have reached the	following learr	ning results	
Professional Competence					
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence. The students can name different treatments for the spine and hollow bones under given fracture morphologies.				
	The students can describe difference movements, and choose the adequate		•	forces and	
Skills	The students can describe the basic handling of several experimental techniques used in biomechanics.				
Personal Competence					
Social Competence	The students can, in groups, solve b	pasic experimental tas	ks.		
Autonomy	The students can, in groups, solve basic experimental tasks.				
Workload in Hours	Independent Study Time 62, Study	Time in Lecture 28			
Credit points					
Course achievement					
Examination					
Examination duration and scale					
the Following	General Engineering Science (G Mechanical Engineering, Focus Bior General Engineering Science (G Biomedical Engineering: Compulsor Engineering Science: Specialisation General Engineering Science (E Mechanical Engineering, Focus Bior General Engineering Science (E Biomedical Engineering: Compulsor General Engineering: Compulsor General Engineering: Elective Co Mechanical Engineering: Specialisat Biomedical Engineering: Specialisat Elective Compulsory Biomedical Engineering: Specialisat Elective Compulsory	nechanics: Compulsory erman program, 7 Y Biomedical Engineerir nglish program, 7 nechanics: Compulsory nglish program, 7 y nglish program, 7 ompulsory cion Biomechanics: Cor cion Artificial Organs a	semester): S ng: Elective Co semester): S y semester): S semester): S mpulsory nd Regenerati Endoprosthes	pecialisation mpulsory pecialisation pecialisation pecialisation ve Medicine: es: Elective	
	Biomedical Engineering: Specialisa	ation Medical Technol	logy and Con	trol Theory:	

Elective Compulsory
Biomedical Engineering: Specialisation Management and Business Administration:
Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0377: Experimental Methods in Biomechanics		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content		
Literature	Wird in der Veranstaltung bekannt gegeben	

Module M127 Therapy	8: MED I: Introduction to Radiology and Radiation
Courses	
Title Introduction to Radiolo	Typ Hrs/wk CP gy and Radiation Therapy (L0383) Lecture 2 3
	Prof. Ulrich Carl
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Therapy The students can distinguish different types of currently used equipment with respect to its use in radiation therapy. The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine). The students can describe the patients' passage from their initial admittance through to follow-up care. Diagnostics The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, as well as sectional imaging techniques (CT, MRT, US). The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for those techniques. The students can choose the right treatment method depending on the patient's clinical history and needs. The student can explain the influence of technical errors on the imaging techniques. The student can explain the right conclusions based on the images' diagnostic findings or the error protocol.
Skills	The student can assess what an individual psychosocial service should look like
	(e.g. follow-up treatment, sports, social help groups, self-help groups, social services, psycho-oncology). Diagnostics

	The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.			
	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of anatomy, pathology and pathophysiology.			
Personal Competence				
Social Competence	The students can assess the special social situation of tumor patients and interact with them in a professional way. The students are aware of the special, often fear-dominated behavior of sick people caused by diagnostic and therapeutic measures and can meet them appropriately.			
	The students can apply their new knowledge and skills to a concrete therapy case. The students can introduce younger students to the clinical daily routine.			
Autonomy	The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the topic and acquire the relevant knowledge themselves.			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Credit points	3			
Course achievement				
Examination	Written exam			
Examination duration and scale	90 minutes			
the Following	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Engineering Science: Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering: Compulsory General Engineering: Science (English program, 7 semester): Specialisation Biomedical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective			

Course L0383: Introduction to Radiology and Radiation Therapy		
Typ Lecture		
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ulrich Carl, Prof. Thomas Vestring	
Language	DE	

Cycle	Isoso				
·	The students will be given an understanding of the technological possibilities in the field of medical imaging, interventional radiology and radiation therapy/radiation oncology. It is assumed, that students in the beginning of the course have heard the word "X-ray" at best. It will be distinguished between the two arms of diagnostic (Prof. Dr. med. Thomas Vestring) and therapeutic (Prof. Dr. med. Ulrich Carl) use of X-rays. Both arms depend on special big units, which determine a predefined sequence in their respective departments				
Literature	 "Technik der medizinischen Radiologie" von T. + J. Laubenberg – 7. Auflage – Deutscher Ärzteverlag – erschienen 1999 "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr – 4. Auflage - Verlag Urban & Fischer – erschienen 02.03.2006 ISBN: 978-3-437-23960-1 "Strahlentherapie und Onkologie für MTA-R" von R. Sauer – 5. Auflage 2003 - Verlag Urban & Schwarzenberg – erschienen 08.12.2009 ISBN: 978-3-437-47501-6 "Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus- 8. Auflage – Georg Thieme Verlag - erschienen 19.09.2012 ISBN: 978-3-13-567708-8 "Der Körper des Menschen " von A. Faller u. M. Schünke - 16. Auflage 2004 – Georg Thieme Verlag – erschienen 18.07.2012 ISBN: 978-3-13-329716-5 "Praxismanual Strahlentherapie" von Stöver / Feyer – 				
	1. Auflage - Springer-Verlag GmbH - erschienen 02.06.2000				

Module M1335	5: BIO II: Artificial Joint R	Replacement		
Courses				
Title Artificial Joint Replacer	ment (L1306)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of orthopedic and	surgical techniques is r	ecommended	
Educational Objectives	After taking part successfully, stude	ents have reached the fo	ollowing learn	ing results
Professional Competence <i>Knowledge</i>		t kinds of artificial limb	S.	
	The students can explain the adva endoprotheses.			ent kinds of
Personal Competence				
Social Competence	The students are able to discuss issand the teachers.	sues related to endopro	these with sti	ident mates
Autonomy	The students are able to acquire in information with respect to its credi		. They can als	so judge the
Workload in Hours	Independent Study Time 62, Study	Time in Lecture 28		
Credit points	3			
Course achievement	None			
	Written exam			
Examination duration and scale	90 min			
the Following	International Management and Engand Biotechnology: Elective Compundaterials Science: Specialisation Naterials Science: Specialisation Naterials Science: Specialisation Naterials Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisations Elective Compulsory Biomedical Engineering: Specialisations Elective Compulsory Orientierungsstudium: Core qualifications Theoretical Mechanical Engineering Compulsory Theoretical Mechanical Engineering Elective Compulsory	Isory Isony Isono and Hybrid Materials Ison Artificial Organs an Ison Implants and Endop Isono Medical Technolo Ition Management and Isono Elective Compuls Isono	s: Elective Cod d Regenerative prostheses: Cod gy and Cont Business Add pory nentary Cours	mpulsory ve Medicine: ompulsory crol Theory: ministration: se: Elective

Course L1306: Arti	ficial Joint Replacement		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Michael Morlock		
Language	DE		
Cycle			
	Inhalt (deutsch)		
	 EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenker-satzes) 		
	2. FUNKTIONSANALYSE (Der menschliche Gang, die menschliche Arbeit, die sportliche Aktivität)		
	3. DAS HÜFTGELENK (Anatomie, Biomechanik, Gelenkersatz Schaftseite und Pfannenseite, Evolution der Implantate)		
Content	4. DAS KNIEGELENK (Anatomie, Biomechanik, Bandersatz, Gelenkersatz femorale, tibiale und patelläre Komponenten)		
	5. DER FUß (Anatomie, Biomechanik, Gelen-kersatz, orthopädische Verfahren)		
	6. DIE SCHULTER (Anatomie, Biomechanik, Gelenkersatz)		
	7. DER ELLBOGEN (Anatomie, Biomechanik, Gelenkersatz)		
	8. DIE HAND (Anatomie, Biomechanik, Ge-lenkersatz)		
	9. TRIBOLOGIE NATÜRLICHER UND KÜNST-LICHER GELENKE (Korrosion, Reibung, Verschleiß)		
	Literatur:		
	Kapandji, I: Funktionelle Anatomie der Gelenke (Band 1-4), Enke Verlag, Stuttgart, 1984.		
Literature	Nigg, B., Herzog, W.: Biomechanics of the musculo-skeletal system, John Wiley&Sons, New York 1994		
Literature	Nordin, M., Frankel, V.: Basic Biomechanics of the Musculoskeletal System, Lea&Febiger, Philadelphia, 1989.		
	Czichos, H.: Tribologiehandbuch, Vieweg, Wiesbaden, 2003.		
	Sobotta und Netter für Anatomie der Gelenke		

Module M0845	5: Feedback Control in I	Medical Technol	ogy	
Courses				
Title Feedback Control in Ma	edical Technology (L0664)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Basics in Control, Basics in Physio	logy		
Educational Objectives		dents have reached the	following learn	ing results
Professional Competence				
	The lecture will introduce into the engineering point of view. Fund introduced like knowledge in cont	amentals in human ph		
Knowledge	Internal control loops of the huma design of external closed loop sys			
	The handling of PID controllers and modern controller like predictive controller or fuzzy controller or neural networks will be illustrated. The operation of simple equivalent circuits will be discussed.			
Skills	Application of modeling, identific technology.	ation, control technolo	gy in the field	of medical
Personal Competence				
Social Competence	Students can develop solutions t their results	o specific problems in	small groups	and present
Autonomy	Students are able to find necessal lecture. They are able to continuous of their learning process. They comma consistent whole.	ously evaluate their kno	wledge and to	take control
Workload in Hours	Independent Study Time 62, Study	y Time in Lecture 28		
Credit points				
Course achievement	None			
Examination	Oral exam			
Examination duration and scale				
Assignment for the Following Curricula	Biomedical Engineering: Specialis	ation Control and Povisation Implants and ation Artificial Organs a	ver Systems in Endoprostheson in Regenerative	Engineering: es: Elective ve Medicine:

Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory

Course L0664: Fee	dback Control in Medical Technology
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	 Always viewed from the engineer's point of view, the lecture is structured as follows: Introduction to the topic Fundamentals of physiological modelling Introduction to Breathing and Ventilation Physiology and Pathology in Cardiology Introduction to the Regulation of Blood Glucose kidney function and renal replacement therapy Representation of the control technology on the concrete ventilator Excursion to a medical technology company Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.
Literature	 Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Module M0832	2: Advanced Topics in	Control		
Courses				
Title Advanced Topics in Co Advanced Topics in Co		Typ Lecture Recitation	Hrs/wk 2 Section 2	CP 3
		(small)		
Responsible Admission				
Requirements	Inone			
Recommended Previous Knowledge	H-infinity optimal control, mixed-	-sensitivity design, line	ear matrix inequa	lities
Educational Objectives	After taking part successfully, st	udents have reached t	he following learr	ning results
Professional Competence				
Knowledge	 Students can explain the scheduling approach They can explain the representations. They can explain how state can be formulated as LMI They can explain how grid synthesis problems for LPI They are familiar with polysome of the basic synthesis structures Students can explain how communication topology of they can explain the comprotocols. They can explain analysis involving either LTI or LPV Students can explain the distributed systems that a they can explain (in outly such distributed systems distributed controllers 	esentation of nonlinear ability and performance conditions dding techniques can by systems ytopic and LFT repressis techniques associal graph theoretic concept multiagent systems onvergence properties and synthesis condition agent models estate space represented accordingly the extension of	r systems in the fire conditions for the used to solve entations of LPV ted with each of epts are used to resolve for formation of spatiang to an actuator, the bounded resolve the solution of the solution of the solution in the solution of the solution o	form of quasi LPV systems analysis and systems and these model epresent the r consensus control loops ally invariant sensor array al lemma to
Skills	 Students are capable of carry out a mixed-sensition do this using polytopic, LF They are able to use stan for these tasks Students are able to desagents with either LTI or L 	vity design of gain-sc T or general LPV mode dard software tools (N	heduled controlle els Matlab robust con tion controllers fo	ers; they can strol toolbox or groups o
	[136	-1		

	 Students are able to design distributed controllers for spatially interconnected systems, using the Matlab MD-toolbox 				
Personal Competence Social Competence Autonomy	Students can work in small groups and arrive at joint results. Students are able to find required information in sources provided (lecture notes, iterature, software documentation) and use it to solve given problems.				
	Independent Study Time 124, Study Time in Lecture 56				
Credit points					
Course achievement	None				
Examination	Oral exam				
Examination duration and scale					
Assignment for the Following Curricula	Riomedical Engineering: Specialisation Medical Technology and Control Theory:				

Course L0661: Adv	anced Topics in Control
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	
Cycle	WiSe
Content	 Linear Parameter-Varying (LPV) Gain Scheduling Linearizing gain scheduling, hidden coupling Jacobian linearization vs. quasi-LPV models Stability and induced L2 norm of LPV systems Synthesis of LPV controllers based on the two-sided projection lemma Simplifications: controller synthesis for polytopic and LFT models Experimental identification of LPV models Controller synthesis based on input/output models Applications: LPV torque vectoring for electric vehicles, LPV control of a robotic manipulator Control of Multi-Agent Systems Communication graphs Spectral properties of the graph Laplacian First and second order consensus protocols Formation control, stability and performance LPV models for agents subject to nonholonomic constraints Application: formation control for a team of quadrotor helicopters Control of Spatially Interconnected Systems Multidimensional signals, I2 and L2 signal norm Multidimensional systems in Roesser state space form Extension of real-bounded lemma to spatially interconnected systems LMI-based synthesis of distributed controllers Spatial LPV control of spatially varying systems Applications: control of temperature profiles, vibration damping for an actuated beam
Literature	 Werner, H., Lecture Notes "Advanced Topics in Control" Selection of relevant research papers made available as pdf documents via StudIP

Course L0662: Advanced Topics in Control		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0548	3: Bioelectromagnetics: P	rinciples and	d Applicatio	ns
Courses				
_	Principles and Applications (L0371) Principles and Applications (L0373)	Typ Lecture Recitation (small)	Hrs/wk 3 Section 2	CP 5
Module Responsible	Prof. Christian Schuster	(2)		
Admission Requirements				
Recommended Previous Knowledge	Basic principles of physics			
Educational Objectives	After taking part successfully, studer	nts have reached t	he following learn	ing results
Professional Competence				
Knowledge	Students can explain the basic bioelectromagnetics, i.e. the quantif in biological tissue. They can defin phenomena and order them correstields. They can give an overview of characterization of electromagnetic examples for therapeutic and diagmedical technology.	ication and applicate and exemplify sponding to wavelver measurement fields in practical	ation of electroma the most importa length and freque and numerical ted applications . Th	gnetic fields ant physical ency of the chniques for ey can give
Skills	Students know how to apply varied electromagnetic fields in biological to make use of the elementary solution assess the most important effects to they can order the effects concespectively, and they can analyzed evelop validation strategies for the effects of electromagnetic fields from make an appropriate choice.	issue. In order to ons of Maxwell's that these models responding to them in a quantieir predictions. The	do this they can r Equations. They predict for biolo wavelength and tative way. They ney are able to e	elate to and are able to gical tissue, frequency, are able to evaluate the
Personal Competence Social Competence	Students are able to work together are able to present their results e exercises).			
Autonomy	Students are capable to gather in publications and relate that information make a connection between the content of other lectures (e.g. the electrical engineering / physics). The field of bioelectromagnetics in English	tion to the context ir knowledge obta ory of electromag ey can communicat	of the lecture. The nined in this lectu netic fields, fund	ney are able are with the amentals of
Workload in Hours	Independent Study Time 110, Study	Time in Lecture 70)	

Credit points	6			
Course achievement	CompulsorBonus Yes 10 %	Form Presentation	Description	
Examination	Oral exam			
Examination duration and scale	45 min			
the Following	Electromagnetic Compa Electrical Engineering: International Managem Elective Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Compulsory Theoretical Mechanical Elective Compulsory	atibility: Elective Co Specialisation Medi ent and Engineering: Specialisation Art g: Specialisation Medi g: Specialisation Medi g: Specialisation Medicalisation Medicalis	Microwave Engineering, ompulsory cal Technology: Elective Corg: Specialisation II. Electrical cificial Organs and Regeneral anagement and Business Aledical Technology and Collimplants and Endoprosthe cialisation Bio- and Medical chnical Complementary Collimps	npulsory I Engineering: tive Medicine: dministration: ontrol Theory: eses: Elective I Technology:

Course L0371: Bioe	electromagnetics: Principles and Applications
Тур	Lecture
Hrs/wk	3
СР	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
	Prof. Christian Schuster
Language	
Cycle	
	- Fundamental properties of electromagnetic fields (phenomena)
	- Mathematical description of electromagnetic fields (Maxwell's Equations)
	- Electromagnetic properties of biological tissue
	- Principles of energy absorption in biological tissue, dosimetry
	- Numerical methods for the computation of electromagnetic fields (especially FDTD)
	- Measurement techniques for characterization of electromagnetic fields
Content	- Behavior of electromagnetic fields of low frequency in biological tissue
	- Behavior of electromagnetic fields of medium frequency in biological tissue
	- Behavior of electromagnetic fields of high frequency in biological tissue
	- Behavior of electromagnetic fields of very high frequency in biological tissue
	- Diagnostic applications of electromagnetic fields in medical technology
	- Therapeutic applications of electromagnetic fields in medical technology
	- The human body as a generator of electromagnetic fields
	- C. Furse, D. Christensen, C. Durney, "Basic Introduction to Bioelectromagnetics",
	CRC (2009)
Literature	- A. Vorst, A. Rosen, Y. Kotsuka, "RF/Microwave Interaction with Biological Tissues", Wiley (2006)
	- S. Grimnes, O. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008)
	- F. Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnetic Fields", CRC (2006)

Course L0373: Bioelectromagnetics: Principles and Applications		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Specialization Artificial Organs and Regenerative Medicine

Module M0623	3: Intelli	gent Sy	stems in Me	dicine		
Courses						
Title				Тур	Hrs/wk	СР
Intelligent Systems in				Lecture	2	3
Intelligent Systems in				Project Seminar Recitation Sec	2 ction ₁	2
Intelligent Systems in	Medicine (L03	333)		(small)	1	1
Module Responsible	IPIOI AIEXAI	nder Schlae	fer			
Admission Requirements	None					
Recommended Previous Knowledge	• princ	iples of sto	ath (algebra, analy ochastics ogramming, Java/C camming skills			
Educational Objectives	After taking	part succe	essfully, students h	nave reached the fo	ollowing learn	ing results
Professional Competence						
Knowledge	The students are able to analyze and solve clinical treatment planning and decision support problems using methods for search, optimization, and planning. They are able to explain methods for classification and their respective advantages and disadvantages in clinical contexts. The students can compare different methods for representing medical knowledge. They can evaluate methods in the context of clinical data and explain challenges due to the clinical nature of the data and its acquisition and due to privacy and safety requirements.					
Skills	regression,	and predic		ing and adapting r ssess the methods hods.		
Personal Competence						
Social Competence				er groups, provide	helpful feedb	ack and car
Autonomy			ect their knowledgresults in an appro	ge and document priate manner.	the results o	f their work
Workload in Hours	Independer	nt Study Tin	ne 110, Study Tim	e in Lecture 70		
Credit points	6					
Course achievement	YAC	rBonus 10 % 10 %	Form Written elaborat Presentation		ription	
Examination	Written exa	m				
Examination duration and scale	90 minutes					
	Electrical E	ngineering:	Specialisation Me	lligence Engineerir dical Technology: l Systems and Robot	Elective Comp	oulsory

	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Assignment for	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
Curricula	Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective
	Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0331: Inte	lligent Systems in Medicine
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	WiSe
Content	 methods for search, optimization, planning, classification, regression and prediction in a clinical context representation of medical knowledge understanding challenges due to clinical and patient related data and data acquisition The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Russel & Norvig: Artificial Intelligence: a Modern Approach, 2012 Berner: Clinical Decision Support Systems: Theory and Practice, 2007 Greenes: Clinical Decision Support: The Road Ahead, 2007 Further literature will be given in the lecture

Course L0334: Intelligent Systems in Medicine		
Тур	Project Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0333: Intelligent Systems in Medicine		
Тур	Typ Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP)

Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L1663)		Seminar	2	3
Introduction to Waveguides, Antennas, and Electromagnetic Compatibility (L1669)		Lecture	3	4
Introduction to Waveg Compatibility (L1877)	uides, Antennas, and Electromagnetic	Recitation (small)	Section 2	2
Development and Reg	ulatory Approval of Implants (L1588)	Lecture	2	3
Experimental Methods	for the Characterization of Materials (L1580)	Lecture	2	3
Numerical Methods in	Biomechanics (L1583)	Seminar	2	3
Seminar Biomedical En	ngineering (L1890)	Seminar	2	3
Six Sigma (L1130)		Lecture	2	3
Fluid Mechanics II (L00	001)	Lecture	2	4
System Simulation (L1	820)	Lecture	2	2
System Simulation (L1	821)	Recitation (large)	Section 1	2
Ceramics Technology	(L0379)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	laneriakino nari successinily sindenis n	ave reached	the following learr	ning results
Professional Competence				
Knowledge				
Skills				
Personal				
Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	12			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation A Elective Compulsory Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory	Implants a	and Endoprosthes chnology and Con	es: Electiv
	Biomedical Engineering: Specialisation Elective Compulsory	wanagement	and Business Ad	ministratio

Course L1663: Nature's Hierarchical Materials		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Gerold Schneider	
Language	EN	
Cycle	WiSe	
Content	Biological materials are omnipresent in the world around us. They are the main constituents in plant and animal bodies and have a diversity of functions. A fundamental function is obviously mechanical providing protection and support for the body. But biological materials may also serve as ion reservoirs (bone is a typical example), as chemical barriers (like cell membranes), have catalytic function (such as enzymes), transfer chemical into kinetic energy (such as the muscle), etc. This lecture will focus on materials with a primarily (passive) mechanical function: cellulose tissues (such as wood), collagen tissues (such as tendon or cornea), mineralized tissues (such as bone, dentin and glass sponges). The main goal is to give an introduction to the current knowledge of the structure in these materials and how these structures relate to their (mostly mechanical) functions.	
Literature	Peter Fratzl, Richard Weinkamer, Nature's hierarchical materialsProgress, in Materials Science 52 (2007) 1263-1334 Journal publications	

Course L1669: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and scale		
Lecturer	Prof. Christian Schuster	
L anguage		
Cycle	SoSe	
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency / high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation and Electromagnetic Compatibility will be introduced and discussed. Topics: - Fundamental properties and phenomena of electrical circuits - Steady-state sinusoidal analysis of electrical circuits - Fundamental properties and phenomena of electromagnetic fields and waves - Steady-state sinusoidal description of electromagnetic fields and waves - Useful microwave network parameters - Transmission lines and basic results from transmission line theory - Plane wave propagation, superposition, reflection and refraction - General theory of waveguides - Most important types of waveguides and their properties - Radiation and basic antenna parameters - Most important types of antennas and their properties - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques	
Literature	 - Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999) - J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012) - D. M. Pozar, "Microwave Engineering", Wiley (2011) - Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008) 	
	 - H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009) - A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007) 	

Course L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1588: Development and Regulatory Approval of Implants	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Roman Nassutt
Language	DE
Cycle	WiSe
Content	
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik – Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html

Course L1580: Experimental Methods for the Characterization of Materials		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Patrick Huber	
Language	DE	
Cycle	WiSe	
Content	 Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry) 	
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).	

Course L1583: Num	nerical Methods in Biomechanics
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	SoSe
Content	 Vorkenntnisse aus " Diskretisierungsmethoden der Mechanik" sind empfohlen Ein Überblick über die gängigsten numerischen Verfahren im Bereich der Biomechanik und Medizintechnik wird vermittelt. Grundkenntnissen aus verschiedenen Disziplinen (Mechanik, Mathematik, Programmierung) werden kombiniert um eine geschlossene Beispielfragestellung zu beantworten Die Vorlesung umfasst analytische Ansätze, rheologische Modelle und Finite Elemente Methoden Die vermittelten theoretischen Ansätze werden im Laufe der Vorlesung und im Rahmen von Hausaufgaben in praktische Übungen angewandt. Der kritische Blick auf die Möglichkeiten und Limitationen der Modellrechnung im Bereich humaner Anwendungen wird geschult.
Literature	Hauger W., Schnell W., Gross D., Technische Mechanik, Band 3: Kinetik, Springer-Verlag Berlin Heidelberg, 12. Auflage, 2012 Huber G., de Uhlenbrock A., Götzen N., Bishop N., Schwieger K., Morlock MM., Modellierung, Simulation und Optimierung, Handbuch Sportbiomechanik, Gollhofer A., Müller E., Hofmann Verlag, Schorndorf, 148-69, 2009

Course L1890: Seminar Biomedical Engineering		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Referat	
Examination duration and scale	schriftliche ausarbeitung und Vortrag (20 min)	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	WiSe	
Content		
Literature	Keine	

Course L1130: Six Sigma		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Claus Emmelmann	
Language	DE	
Cycle	WiSe	
Content	 Introduction and structuring Basic terms of quality management Measuring and inspection equipment Tools of quality management: FMEA, QFD, FTA, etc. Quality management methodology Six Sigma, DMAIC 	
Literature	Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008 Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996 Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008	

Course L0001: Fluid	d Mechanics II
Typ	Lecture
Hrs/wk	
СР	
	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination	
duration and	
scale	
	Prof. Michael Schlüter
Language	
Cycle	WiSe
Content	 Differential equations for momentum-, heat and mass transfer Examples for simplifications of the Navier-Stokes Equations Unsteady momentum transfer Free shear layer, turbulence and free jets Flow around particles - Solids Process Engineering Coupling of momentum and heat transfer - Thermal Process Engineering Rheology - Bioprocess Engineering Coupling of momentum- and mass transfer - Reactive mixing, Chemical Process Engineering Flow threw porous structures - heterogeneous catalysis Pumps and turbines - Energy- and Environmental Process Engineering Wind- and Wave-Turbines - Renewable Energy Introduction into Computational Fluid Dynamics
Literature	 Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.

Course L1820: Sys	tem Simulation
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example: Hydraulic systems and heat transfer • Example: System with different subsystems
Literature	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

Course L1821: System Simulation		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Dr. Stefan Wischhusen	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28	
Examination Form	Klausur		
Examination duration and scale	90 Minuten		
Lecturer	Dr. Rolf Janßen		
Language	DE/EN		
Cycle	WiSe		
	The course focus predomina metauurgical techniques and aspects of glass and cement s forming techniques of cerar Examples will be discussed in	sing with emphasis on advanced structural ceramics. atly on powder-based processing, e.g. "powder- sintering (soild state and liquid phase). Also, some science as well as new developments in powderless nics and ceramic composites will be addressed order to give engineering students an understanding d specific applications of ceramic components.	
	Content:	1. Introduction	
	Inhalt:	2. Raw materials	
Content		3. Powder fabrication	
		4. Powder processing	
		5. Shape-forming processes	
		6. Densification, sintering	
		7. Glass and Cement technology	
		8. Ceramic-metal joining techniques	
	W.D. Kingery, "Introduction to 0	Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991		
Literature	Literature D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992		
	Skript zur Vorlesung		
	Skript zur voriesung		

Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP)

Courses				
Title		Тур	Hrs/wk	CP
Nature's Hierarchical Materials (L1663)		Seminar	2	3
Introduction to Waveguides, Antennas, and Electromagnetic Compatibility (L1669)		Lecture	3	4
Introduction to Waveg Compatibility (L1877)	uides, Antennas, and Electromagnetic	Recitation (small)	Section 2	2
Development and Reg	ulatory Approval of Implants (L1588)	Lecture	2	3
Experimental Methods	for the Characterization of Materials (L1580)	Lecture	2	3
Numerical Methods in	Biomechanics (L1583)	Seminar	2	3
Seminar Biomedical Er	ngineering (L1890)	Seminar	2	3
Six Sigma (L1130)		Lecture	2	3
Fluid Mechanics II (L00		Lecture	2	4
System Simulation (L1	820)	Lecture	2	2
System Simulation (L1	821)	Recitation	Section 1	2
Ceramics Technology ((10379)	(large) Lecture	2	3
Ceramics reciniology (20379)	Lecture	2	
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached	the following learr	ning results
Professional Competence				
Knowledge				
Skills				
Personal				
Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation I Elective Compulsory Biomedical Engineering: Specialisation A	Medical Ted	chnology and Con	trol Theory:
	Elective Compulsory	a cariciai Orga	no and regenerati	ve incurente

Course L1663: Nature's Hierarchical Materials		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Gerold Schneider	
Language	EN	
Cycle	WiSe	
Content	Biological materials are omnipresent in the world around us. They are the main constituents in plant and animal bodies and have a diversity of functions. A fundamental function is obviously mechanical providing protection and support for the body. But biological materials may also serve as ion reservoirs (bone is a typical example), as chemical barriers (like cell membranes), have catalytic function (such as enzymes), transfer chemical into kinetic energy (such as the muscle), etc. This lecture will focus on materials with a primarily (passive) mechanical function: cellulose tissues (such as wood), collagen tissues (such as tendon or cornea), mineralized tissues (such as bone, dentin and glass sponges). The main goal is to give an introduction to the current knowledge of the structure in these materials and how these structures relate to their (mostly mechanical) functions.	
Literature	Peter Fratzl, Richard Weinkamer, Nature's hierarchical materialsProgress, in Materials Science 52 (2007) 1263-1334 Journal publications	

Course L1669: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and scale		
	Prof. Christian Schuster	
Language		
Cycle		
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency / high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation and Electromagnetic Compatibility will be introduced and discussed. Topics: - Fundamental properties and phenomena of electrical circuits - Steady-state sinusoidal analysis of electrical circuits - Fundamental properties and phenomena of electromagnetic fields and waves - Steady-state sinusoidal description of electromagnetic fields and waves - Useful microwave network parameters - Transmission lines and basic results from transmission line theory - Plane wave propagation, superposition, reflection and refraction - General theory of waveguides - Most important types of waveguides and their properties - Radiation and basic antenna parameters - Most important types of antennas and their properties - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques	
Literature	 - Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999) - J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012) - D. M. Pozar, "Microwave Engineering", Wiley (2011) - Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008) - H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009) 	
	- A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)	

Course L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1588: Development and Regulatory Approval of Implants		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale	90 Minuten	
Lecturer	Dr. Roman Nassutt	
Language	DE	
Cycle	WiSe	
Content		
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik – Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html 	

Course L1580: Experimental Methods for the Characterization of Materials		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale	90 min	
Lecturer	Prof. Patrick Huber	
Language	DE	
Cycle	WiSe	
Content	 Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry) 	
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).	

Course L1583: Numerical Methods in Biomechanics		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Michael Morlock	
Language	DE/EN	
Cycle	SoSe	
Content	 Vorkenntnisse aus " Diskretisierungsmethoden der Mechanik" sind empfohlen Ein Überblick über die gängigsten numerischen Verfahren im Bereich der Biomechanik und Medizintechnik wird vermittelt. Grundkenntnissen aus verschiedenen Disziplinen (Mechanik, Mathematik, Programmierung) werden kombiniert um eine geschlossene Beispielfragestellung zu beantworten Die Vorlesung umfasst analytische Ansätze, rheologische Modelle und Finite Elemente Methoden Die vermittelten theoretischen Ansätze werden im Laufe der Vorlesung und im Rahmen von Hausaufgaben in praktische Übungen angewandt. Der kritische Blick auf die Möglichkeiten und Limitationen der Modellrechnung im Bereich humaner Anwendungen wird geschult. 	
Literature	Hauger W., Schnell W., Gross D., Technische Mechanik, Band 3: Kinetik, Springer-Verlag Berlin Heidelberg, 12. Auflage, 2012 Huber G., de Uhlenbrock A., Götzen N., Bishop N., Schwieger K., Morlock MM., Modellierung, Simulation und Optimierung, Handbuch Sportbiomechanik, Gollhofer A., Müller E., Hofmann Verlag, Schorndorf, 148-69, 2009	

Course L1890: Seminar Biomedical Engineering		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Referat	
Examination duration and scale	schriftliche ausarbeitung und Vortrag (20 min)	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	WiSe	
Content		
Literature	Keine	

Course L1130: Six Sigma			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Prof. Claus Emmelmann		
Language	DE		
Cycle	WiSe		
Content	 Introduction and structuring Basic terms of quality management Measuring and inspection equipment Tools of quality management: FMEA, QFD, FTA, etc. Quality management methodology Six Sigma, DMAIC 		
Literature	Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008 Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996 Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008		

Course L0001: Flui	d Mechanics II
Typ	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	
Examination	
duration and	
scale	
	Prof. Michael Schlüter
Language	
Cycle	WiSe
Content	 Differential equations for momentum-, heat and mass transfer Examples for simplifications of the Navier-Stokes Equations Unsteady momentum transfer Free shear layer, turbulence and free jets Flow around particles - Solids Process Engineering Coupling of momentum and heat transfer - Thermal Process Engineering Rheology - Bioprocess Engineering Coupling of momentum- and mass transfer - Reactive mixing, Chemical Process Engineering Flow threw porous structures - heterogeneous catalysis Pumps and turbines - Energy- and Environmental Process Engineering Wind- and Wave-Turbines - Renewable Energy Introduction into Computational Fluid Dynamics
Literature	 Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.

Course L1820: Sys	tem Simulation
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. Instruction and modelling of physical processes Modelling and limits of model Time constant, stiffness, stability, step size Terms of object orientated programming Differential equations of simple systems Introduction into Modelica Introduction into simulation tool Example: Hydraulic systems and heat transfer Example: System with different subsystems
Literature	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

Course L1821: System Simulation	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0379: Ceramics Technology		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, S	tudy Time in Lecture 28
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Dr. Rolf Janßen	
Language	DE/EN	
Cycle	WiSe	
	Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metauurgical techniques and sintering (soild state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.	
	Content:	1. Introduction
	Inhalt:	2. Raw materials
Content		3. Powder fabrication
		4. Powder processing
		5. Shape-forming processes
		6. Densification, sintering
		7. Glass and Cement technology
		8. Ceramic-metal joining techniques
	W.D. Kingery, "Introduction to	Ceramics", John Wiley & Sons, New York, 1975
	ASM Engineering Materials Ha	ndbook Vol.4 "Ceramics and Glasses", 1991
Literature	Literature D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 199	
	Skript zur Vorlesung	

Module M0629	9: Intelligent Autonomous Agents and Cognitive Robotics	
Courses		
_	Typ Hrs/wk CP s Agents and Cognitive Robotics (L0341) s Agents and Cognitive Robotics (L0512) Recitation Section 2 2 Recitation (small)	
Module Responsible	Rainer Marrone	
Admission Requirements	INODE	
Recommended Previous Knowledge	Vectors, matrices, Calculus	
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	Students can explain the agent abstraction, define intelligence in terms of rational behavior, and give details about agent design (goals, utilities, environments). They can describe the main features of environments. The notion of adversarial agent cooperation can be discussed in terms of decision problems and algorithms for solving these problems. For dealing with uncertainty in real-world scenarios, students can summarize how Bayesian networks can be employed as a knowledge representation and reasoning formalism in static and dynamic settings. In addition, students can define decision making procedures in simple and sequential settings, with and with complete access to the state of the environment. In this context, students can describe techniques for solving (partially observable) Markov decision problems, and they can recall techniques for measuring the value of information. Students can identify techniques for simultaneous localization and mapping, and can explain planning techniques for achieving desired states. Students can explain coordination problems and decision making in a multi-agent setting in term of different types of equilibria, social choice functions, voting protocol, and mechanism design techniques.	
Skills	Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent application students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesian networks/dynamic Bayesian networks and apply bayesian reasoning for simple queries. Students can also name and apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situations students will apply techniques for finding different equilibria states,e.g., Nash equilibria. For multi-agent decision making students will apply different voting protocols and compare and explain the results.	
Personal Competence		
Social Competence	Students are able to discuss their solutions to problems with others. They communicate in English	
Autonomy	Students are able of checking their understanding of complex concepts by solving varaints of concrete problems	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Credit points	6	
Course		

achievement	None
Examination	Written exam
Examination duration and scale	90 minutes
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Numerics and Computer Science: Elective Compulsory

Course L0341: Inte	lligent Autonomous Agents and Cognitive Robotics		
Тур	Lecture		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Rainer Marrone		
Language	EN		
Cycle	WiSe		
Content	 Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference by enumeration), typical-case complexity, pragmatics: reasoning from effect (that can be perceived by an agent) to cause (that cannot be directly perceived). Probabilistic reasoning over time: Environmental state may change even without the agent performing actions, dynamic Bayesian networks, Markov assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation, special cases: hidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decision networks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteration, MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks Simultaneous Localization and Mapping Planning Game theory (Golden Balls: Split or Share) Decisions with multiple agents, Nash equilibrium, Bayes-Nash equilibrium Social Choice Voting protocols, preferences, paradoxes, Arrow's Theorem, Mechanism Design Fundamentals, dominant strategy implementation, Revelation Principle, Gibbard-Satterthwaite Imp		
Literature	 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Norvig, Prentice Hall, 2010, Chapters 2-5, 10-11, 13-17 Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005 Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press, 2009 		

Course L0512: Intelligent Autonomous Agents and Cognitive Robotics		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Rainer Marrone	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0746	6: Microsystem I	Engineering			
Courses					
Title Microsystem Engineering (L0680)			Typ Lecture Project-/problem-	Hrs/wk	CP 4
Microsystem Engineeri	ing (L0682)		based Learning	2	2
Module Responsible	Prof. Marifred Rasper				
Admission Requirements	LNODE				
Recommended Previous Knowledge	Basic courses in physic	s, mathematics ar	nd electric engineerir	ng	
Educational Objectives	LATTER TAKING NART SUICCE	ssfully, students h	ave reached the follo	owing learn	ing results
Professional Competence				-ltil-	£ MEMC -
Knowledge	The students know abo well as their application	ns in sensors and a	actuators.		
Skills	Students are able to components and to eva	analyze and des aluate the potentia	scribe the functional all of microsystems.	al behaviou	ur of MEMS
Personal Competence		olvo sposific probl	ome alone or in a gr	oup and to	procent the
Social Competence	Students are able to so results accordingly.	oive specific probl	ems alone of in a gro	oup and to	present the
Autonomy	Students are able to acquire particular knowledge using specialized literature and t integrate and associate this knowledge with other fields.				
	Independent Study Tim	ne 124, Study Time	e in Lecture 56		
Credit points				_	
Course achievement	CompulsorBonus No 10 %	Form Presentation	Descript	tion	
Examination	Written exam				
Examination duration and scale	2h				
Assignment for the Following Curricula	Compulsory Biomedical Engineering: Specialisation Implants and Endoprostneses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration Elective Compulsory				
	Microelectronics and M	icrosystems: Core	qualification: Electiv	e Compuls	ory

Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0680: Mici	osystem Engineering
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
	Prof. Manfred Kasper
Language	
Cycle	
	Object and goal of MEMS
	Scaling Rules
	Lithography
	Film deposition
	Structuring and etching
	Energy conversion and force generation
	Electromagnetic Actuators
	Reluctance motors
Content	Piezoelectric actuators, bi-metal-actuator
	Transducer principles
	Signal detection and signal processing
	Mechanical and physical sensors
	Acceleration sensor, pressure sensor
	Sensor arrays
	System integration
	Yield, test and reliability
	M. Kasper: Mikrosystementwurf, Springer (2000)
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press (1997)

Course L0682: Microsystem Engineering		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Manfred Kasper	
Language	EN	
Cycle	WiSe	
Content	Examples of MEMS components	
	Layout consideration	
	Electric, thermal and mechanical behaviour	
	Design aspects	
Literature	Wird in der Veranstaltung bekannt gegeben	

Module M0751	L: Vibration Theory		
Courses			
Title Vibration Theory (L070	Typ Hrs/wk CP Integrated Lecture 4 6		
Module Responsible	Prof. Norbert Hoffmann		
Admission Requirements	None		
Recommended Previous Knowledge	5		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Students are able to denote terms and concepts of Vibration Theory and develop them further.		
	Students are able to denote methods of Vibration Theory and develop them further.		
Personal Competence			
· ·	Students can reach working results also in groups.		
	Students are able to approach individually research tasks in Vibration Theory.		
	Independent Study Time 124, Study Time in Lecture 56		
Credit points Course			
achievement	None		
Examination	Written exam		
Examination duration and scale			
the Following	Energy Systems: Core qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core qualification: Compulsory Naval Architecture and Ocean Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory		

Course L0701: Vibration Theory		
Тур	Integrated Lecture	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Norbert Hoffmann	
Language	DE/EN	
Cycle	WiSe	
Content	waves.	
Literature	K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen. Springer Verlag, 2013.	

Γitle		Тур	Hrs/wk	СР
Гесhnology Manageme	ent (L0849)	Project-/problem- based Learning	3	3
Technology Manageme	ent Seminar (L0850)	Project-/problem- based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous Knowledge	Bachelor knowledge in business m	anagement		
Educational Objectives	After taking part successfully, stud	lents have reached the fol	lowing learn	ing results
Professional Competence	Students will gain deep insights in	to:		
Knowledge	 International R&D-Management Technology Timing Strategies Technology Strategies and Lifecycle Management (I/II) Technology Intelligence and Planning Technology Portfolio Management Technology Portfolio Methodology Technology Acquisition and Exploitation IP Management Organizing Technology Development Technology Organization & Management Technology Funding & Controlling 			
Skills	 Develop an understanding of the importance of Technology Management - or a national as well as international level Equip students with an understanding of important elements of Technology Management (strategic, operational, organizational and process-relate aspects) Foster a strategic orientation to problem-solving within the innovation process as well as Technology Management and its importance for corporate strategy Clarify activities of Technology Management (e.g. technology sourcing maintenance and exploitation) Strengthen essential communication skills and a basic understanding of managerial, organizational and financial issues concerning Technology-Innovation- and R&D-management. Further topics to be discussed include: 			
Personal	 Basic concepts, models technology, R&D and innova- Innovation as a process (steep 	ation	the mana	agement
Competence Social Competence	 Interact within a team 			

Autonomy	 Discuss recent research debates in the context of Technology and Innovation Management Develop presentation skills Discussion of international cases in R&D-Management 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 minutes			
the Following	Global Innovation Management: Core qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory			

Course L0849: Tecl	hnology Management
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	The role of technology for the competitive advantage of the firm and industries; Basic concepts, models and tools for the management of technology; managerial decision making regarding the identification, selection and protection of technology (make or buy, keep or sell, current and future technologies). Theories, practical examples (cases), lectures, interactive sessions and group study. This lecture is part of the Module Technology Management and can not separately choosen.
Literature	Leiblein, M./Ziedonis, A.: Technology Strategy and Inoovation Management, Elgar Research Collection, Northhampton (MA) 2011

Course L0850: Tech	nnology Management Seminar
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Beside the written exam at the end of the module, students have to give one presentation (RE) on a research paper and two presentations as part of a group discussion (GD) in the seminar in order to pass. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.
Literature	see lecture Technology Management.

Courses					
Title			Тур	Hrs/wk	СР
Microsystems Technology (L0724)			Lecture	2	4
Microsystems Technology (L0725)			Project-/problem- based Learning	2	2
Module Responsible	Prof. Hoc Khiem Trieu		-		
Admission Requirements	None				
Recommended Previous Knowledge	Dacies in physics, shor	nistry, mechan	ics and semiconducto	r technology	
Educational Objectives	I ATTER TAKING NART SLICCE	essfully, studen	ts have reached the fo	ollowing lear	ning result
Professional					
Competence	Students are able				
		r the fabricatio			
Knowledge	Knowledge • to explain in details operation principles of microsensors and microact and				croactuato
	to discuss the potential	ential and limit	ation of microsystems	in applicatio	n.
	Students are capable				
	 to analyze the fea 	sibility of micro	systems,		
	 to develop proces 	s flows for the	fabrication of microstr	uctures and	
Skills	to apply them.				
Personal Competence					
Social Competence	Students are able to prepare and perform their lab experiments in team work a well as to present and discuss the results in front of audience.				
Autonomy	None				
	Independent Study Tin	ne 124, Study	Fime in Lecture 56		
Credit points					
	Compulsor B onus	Form	Studie	ription erenden f ruppen	ühren e

Course achievement	Yes N	NANA	Subject oractical v	theoretical work	and Laborpraktikum durch. Jede Gruppe präsentiert und diskutiert die Theorie sowie die Ergebniise ihrer Labortätigkeit. vor dem gesamten Kurs.
Examination	Oral exam				
Examination duration and scale	30 min				
Assignment for the Following Curricula	Technology: Electrical Eng International Compulsory Biomedical E Elective Com Biomedical Compulsory Biomedical E Elective Com Biomedical E Elective Com	Elective Congineering: Sp Managemen ngineering: pulsory Engineering: Engineering: pulsory Engineering: pulsory	npulsory pecialisat nt and En Specialis Special Speciali	ion Medical angineering: Station Artificitisation Imposation Medisation Mana	Nanoelectronics and Microsystems Technology: Elective Compulsory Epecialisation II. Mechatronics: Elective ial Organs and Regenerative Medicine: clants and Endoprostheses: Elective ical Technology and Control Theory: ingement and Business Administration: lification: Elective Compulsory

	osystems Technology
Тур	Lecture
Hrs/wk	
СР	
	Independent Study Time 92, Study Time in Lecture 28
	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication photolithography, improving resolution, next-generation lithography, nand imprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVI techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVE PECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH theory, corner undercutting, measures for compensation and etch-sto techniques; plasma processes, dry etching: back sputtering, plasma etching RIE, Bosch process, cryo process, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, filr stress, stiction: theory and counter measures; Origami microstructures, Ep Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generatin sensors: Seebeck effect and thermopile; modulating sensors: thermo resisto Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermologie and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric an capacitive; angular rate sensor: operating principle and fabrication process) Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AM and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal

conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip)

- Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics)
- MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration)
- Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship)
- System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)

M. Madou: Fundamentals of Microfabrication, CRC Press, 2002

N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009

Literature

T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010

G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L0725: Microsystems Technology					
Тур	Project-/problem-based Learning				
Hrs/wk	2				
СР	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Lecturer	Prof. Hoc Khiem Trieu				
Language	EN				
Cycle	WiSe				
Content	See interlocking course				
Literature	See interlocking course				

Courses				
Title Control Systems Theor		Typ Lecture Recitation	Hrs/wk 2	CP 4
Control Systems Theor	ry and Design (L0657)	(small)	Section 2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	INONE			
Recommended Previous Knowledge	Introduction to Control Systems			
Educational Objectives		ents have reached	the following lear	rning results
Professional Competence				
Knowledge	 Students can explain how lispace models; they can intexternal excitation as traject. They can explain the system their relationship to state fee. They can explain the signific. They can explain observer-bachieve tracking and disturb. They can extend all of the absolute the can explain the z-tratransform. They can explain state spacetime systems. They can explain the experious systems, and how the iden normal equation. They can explain how a significant discrete-time impulse response. 	erpret the system ories in state space of properties controlled back and state eance of a minimal ased state feedback ance rejection pove to multi-input ansform and its a models and transemental identification problem tate space mode	n response to inite e collability and observation, respective realisation ack and how it can multi-output systemationship with after function mode in can be solved	ervability, are tively an be used to tems the Laplace els of discretels of dynam by solving
Skills	 Students can transform transvice versa They can assess controllable realisations They can design LQG control They can carry out a control time domain, and decide whi They can identify transfer dynamic systems from experion they can carry out all these control Toolbox, System Iden 	lers for multivarial lers for multivarial ller design both in ch is appropriate function models imental data se tasks using sta	ability and const ole plants continuous-time for a given sampl and state spac	and discrete ling rate ce models o
Personal Competence				
Social Competence	Students can work in small groups	on specific problen	ns to arrive at joir	nt solutions.
	Students can obtain information 1	rom provided sou	urces (lecture no	tes. softwar

Autonomy	They can assess their knowledge in weekly on-line tests and thereby control their learning progress.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Machatronics: Care qualification: Compulsory

Course L0656: Con	trol Systems Theory and Design
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	State space methods (single-input single-output) State space models and transfer functions, state feedback Coordinate basis, similarity transformations Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem Controllability and pole placement State estimation, observability, Kalman decomposition Observer-based state feedback control, reference tracking Transmission zeros Optimal pole placement, symmetric root locus Multi-input multi-output systems Transfer function matrices, state space models of multivariable systems, Gilbert realization Poles and zeros of multivariable systems, minimal realization Closed-loop stability Pole placement for multivariable systems, LQR design, Kalman filter Digital Control Discrete-time systems: difference equations and z-transform Discrete-time state space models, sampled data systems, poles and zeros Frequency response of sampled data systems, choice of sampling rate System identification and model order reduction Least squares estimation, ARX models, persistent excitation Identification of state space models, subspace identification Balanced realization and model order reduction Case study Modelling and multivariable control of a process evaporator using Matlab and Simulink
Literature	 Software tools Matlab/Simulink Werner, H., Lecture Notes "Control Systems Theory and Design" T. Kailath "Linear Systems", Prentice Hall, 1980 K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997 L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999

Course L0657: Control Systems Theory and Design	
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
		T	Here foods	CD
Title The Digital Enterprise	(10932)	Typ Lecture	Hrs/wk 2	CP 2
Production Planning ar		Lecture	2	2
Production Planning ar		Recitation	Section ₁	1
roduction riamming ar	14 2011.101 (2000)	(small) Recitation	Soction	-
Exercise: The Digital E	nterprise (L0933)	(small)	Section 1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended				
	Fundamentals of Production and	Quality Management	t	
Knowledge				
Educational Objectives	After taking part successfully, stu	idents have reached	the following learn	ing results
Professional	<u> </u>			
Competence				
Knowledge	Students can explain the content to them.	s of the module in d	etail and take a crit	ical positio
Skills	Students are capable of choosing and applying models and methods from the module to industrial problems.			
Personal Competence				
Social Competence	Students can develop joint solution	ons in mixed teams a	and present them t	o others.
Autonomy	-		·	
Norkload in Hours	Independent Study Time 96, Stud	ly Time in Lecture 84	4	
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and scale	180 Minuten			
	International Management and E	ngineering: Speciali	sation II. Product D	evelopme
	and Production: Elective Compuls		on Duodinati	
	Logistics, Infrastructure and M Elective Compulsory	iobility: Specialisation	on Production an	a Logistic
	Biomedical Engineering: Specialis	sation Artificial Orga	ns and Regenerativ	e Medicin
	Elective Compulsory			=
	Biomedical Engineering: Special Compulsory	alisation Implants a	and Endoprosthes	es: Electiv
	Biomedical Engineering: Special	lisation Medical Tec	hnology and Cont	rol Theor
Assignment for	Elective Compulsory			
the Following		isation Management	and Business Adı	ministratio
	Product Development, Mater	ials and Product	ion: Specialisatio	n Produ
	Development: Elective Compulso	ry	•	
	Product Development, Materia Compulsory	als and Production	n: Specialisation	Productio
		and Draduction, Co	ocialisation Matori	alc: Eloctiv
	Product Development, Materials	and Production: 50	יבכומווסמנוטוו וייומוביי	ais, Lieuri
	Product Development, Materials Compulsory Theoretical Mechanical Engine	·		

Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0932: The	Digital Enterprise
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered. Content: Business Process Management and Data Modelling, Simulation Knowledge and Competence Management Process Management (PPC, Workflow Management) Computer Aided Planning (CAP) and NC-Programming Virtual Reality (VR) and Augmented Reality (AR) Computer Aided Quality Management (CAQ) Industry 4.0
	Scheer, AW.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002 Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag. Berlin 3. Auflage 2006 Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004 Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007 Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006

Course L0929: Production Planning and Control		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Hermann Lödding	
Language	DE	
Cycle	WiSe	
Content	 Models of Production and Inventory Management Production Programme Planning and Lot Sizing Order and Capacity Scheduling Selected Strategies of PPC Manufacturing Control Production Controlling Supply Chain Management 	
Literature	 Vorlesungsskript Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002 	

Course L0930: Production Planning and Control	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0933: Exercise: The Digital Enterprise		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Axel Friedewald	
Language	DE	
Cycle		
Content	See interlocking course	
Literature	Siehe korrespondierende Vorlesung See interlocking course	

Module M092:	L: Electronic Circuits for	Medical Applic	ations	
Courses				
Title	Medical Applications (L0696)	Typ Lecture	Hrs/wk	CP 3
Electronic Circuits for I	Medical Applications (L1056)	Recitation S (small)	ection 1	2
Electronic Circuits for I	Medical Applications (L1408)	Practical Course	1	1
Module Responsible	Prof. Matthias Kuni			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of electrical enginee	ering		
Educational Objectives	After taking part successfully, stud	ents have reached the	following learn	ning results
Professional Competence				
Knowledge	 Students can explain the bacentral nervous system Students are able to explorate propagation along an axon Students can exemplify the devices Students can describe the sapplications Students can explain the fur Students are able to discuss and artificial eyes 	ain the build-up of a communication between pecial features of lownctions of prostheses,	n action pote een neurons a noise amplifier e. g. an artificia	ntial and in the second of the
Skills	 Students can calculate the potential Students can give scenario power signal acquisition. Students can develop the b Students can define the bui eye. 	s for further improver lock diagrams of prost	ment of low-no	ise and lov
Personal Competence				
Social Competence	 Students are trained to solve teams together with experts Students are able to recogn for assistance to the right till Students can document the results in a way that others 	s with different profess lize their specific limita me. ir work in a clear man	ional backgrou ations, so that ner and comm	nd. they can as unicate the
	 Students are able to realist define actions for improvem Students can break down 	ents when necessary.		

Autonomy	 schedule their work in a realistic way. Students can handle the complex data structures of bioelectrical experiments without needing support. Students are able to act in a responsible manner in all cases and situations of experimental work. 	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Credit points	6	
	CompulsorBonus Form Description	
Course achievement	res None practical work	
	No None Excercises	
Examination	Written exam	
Examination duration and scale		
_	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Microelectronics and Microsystems: Specialisation Microelectronics Complements: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	

Course L0696: Elec	tronic Circuits for Medical Applications
Тур	Lecture
Hrs/wk	2
СР	3
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Matthias Kuhl
Language	
Cycle	WiSe
Content	 Market for medical instruments Membrane potential, action potential, sodium-potassium pump Information transfer by the central nervous system Interface tissue - electrode Amplifiers for medical applications, analog-digital converters Examples for electronic implants Artificial eye, cochlea implant
Literature	Kim E. Barret, Susan M. Barman, Scott Boitano and Heddwen L. Brooks Ganong's Review of Medical Physiology, 24nd Edition, McGraw Hill Lange, 2010 Tier- und Humanphysiologie: Eine Einführung von Werner A. Müller (Author), Stephan Frings (Author), 657 p., 4. editions, Springer, 2009 Robert F. Schmidt (Editor), Hans-Georg Schaible (Editor) Neuro- und Sinnesphysiologie (Springer-Lehrbuch) (Paper back), 488 p., Springer, 2006, 5. Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springer, 4th ed., 616 p., 2007 Vorlesungen der Universität Heidelberg zur Tier- und Humanphysiologie: http://www.sinnesphysiologie.de/gruvo03/gruvoin.htm Internet: http://butler.cc.tut.fi/~malmivuo/bem/bembook/

Course L1056: Elec	Course L1056: Electronic Circuits for Medical Applications		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Matthias Kuhl		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1408: Electronic Circuits for Medical Applications				
Тур	Practical Course			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Matthias Kuhl			
Language	EN			
Cycle	WiSe			
Content	 Market for medical instruments Membrane potential, action potential, sodium-potassium pump Information transfer by the central nervous system Interface tissue - electrode Amplifiers for medical applications, analog-digital converters Examples for electronic implants Artificial eye, cochlea implant 			
Literature	Kim E. Barret, Susan M. Barman, Scott Boitano and Heddwen L. Brooks Ganong's Review of Medical Physiology, 24nd Edition, McGraw Hill Lange, 2010 Tier- und Humanphysiologie: Eine Einführung von Werner A. Müller (Author), Stephan Frings (Author), 657 p., 4. editions, Springer, 2009 Robert F. Schmidt (Editor), Hans-Georg Schaible (Editor) Neuro- und Sinnesphysiologie (Springer-Lehrbuch) (Paper back), 488 p., Springer, 2006, 5. Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springer, 4th ed., 616 p., 2007 Vorlesungen der Universität Heidelberg zur Tier- und Humanphysiologie: http://www.sinnesphysiologie.de/gruvo03/gruvoin.htm Internet: http://butler.cc.tut.fi/~malmivuo/bem/bembook/			

Module M1150	D: Continuum Mechanics			
Courses				
Title Continuum Mechanics Continuum Mechanics		Typ Lecture Recitation (small)	Hrs/wk 2 Section 2	CP 3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of linear continuum mechanics a (forces and moments, stress, linear constitutive laws, strain energy).			
Educational Objectives	After taking part successfully, students h	ave reached t	he following learr	ning results
Professional Competence				
Knowledge	The students can explain the fundamental concepts to calculate the mechanical behavior of materials.			
Skills	The students can set up balance laws a specific aspects, both in applied contexts			on theory to
Personal Competence Social Competence	The students are able to develop solution form and to develop ideas further.	ns, to present	them to specialis	sts in written
Autonomy	The students are able to assess their independently and on their own iden continuum mechanics and acquire the kr	ntify and solv	e problems in	
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 50	6	
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
	Biomedical Engineering: Specialisation Elective Compulsory	ement: Specia Course: Elect artificial Organ Implants ar Medical Tech	alisation Materia ive Compulsory s and Regenerati nd Endoprosthes inology and Con	ve Medicine: ses: Elective trol Theory:
l	Biomedical Engineering: Specialisation	wanagement	and Business Ad	ministration:

	Compulsory Development,	Materials	and	Production:	Core	qualification:	Elective
Compuls	ory					•	
Theoreti	cal Mechanical	Engineerin	ıg: Te	chnical Con	pleme	ntary Course:	Elective
Compuls	ory	3			•	•	
Theoreti	caĺ Mechanical E	naineerina	: Core	qualification	ı: Electi	ve Compulsory	,

Course L1533: Continuum Mechanics				
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Christian Cyron			
Language	DE			
Cycle	WiSe			
Content	 kinematics of undeformed and deformed bodies balance equations (balance of mass, balance of energy,) stress states material modelling 			
	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer			

Course L1534: Con	tinuum Mechanics Exercise				
Тур	Recitation Section (small)				
Hrs/wk					
СР	3				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28				
Lecturer	Prof. Christian Cyron				
Language	DE				
Cycle	WiSe				
Content	 kinematics of undeformed and deformed bodies balance equations (balance of mass, balance of energy,) stress states material modelling 				
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer				

Module M115	L: Material Modeling			
Courses				
Title Material Modeling (L15 Material Modeling (L15		Typ Lecture Recitation (small)	Hrs/wk 2 Section 2	CP 3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
	Basics of linear and nonlinear continu Mechanics II and Continuum Mechar nonlinear strain, free-body principle, energy)	nics (forces and	moments, stress	, linear and
Educational Objectives	After taking part successfully, student	s have reached	the following learn	ing results
Professional Competence				
Knowledge	laws			
Skills	The students can implement their o particular, the students can apply the science and evaluate the corresponding	eir knowledge to	various problems	
Personal Competence				
Social Competence	The students are able to develop so develop ideas further.	lutions, to prese	ent them to specia	alists and to
Autonomy	The students are able to assess the independently and on their own identimodeling and acquire the knowledge	ify and solve pro	blems in the area	
Workload in Hours	Independent Study Time 124, Study T	ime in Lecture 5	6	
Credit points		mie m zectare s	<u> </u>	
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following	Materials Science: Specialisation Mode Mechanical Engineering and Mana Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Elective Compulsory	agement: Speci n Artificial Orgar ion Implants a on Medical Tecl	alisation Materians and Regeneration and Endoprosthese noology and Conf	ve Medicine: es: Elective crol Theory:

Product Development, Materials and Production: Core qualification: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L1535: Mat	erial Modeling
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	One of the most important questions when modeling mechanical systems in practice is how to model the behavior of the materials of their different components. In addition to simple isotropic elasticity in particular the following phenomena play key roles - anisotropy (material behavior depending on direction, e.g., in fiber-reinforced materials) - plasticity (permanent deformation due to one-time overload, e.g., in metal forming) - viscoelasticity (absorption of energy, e.g., in dampers) - creep (slow deformation under permanent load, e.g., in pipes) This lecture briefly introduces the theoretical foundations and mathematical modeling of the above phenomena. It is complemented by exercises where simple examples problems are solved by calculations and where the implementation of the content of the lecture in computer simulations is explained. It will also briefly discussed how important material parameters can be determined from experimental data.
Literature	

Course L1536: Material Modeling		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Christian Cyron	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1199	9: Advanced Function	onal Materials					
Courses							
Title Advanced Functional N	Materials (L1625)	Typ Seminar	Hrs/wk 2	CP 6			
Module Responsible	Prof. Patrick Huber						
Admission Requirements	None	None					
Recommended Previous Knowledge		s Science, e.g. Materials Scie	nce I/II				
Educational Objectives	After taking part successfull	y, students have reached the	following learn	ing results			
Professional Competence							
Knowledge	their applications in tec	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.					
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.						
Personal Competence							
Social Competence	The students are able to further.	The students are able to present solutions to specialists and to develop ideas further.					
	The students are able to						
Autonomy		ngths and weaknesses. y expertise by their own.					
Workload in Hours	Independent Study Time 15	2, Study Time in Lecture 28					
Credit points	6						
Course achievement	None						
Examination	Presentation						
Examination duration and scale							
Assignment for the Following Curricula	Compulsory Biomedical Engineering: Specific Compulsory Biomedical Engineering: Scompulsory Biomedical Engineering: Scompulsory Biomedical Engineering: Scompulsory Biomedical Engineering: Specific Compulsory	lification: Compulsory and Management: Specialisecialisation Artificial Organs as Specialisation Implants and pecialisation Medical Technologicalisation Management and gineering: Technical Comple	and Regenerativ Endoprosthese plogy and Cont ad Business Adr	re Medicine: es: Elective rol Theory: ministration:			

Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L1625: Adv	anced Functional Materials
Тур	Seminar
Hrs/wk	2
СР	6
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	 Porous Solids - Preparation, Characterization and Functionalities Fluidics with nanoporous membranes Thermoplastic elastomers Optimization of polymer properties by nanoparticles Fiber composites in automotive Modeling of materials based on quantum mechanics Biomaterials
Literature	Aktuelle Publikationen aus der Fachliteratur werden während der Veranstaltung bekanntgegeben.

	9: MED II: Introduction	to Biochemist	ry and M	1olecular		
Biology						
Courses						
		T	Har to a	CD		
Title Introduction to Biocher	mistry and Molecular Biology (L0386)	Typ Lecture	Hrs/wk 2	CP 3		
Module Responsible	Prof. Hans-Jürgen Kreienkamp					
Admission Requirements	None					
Recommended Previous Knowledge						
Educational Objectives	After taking part successfully, stude	ents have reached the	following lear	ning results		
Professional						
Competence						
Knowledge	describe basic biomolecules;explain how genetic informat	 describe basic biomolecules; explain how genetic information is coded in the DNA; explain the connection between DNA and proteins; 				
Skills	 The students can recognize the importance disease; describe selected molecular-companies explain the relevance of thes 	diagnostic procedures;		course of a		
Personal						
Competence Social Competence	The students can participate in disc	cussions in research ar	nd medicine o	n a technical		
Autonomy	The students can develop understa literature, by themselves.	nding of topics from t	he course, us	ing technical		
Workload in Hours	Independent Study Time 62, Study	Time in Lecture 28				
Credit points	3					
Course achievement	None					
Examination	Written exam					
Examination duration and scale	60 minutes					
Assignment for the Following	General Engineering Science (General Engineering: Compulsor General Engineering Science (General Engineering Science (General Engineering, Focus Biom Data Science: Specialisation Medicir Electrical Engineering: Specialisation Engineering Science: Specialisation General Engineering Science (Electrical Engineering Science (Electrical Engineering Science (Electrical Engineering: Compulsor General Engineering: Science (Electrical Engineering) Science (Electrical Engineering, Focus Biom Mechanical Engineering: Specialisation Medicir Electrical Engineering: Specialisation Medicir Electrical Engineering: Specialisation Mechanical Engineering	y erman program, 7 nechanics: Compulsory ne: Compulsory n Medical Technology: Biomedical Engineerin nglish program, 7 y nglish program, 7 nechanics: Compulsory	semester): S Elective Com ng: Compulsor semester): S semester): S	Specialisation pulsory y Specialisation		

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Elective Compulsory
Biomedical Engineering: Specialisation Medical Technology and Control Theory:
Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0386: Introduction to Biochemistry and Molecular Biology		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Hans-Jürgen Kreienkamp	
Language	DE	
Cycle	WiSe	
Content		
	Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage	
	Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008	
Literature		

Module M1333	3: BIO I: Implants and	Fracture Healing		
Courses				
Title Implants and Fracture	Healing (L0376)	Typ Lecture	Hrs/wk 2	CP 3
	Prof. Michael Morlock			
Admission Requirements	None			
	It is recommended to participat "Implants and Fracture Healing".		anatomie" befo	ore attending
Educational Objectives	After taking part successfully, st	udents have reached the	following lear	ning results
Professional Competence				
Knowledge	The students can describe the d for their existence. The students can name differen given fracture morphologies.	-		·
Skills	The students can determine the static situations under specific a		human body	under quasi-
Personal Competence				
Social Competence	The students can, in groups, calculation of internal forces.	solve basic numerica	i modeling ta	asks for the
Autonomy	The students can, in groups, calculation of internal forces.	solve basic numerica	l modeling ta	asks for the
Workload in Hours	Independent Study Time 62, Stu	dy Time in Lecture 28		
Credit points				
Course achievement				
Examination				
Examination duration and scale				
the Following	General Engineering Science Mechanical Engineering, Focus E General Engineering Science Biomedical Engineering: Compul Engineering Science: Specialisat General Engineering Science Biomedical Engineering: Compul General Engineering: Compul General Engineering Science Mechanical Engineering, Focus E Mechanical Engineering: Special Biomedical Engineering: Special Elective Compulsory	Biomechanics: Compulsor (German program, 7 Isory ion Biomedical Engineeri (English program, 7 Isory (English program, 7 Biomechanics: Compulsor isation Biomechanics: Co isation Artificial Organs a alisation Implants and	semester): Some semester): Som	Specialisation Specialisation Specialisation Ve Medicine: Ses: Elective

Orientierungsstudium: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0376: Imp	lants and Fracture Healing		
Тур	Lecture		
Hrs/wk	2		
СР			
	Independent Study Time 62, Study Time in Lecture 28		
	Prof. Michael Morlock		
Language Cycle			
3,010	Topics to be covered include:		
	Introduction (history, definitions, background importance)		
	2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)		
	3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)		
	3.1 The spine in its entirety		
	3.2 Cervical spine		
	3.3 Thoracic spine		
	3.4 Lumbar spine		
	3.5 Injuries and diseases		
Content	4. Pelvis (anatomy, biomechanics, fracture treatment)		
Content	5 Fracture Healing		
	5.1 Basics and biology of fracture repair		
	5.2 Clinical principals and terminology of fracture treatment		
	5.3 Biomechanics of fracture treatment		
	5.3.1 Screws		
	5.3.2 Plates		
	5.3.3 Nails		
	5.3.4 External fixation devices		
	5.3.5 Spine implants		
	6.0 New Implants		
	o.o new implants		
	Cochran V.B.: Orthopädische Biomechanik		
	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics		
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine		
	Nigg, B.: Biomechanics of the musculo-skeletal system		
Literature	Schiebler T.H., Schmidt W.: Anatomie		
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat		

Module M1334	4: BIO II: Biomaterials
Courses	
Title Biomaterials (L0593)	Typ Hrs/wk CP Lecture 2 3
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of orthopedic and surgical techniques is recommended.
Educational Objectives	LATTOR TAKING NART CHECEGCOOK COLUMN STILL COLUMN TO ACHOR TO TOUR WING LOARNING PACIFIES
Professional Competence	
Knowledge	The students can describe the materials of the human body and the materials beir used in medical engineering, and their fields of use.
Skills	The students can explain the advantages and disadvantages of different kinds biomaterials.
Personal Competence	
Social Competence	The students are able to discuss issues related to materials being present or being used for replacements with student mates and the teachers.
Autonomy	The students are able to acquire information on their own. They can also judge the information with respect to its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Blockive Compulsory

Course L0593: Biomaterials	
Тур	Lecture
Hrs/wk	2

	3 Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Michael Morlock		
Language			
Cycle	WiSe Topics to be covered include:		
	Introduction (Importance, nomenclature, relations)		
	2.1 Basics (components, testing methods)		
	2.2 Bone (composition, development, properties, influencing factors)		
	2.3 Cartilage (composition, development, structure, properties, influencing factors)		
	2.4 Fluids (blood, synovial fluid)		
	3 Biological structures		
	3.1 Menisci of the knee joint		
	3.2 Intervertebral discs		
	3.3 Teeth		
	3.4 Ligaments		
Content	3.5 Tendons		
Content	3.0 3kili		
	3.7 Nervs		
	3.8 Muscles		
	4. Replacement materials		
	4.1 Basics (history, requirements, norms)		
	4.2 Steel (alloys, properties, reaction of the body)		
	4.3 Titan (alloys, properties, reaction of the body)		
	4.4 Ceramics and glas (properties, reaction of the body)		
	4.5 Plastics (properties of PMMA, HDPE, PET, reaction of the body)		
	4.6 Natural replacement materials		
	Knowledge of composition, structure, properties, function and changes/adaptation of biological and technical materials (which are used for replacements in-vivo Acquisition of basics for theses work in the area of biomechanics.		
	Hastings G and Ducheyne P.: Natural and living biomaterials. Boca Raton: CR Press, 1984.		
	Williams D.: Definitions in biomaterials. Oxford: Elsevier, 1987.		
	Hastings G.: Mechanical properties of biomaterials: proceedings held at Keel University, September 1978. New York: Wiley, 1998.		
Literature	Black J.: Orthopaedic biomaterials in research and practice. New York: Churchi Livingstone, 1988.		
	Park J. Biomaterials: an introduction. New York: Plenum Press, 1980.		
	1		

Wintermantel, E. und Ha, SW : Biokompatible Werkstoffe und Bauweisen. Berli Springer, 1996.	١,

Module M0808	B: Finite Element	ts Methods			
Courses					
Title Finite Element Method Finite Element Method			Typ Lecture Recitation	Hrs/wk 2 Section 2	CP 3
Finite Element Method	S (LU6U4)		(large)	2	3
Module Responsible	Prof. Otto von Estorii				
Admission Requirements	none				
Recommended Previous Knowledge	Mechanics I (Statics, Kinematics, Dynamics) Mathematics I, II, III (in				lydrostatics,
Educational Objectives	After taking part succes	ssfully, students h	ave reached th	ne following learn	ing results
Professional Competence					
Knowledge	The students possess a element method and an basis of the method.				
Skills	The students are capa finite elements, assem resulting system of equ	bling the corresp			
Personal Competence Social Competence	Students can work in sr	- ,	•	-	
Autonomy	The students are able and develop own finite are critically scrutinized	element routines.			
Workload in Hours	 Independent Study Tim	e 124. Study Time	e in Lecture 56		
Credit points	<u>. </u>	, 5.553 ;			
-	CompulsorBonus	Form Midterm	De	escription	
Examination	Written exam				
Examination duration and scale					
	Civil Engineering: Core Energy Systems: Core of Aircraft Systems Engine Aircraft Systems Engine	qualification: Elect eering: Specialisat	ive Compulsor ion Aircraft Sy	stems: Elective C	

Assignment for the Following Curricula	Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Product Development, Materials and Production: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Compulsory
--	--

Course L0291: Finite Element Methods		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Otto von Estorff	
Language	EN	
Cycle	WiSe	
Content	- General overview on modern engineering - Displacement method - Hybrid formulation - Isoparametric elements - Numerical integration - Solving systems of equations (statics, dynamics) - Eigenvalue problems - Non-linear systems - Applications - Programming of elements (Matlab, hands-on sessions) - Applications	
Literature	Bathe, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin	

Course L0804: Finite Element Methods	
Тур	Recitation Section (large)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1342	2: Polymers				
Courses					
-	es of Polymers (L0389) with polymers (L1892)	Typ Lecture Lecture	Hrs/wk 2 2	CP 3 3	
Module Responsible	Dr. Hans Wittich				
Admission Requirements	INODE				
Recommended Previous Knowledge	Basics: chemistry / physics / mate	erial science			
Educational Objectives	After taking part successfully, stu	dents have reached the	e following learn	ing results	
Professional					
Competence	Students can use the knowledge analysis.	·	_	_	
Knowledge	They can explain the complex rel	ationships structure-pro	operty relationsh	nip and	
	the interactions of chemical structure of the polymers, including to explain neighboring contexts (e.g. sustainability, environmental protection).				
	Students are capable of				
Skills	- using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials.				
	- selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.				
Personal					
Competence	Students can				
		heterogenius groups ar	nd document the	am	
Carial Camanatan	- arrive at funded work results in heterogenius groups and document them provide appropriate feedback and handle feedback on their own performance				
Social Competence	constructively.	and nandle feedback	on their own p	регтогтапсе	
	Students are able to				
	- assess their own strengths and weaknesses.				
Autonomy	- assess their own state of lear steps on this basis.	ning in specific terms	and to define f	urther work	
	- assess possible consequences o	f their professional acti	vity.		
	Independent Study Time 124, Stu	ıdy Time in Lecture 56			
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and					

scale	
Assignment for the Following Curricula	Compulsory

Course L0389: Structure and Properties of Polymers		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Hans Wittich	
Language	DE	
Cycle	WiSe	
	- Structure and properties of polymers	
	- Structure of macromolecules	
	Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution	
	- Morphology	
	amorph, crystalline, blends	
Content	- Properties	
	Elasticity, plasticity, viscoelacity	
	- Thermal properties	
	- Electrical properties	
	- Theoretical modelling	
	- Applications	
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag	

Course L1892: Prod	Course L1892: Processing and design with polymers		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bodo Fiedler, Dr. Hans Wittich		
Language	DE/EN		
Cycle	WiSe		
Content	Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining Designing with Polymers: Materials Selection; Structural Design; Dimensioning		
Literature	Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag Crawford: Plastics engineering, Pergamon Press Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag Konstruieren mit Kunststoffen, Gunter Erhard, Hanser Verlag		

Module M0632	2: Regenerative	Medicine			
Courses					
Title Regenerative Medicine Lecture Tissue Enginee	e (L0347) ering - Regenerative Med	licine (L1664)	Typ Seminar Seminar	Hrs/wk 2 2	CP 3 3
Module Responsible	Prof. Ralf Pörtner				
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part succe	essfully, students h	ave reached the fo	ollowing learn	ing results
Professional Competence					
Knowledge	After successful completion of the module students will be able to describe the basic methods of regenerative medicine and to explain the use of the tissue cells for different methods of tissue engineering. They are able to give a basic overview of methods for the cultivation of animal and human cells.				
Skills	 After successful completion of the module students are able to use medical databases for acquirierung and presentation of relevant up-to-date data independently able to present their work results in the form of presentations able to carry out basic cell culture methods and the corresponding analysis independently able to analyse and evaluate current research topics for Tissue Engineering and regenerative medicine. 				
Personal Competence Social Competence	Students are able to wand discuss their resustudents are able to reachers.	lts in the plenary a	nd to defend them		
Autonomy	After completion of a problem in teams of a the results.	approx. 2-4 person	s independently in		
	Independent Study Tir	me 124, Study Time	e in Lecture 56		
Credit points					
Course achievement	CompulsorBonus Yes 20 %	Form Written elaborat	ion Ausark	iption beitung zu Rir col for lecture	
Examination	Presentation				

Examination duration and scale	Oral presentation + discussion (30 min)
the Following	Riamodical Engineering: Specialisation Management and Rusiness Administration:

Course L0347: Regenerative Medicine		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ralf Pörtner, Dr. Frank Feyerabend	
Language	DE	
Cycle	WiSe	
	The course deals with the application of biotechnological engineering principles for re-generation of human tissues. The main topics are "tissue engineering" for the generation of "artificial organs" such as cartilage, liver, blood vessel etc., and their applications: • Introduction (historical development, examples for medical and technical applications, commercial aspets)	
Content	 Cell specific fundamentals (cell physiology, biochemistry, metabolism, special requirements for cell cultivation "in vitro") Process specific fundamentals (requirements for culture systems, examples for reactor design, mathematical modelling, process and control strategies) Examples for applications for clinical applications, drug testing and material testing The fundamentals will be presented by the lecturers. The "state of the art" of specific applications will be exploited by the students based on selected papers and presented during the course. 	
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Academic Pr Inc; ISBN-10: 0123693713, ISBN-13: 978-0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-3540777540	

Course L1664: Lecture Tissue Engineering - Regenerative Medicine		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ralf Pörtner, Prof. Michael Morlock	
Language	DE	
Cycle WiSe		
Content Discussion of current research topics for tissue engineering and regemedicine by invited experts Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Pr Inc; ISBN-10: 0123693713 , ISBN-13: 978-0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulr (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausge Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; 978-3540777540		

Module M0630	0: Robotics and	Navigation i	n Medicine		
Courses					
Title			Тур	Hrs/wk	СР
	on in Medicine (L0335)		Lecture	2	3
	on in Medicine (L0338)		Project Seminar	2	2
Robotics and Navigation	on in Medicine (L0336)		Recitation Sec (small)	tion 1	1
Module Responsible	Prof. Alexander Schlae	efer			
Admission Requirements					
Recommended Previous Knowledge	 principles of programming, e.g., in Java or C++ 				
Educational Objectives		essfully, students h	ave reached the fo	ollowing learn	ing results
Professional					
Competence	;				
Knowledge	The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.				
Skills	The students are able to design and evaluate navigation systems and robotic systems for medical applications.				
Personal Competence					
Social Competence	The students discuss the results of other groups, provide helpful feedback and can incoorporate feedback into their work.				
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.				
Workload in Hours	Independent Study Tir	me 110, Study Time	e in Lecture 70		
Credit points	6				
Course achievement	I Voc 10 %	Form Written elaborati Presentation	Descr on	iption	
Examination	Written exam				
Examination duration and scale	90 minutes				
	Computer Science: Sp Electrical Engineering International Manager Elective Compulsory International Manager and Biotechnology: Ele Mechatronics: Special Biomedical Engineering Elective Compulsory Biomedical Engineering	: Specialisation Medment and Engineering ment and Engineer ective Compulsory isation Intelligent Song: Specialisation A	dical Technology: Eng: Specialisation ring: Specialisation ystems and Robot rtificial Organs and	Elective Comp II. Electrical I II. Process ics: Elective C d Regenerativ	oulsory Engineering Engineering Compulsory ve Medicine

the Following	Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
Curricula	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory Product Development, Materials and Production: Specialisation Product
	Development: Elective Compulsory
	Product Development, Materials and Production: Specialisation Production: Elective
	Compulsory
	Product Development, Materials and Production: Specialisation Materials: Elective
	Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0335: Robotics and Navigation in Medicine		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	SoSe	
Content	 kinematics calibration tracking systems navigation and image guidance motion compensation The seminar extends and complements the contents of the lecture with respect to recent research results. 	
Literature	Spong et al.: Robot Modeling and Control, 2005 Troccaz: Medical Robotics, 2012 Further literature will be given in the lecture.	

Course L0338: Robotics and Navigation in Medicine	
Тур	Project Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0336: Robotics and Navigation in Medicine			
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Alexander Schlaefer		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M138 Engineering	4: Case Studies for Reger	nerative N	dedicine and	d Tissue
Courses				
Title Case Studies for Regenerative Medicine and Tissue Engineering (L1963)		Typ Seminar	Hrs/wk 3	CP 6
	Prof. Ralf Pörtner			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students	have reached	the following learn	ing results
Professional Competence				
Knowledge Skills				
Personal Competence Social Competence Autonomy				
	Independent Study Time 138, Study Tin	ne in Lecture 4	2	
Credit points				
Course achievement	None			
Examination	Presentation			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisatio Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Elective Compulsory	n Implants a Management	nd Endoprosthese and Business Adr	es: Elective

Course L1963: Case Studies for Regenerative Medicine and Tissue Engineering			
Typ Seminar			
Hrs/wk	3		
СР	6		
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42		
Lecturer	Prof. Ralf Pörtner, Prof. Michael Morlock		
Language	DE		
Cycle	SoSe		
Content			
Literature			

Module M0634	4: Introduction i	into Medical	Technology an	d Syst	ems
Courses					
Courses			_	, .	
	cal Technology and System cal Technology and System		Typ Lecture Project Seminar	Hrs/wk 2 2	CP 3 2
Introduction into Medic	cal Technology and System	ms (L1876)	Recitation Section (large)	1	1
Module Responsible	Prof. Alexander Schlae	fer			
Admission Requirements	None				
Recommended Previous Knowledge	principles of stochasti	cs	ulus)		
Educational Objectives	After taking part succe	essfully, students h	ave reached the follo	wing learn	ing results
Professional Competence					
Knowledge	The students can ex systems, computer aid to give an overview of	ded surgery, and m	nedical information sy	ystems. Th	ey are able
Skills	The students are able clinical applications.	e to evaluate syste	ems and medical dev	ices in the	e context of
Personal Competence					
Social Competence	The students describe tasks that are solved in		edical technology as	a project,	and define
Autonomy	The students can refle They can present the r			results of	their work.
Workload in Hours	Independent Study Tin	ne 110, Study Time	e in Lecture 70		
Credit points	6				
Course achievement	CompulsorBonus Yes 10 % Yes 10 %	Form Written elaborati Presentation	Descript on	ion	
Examination	Written exam				
Examination duration and scale					
Assignment for the Following	General Engineering Biomedical Engineering Computer Science: Sp. Computer Science: Sp. Computer Science: Sp. Compulsory Data Science: Core qual Electrical Engineering: Engineering Science: Sp. General Engineering Biomedical Engineering Computational Science: Engineering Science: En	g: Compulsory pecialisation Comp ecialisation II. Math alification: Elective Core qualification: Specialisation Biom Science (English g: Compulsory ce and Enginee	outer and Software nematics and Enginee Compulsory Elective Compulsory edical Engineering: Compulsory ring: Specialisation	Engineering Scienompulsory	ng: Elective nce: Elective pecialisation
<u> </u>	ı				

Course L0342: Introduction into Medical Technology and Systems		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	DE	
Cycle	SoSe	
Content	 imaging systems computer aided surgery medical sensor systems medical information systems regulatory affairs standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning. 	
Literature	Wird in der Veranstaltung bekannt gegeben.	

Course L0343: Introduction into Medical Technology and Systems		
Тур	Project Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1876: Introduction into Medical Technology and Systems		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	DE	
Cycle	SoSe	
Content	 imaging systems computer aided surgery medical sensor systems medical information systems regulatory affairs standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning. 	
Literature	Wird in der Veranstaltung bekannt gegeben.	

Module M0752	2: Nonlinear Dynamics			
Courses				
Title Nonlinear Dynamics (L	.0702)	Typ Integrated Lecture	Hrs/wk 4	CP 6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous Knowledge	Linear Algebra			
Educational Objectives	After taking part successfully, students h	nave reached the follo	wing learni	ng results
Professional Competence				
Knowledge	to develop and research new terms and	concepts.		
Skills	Dynamics and to develop novel methods		cesures of	Nonlinear
Personal Competence				
Social Competence	Students can reach working results also	= .		ا ، ، ، ، ا
Autonomy	Students are able to approach given res follow up novel research tasks by thems		ally and to i	dentify and
	Independent Study Time 124, Study Tim	e in Lecture 56		
Credit points				<u> </u>
Course achievement	None			
Examination	Written exam			
Examination duration and scale	2 Hours			
	Aircraft Systems Engineering: Specialisa: International Management and Engineer Compulsory Mechanical Engineering and Managem Compulsory Mechatronics: Specialisation System Des Mechatronics: Specialisation Intelligent S	ring: Specialisation II. nent: Specialisation I sign: Elective Compuls systems and Robotics	Mechatronic Sory Elective C	ics: Elective cs: Elective ompulsory
Assignment for the Following Curricula	Elective Compulsory Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Elective Compulsory Product Development, Materials and Compulsory Theoretical Mechanical Engineering: To Compulsory Theoretical Mechanical Engineering: Compulsory	Medical Technology Management and Bu Production: Core echnical Complemen	and Contousiness Adm qualificatio tary Cours	rol Theory: ninistration: n: Elective e: Elective

Course L0702: Nonlinear Dynamics		
Тур	Integrated Lecture	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Norbert Hoffmann	
Language	DE/EN	
Cycle	SoSe	
Content	Fundamentals of Nonlinear Dynamics.	
Literature	S. Strogatz: Nonlinear Dynamics and Chaos. Perseus, 2013.	

Courses				
Title Semiconductor Techno Semiconductor Techno		Typ Lecture Practical Course	Hrs/wk 4 2	CP 4 2
Module Responsible	Prof. Hoc Khiem Trieu			
Admission Requirements	None			
Recommended Previous Knowledge	Basics in physics, chemistry, mater	ial science and semicond	luctor device)S
Educational Objectives	After taking part successfully, stud	ents have reached the fo	llowing learn	ing results
Professional Competence				
Knowledge	 to describe and to explain substrates, to discuss in details the relevimpact thereof on the fabrication and to present integrated process 	rant fabrication processe of semiconductor device	s, process fl	ows and th
Skills	 Students are capable to analyze the impact of proce to select and to evaluate proce to develop process flows for the 	esses and	_	
Personal Competence				
Social Competence	Students are able to prepare and well as to present and discuss the			am work a
Autonomy	None			
Workload in Hours	Independent Study Time 96, Study	Time in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination				

duration and scale	
the Following	Electrical Engineering: Specialisation Nanoelectronics and Microsystems Technology: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Microelectronics and Microsystems: Core qualification: Elective Compulsory

Course L0722: Sem	niconductor Technology
	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
	Prof. Hoc Khiem Trieu
Language	DE/EN
Cycle	SoSe
	 Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski, Bridgeman and float zone process) Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping profile, higher order effects and
Content	 process technology, ion implantation: theory, implantation profile, channeling, implantation damage, annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions, kinetics, influences on growth rate, process technology and equipment, anodic oxidation, plasma oxidation, thermal oxidation of GaAs) Deposition techniques (theory: nucleation, film growth and structure zone model, film growth process, reaction kinetics, temperature dependence and equipment; epitaxy: gas phase, liquid phase, molecular beam epitaxy; CVD
	 Structuring techniques (subtractive methods, photolithography: resist properties, printing techniques: contact, proximity and projection printing, resolution limit, practical issues and equipment, additive methods: liftoff technique and electroplating, improving resolution: excimer laser light source, immersion lithography and phase shift lithography, electron beam lithography, X-ray lithography, EUV lithography, ion beam lithography, wet chemical etching: isotropic and anisotropic, corner undercutting, compensation masks and etch stop techniques; dry etching: plasma enhanced etching, backsputtering, ion milling, chemical dry etching, RIE, sidewall passivation)
	 Process integration (CMOS process, bipolar process) Assembly and packaging technology (hierarchy of integration, packages, chip-on-board, chip assembly, electrical contact: wire bonding, TAB and flip

	chip, wafer level package, 3D stacking)
	S.K. Ghandi: VLSI Fabrication principles - Silicon and Gallium Arsenide, John Wiley & Sons
	S.M. Sze: Semiconductor Devices - Physics and Technology, John Wiley & Sons
	U. Hilleringmann: Silizium-Halbleitertechnologie, Teubner Verlag
Literature	H. Beneking: Halbleitertechnologie - Eine Einführung in die Prozeßtechnik von Silizium und III-V-Verbindungen, Teubner Verlag
	K. Schade: Mikroelektroniktechnologie, Verlag Technik Berlin
	S. Campbell: The Science and Engineering of Microelectronic Fabrication, Oxford University Press
	P. van Zant: Microchip Fabrication - A Practical Guide to Semiconductor Processing, McGraw-Hill

Course L0723: Semiconductor Technology	
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Hoc Khiem Trieu
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M083!	5։ Hւ	ımano	oid Rol	botic	s				
Courses									
Title Humanoid Robotics (LO	0663)					Typ Seminar		Hrs/wk 2	CP 2
Module Responsible			h						
Admission Requirements	None								
Recommended Previous Knowledge	•		ction to c theory a						
Educational Objectives	After	taking pa	art succe	ssfully,	students	have reached	the follo	wing learn	ing results
Professional Competence									
Knowledge			ts learn t		umanoid i basic coi	obots. ntrol concepts	for differ	ent tasks	in humanoid
Skills		based of Student	on specifi ts genera	ied litera alize dev	ature veloped r	out selected esults and pre give a prese	esent then		
Personal Competence									
Social Competence		present They a	them	to pro	vide app	oing solutions			
Autonomy		present Student	tation for ts familia low prese	specific rize the	c tasks ar emselves	s and draw nd select the b with a scienti er students, s	oest soluti fic field, a	on ire able of	introduce it
Workload in Hours	!	endent S	Study Tim	ne 32, S	Study Tim	e in Lecture 2	8		
Credit points									
Course achievement Examination	!								
Examination Examination duration and scale	30 mi								
	Mecha Biome Electi Biome	atronics: edical En ve Comp	Specialis gineering oulsory	sation S g: Spec	system De ialisation	Systems and esign: Elective Artificial Orga n Implants	Compuls ans and R	ory egenerativ	ve Medicine:

Assignment for	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
the Following	Elective Compulsory
Curricula	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective
	Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science:
	Elective Compulsory

Course L0663: Hun	nanoid Robotics
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Patrick Göttsch
Language	DE
Cycle	SoSe
Content	 Grundlagen der Regelungstechnik Control systems theory and design
Literature	- B. Siciliano, O. Khatib. "Handbook of Robotics. Part A: Robotics Foundations", Springer (2008).

Module M083	8: Linear and Nonline	ar System Identifi	kation		
Courses					
Title Linear and Nonlinear S	System Identification (L0660)	Typ Lecture	Hrs/wk CP 2 3		
Module Responsible	Prof. Herbert Werner				
Admission Requirements	INONE				
Recommended Previous Knowledge	 Discrete-time systems 	value decomposition			
Educational Objectives	LATTER TAKING NART SUCCESSIUM S	students have reached the	following learning results		
Professional Competence					
Knowledge	 Students can explain the general framework of the prediction error method and its application to a variety of linear and nonlinear model structures They can explain how multilayer perceptron networks are used to model nonlinear dynamics They can explain how an approximate predictive control scheme can be based on neural network models They can explain the idea of subspace identification and its relation to Kalmar realisation theory 				
Skills	 Students are capable of applying the predicition error method to the experimental identification of linear and nonlinear models for dynamic systems They are capable of implementing a nonlinear predictive control scheme based on a neural network model They are capable of applying subspace algorithms to the experimental identification of linear models for dynamic systems They can do the above using standard software tools (including the Matlab System Identification Toolbox) 				
Personal Competence					
Social Competence	Students can work in mixed gro	oups on specific problems	to arrive at joint solutions.		
Autonomy	Students are able to find requiversature, software documenta				
Workload in Hours	Independent Study Time 62, St	tudy Time in Lecture 28			
Credit points					
Course achievement	LNODE				
Examination	Oral exam				
Examination duration and scale	30 min				
	Electrical Engineering: Specia Elective Compulsory Mechatronics: Specialisation In		-		

	Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Assignment for	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
the Following	
Curricula	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
	Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective
	Compulsory
	Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L0660: Line	ear and Nonlinear System Identification
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	 Prediction error method Linear and nonlinear model structures Nonlinear model structure based on multilayer perceptron network Approximate predictive control based on multilayer perceptron network model Subspace identification
Literature	 Lennart Ljung, System Identification - Theory for the User, Prentice Hall 1999 M. Norgaard, O. Ravn, N.K. Poulsen and L.K. Hansen, Neural Networks for Modeling and Control of Dynamic Systems, Springer Verlag, London 2003 T. Kailath, A.H. Sayed and B. Hassibi, Linear Estimation, Prentice Hall 2000

Courses										
Title Optimal and Robust Co Optimal and Robust Co						Typ Lect Reci		Sectio	Hrs/wk	CP 3
•						(sma	all)			
Module Responsible		Herbert \	Werner							
Admission Requirements	None									
Recommended Previous Knowledge	•	State s	pace me	thods	-	sponse, i		us)		
Educational Objectives	After	taking p	art succ	essfully	, studer	ts have ı	reached	the follo	owing learr	ning results
Professional Competence										
Knowledge	•	 Students can explain the significance of the matrix Riccati equation for the solution of LQ problems. They can explain the duality between optimal state feedback and optimal state estimation. They can explain how the H2 and H-infinity norms are used to represent stability and performance constraints. They can explain how an LQG design problem can be formulated as special case of an H2 design problem. They can explain how model uncertainty can be represented in a way that lends itself to robust controller design They can explain how - based on the small gain theorem - a robust controller can guarantee stability and performance for an uncertain plant. They understand how analysis and synthesis conditions on feedback loops can be represented as linear matrix inequalities. 								
Skills	•	multiva They a form of it. They al control carrying They a system They a matrix They c	ariable pi re capal f a gene re capal g out a r re capal n, and of re capal inequali	lant mo ble of r ralized ble of tra nto cor nixed-so ble of co designi ble of fo ties (LM r out al	dels. represer plant, a anslatin nstraints ensitivit onstruct ng a mi ormulat II), and o	nting a Hand of using an Lose and Lose	I2 or H ing star nd frequesed-loom FT unce ctive ro ysis and	infinity ndard so uency do sensitertainty bust con synthed LMI-sol	LQG cordesign profession special cordesign for secondition special cordesign for secondition software to the second secon	oblem in the second for solving ifications of one, and one
Personal Competence										
Social Competence				_	-	•	-		-	
Autonomy									rovided (le problems.	cture note

Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
the Following	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Core qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L0658: Opti	mal and Robust Control
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	
Cycle	SoSe
Content	 Optimal regulator problem with finite time horizon, Riccati differential equation Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system Kalman's identity, phase margin of LQR controllers, spectral factorization Optimal state estimation, Kalman filter, LQG control Generalized plant, review of LQG control Signal and system norms, computing H2 and H∞ norms Singular value plots, input and output directions Mixed sensitivity design, H∞ loop shaping, choice of weighting filters Case study: design example flight control Linear matrix inequalities, design specifications as LMI constraints (H2, H∞ and pole region) Controller synthesis by solving LMI problems, multi-objective design Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty
Literature	 Werner, H., Lecture Notes: "Optimale und Robuste Regelung" Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 Skogestad, S. and I. Postlewhaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998

Course L0659: Opt	Course L0659: Optimal and Robust Control			
Тур	Recitation Section (small)			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Herbert Werner			
Language	EN			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

ourses				
itle larketing of Innovatior		Typ Lecture Project-/problem-	Hrs/wk 4	CP 4
BL Marketing of Innov	ations (L0862)	based Learning	1	2
•	Prof. Christian Lüthje			
Admission Requirements	None			
Recommended Previous Knowledge	 Module International Busine Basic understanding of bus decision theory, project ma Bachelor-level Marketing Competitor Strategies, Basi Unerstanding the difference Understanding of the impomarkets Good English proficiency; p 	iness administration princi nagement, international be Knowledge (Marketing Insics of Buying Behavior) es beweetn B2B and B2C n rtance of managing innova	usiness) struments, narketing	Market ar
Educational Objectives	After taking part successfully, stud	dents have reached the fol	lowing learn	ing results
Professional Competence				
Knowledge	 Students will have gained a deep Specific characteristics in the Approaches for analyzing the development The gathering of information Concepts and approaches product and service develor Approaches and tools for each of new products and innovation Marketing mix elements requirements and challenged Pricing methods for new products and innovation The organization of comple Communication concepts a 	he marketing of innovative he current market situation on about future customer not to integrate lead users pment processes ensuring customer-orientative services that take into consider of innovative products a coducts and services x sales forces and persona	eeds and read and their ion in the dideration to the services I selling	ture mark quirements needs in evelopmer he specif
Skills	 Design and to evaluate strategies Analyze markets by applyir Conduct forecasts and dev planning Translate customer needs and successfully apply adviservice development Use adequate methods to f services Choose suitable pricing innovations Make strategic sales decisions 	decisions regarding management of the decisions regarding management of the decisions regarding management of the decision of	oortfolios as a basis and marke er-oriented innovative p	for strateg table offer product an roducts an

Competence	
	The students will be able to
Social Competence	 have fruitful discussions and exchange arguments develop original results in a group present results in a clear and concise way carry out respectful team work
Autonomy	 Acquire knowledge independently in the specific context and to map this knowledge on other new complex problem fields. Consider proposed business actions in the field of marketing and reflect on them.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written elaboration, excercises, presentation, oral participation
Assignment for the Following Curricula	Global Technology and Innovation Management & Entrepreneurship: Core qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory

services, model, objectives and examples of innovation marketin characteristics of services, challenges of service marketing) II. Methods and approaches of strategic marketing planning • patterns of industrial development, patent and technology portfolios III. Strategic foresight and scenario analysis • objectives and challenges of strategic foresight, scenario analysis, Delgmethod IV. User innovations • Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering • Conjoint Analysis, Kano, OFD, Morphological Analysis, Blueprinting VII. Pricing • Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management • Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications • Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christenen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boste et al., McGraw Hill Tidd: J. & Hull, Frank M. (Editors) (2007) Service Innovation, London	Course L2009: Mar	keting of Innovations		
CP Workload in Hours Independent Study Time 64, Study Time in Lecture 56 Prof. Christian Lüthje Language EN Cycle SoSe I. Introduction Innovation and service marketing (importance of innovative products an services, model, objectives and examples of innovation marketin characteristics of services, challenges of service marketing) II. Methods and approaches of strategic marketing planning patterns of industrial development, patent and technology portfolios III. Strategic foresight and scenario analysis objectives and challenges of strategic foresight, scenario analysis, Delgmethod IV. User innovations Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis Content V. Customer-oriented Product and Service Engineering Conjoint Analysis, Kano, OFD, Morphological Analysis, Blueprinting WII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Diffusion of Innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 10 (1419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrow Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p. 3-2-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boste et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London	Тур	Lecture		
Lecturer Prof. Christian Lüthje EN	Hrs/wk	4		
Lecturer Language EN Cycle SoSe I. Introduction Innovation and service marketing (importance of innovative products as services, model, objectives and examples of innovation marketin characteristics of services, challenges of service marketing) III. Methods and approaches of strategic marketing planning patterns of industrial development, patent and technology portfolios III. Strategic foresight and scenario analysis objectives and challenges of strategic foresight, scenario analysis, Delpmethod IV. User innovations Role of users in the innovation process, user communities, user innovatio toolkits, lead users analysis V. Customer-oriented Product and Service Engineering Content Content VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335 . Chapter 10 (438-210), Chapter 7 (227-256), Chapter 10 (33-365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p. 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bost et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London	СР	4		
Cycle SoSe I. Introduction I. Introduction I. Introduction II. Introduction III. Introduction III. Introduction III. Methods and service marketing (importance of innovative products an services, model, objectives and examples of innovation marketin characteristics of services, challenges of service marketing) III. Methods and approaches of strategic marketing planning III. Strategic foresight and scenario analysis IV. User innovations IV. User innovations IV. User innovations IV. User innovations IV. Customer-oriented Product and Service Engineering IV. Customer-oriented Product and Service Engineering IVII. Pricing IVII. Pricing IVII. Sales Manayement IVII. Sales Management IVII. Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms failr, p. 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boste et al., McGraw Hill Itidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London	Workload in Hours	Independent Study Time 64, Study Time in Lecture 56		
Cycle I. Introduction II. Methods and approaches of strategic marketing planning II. Methods and approaches of strategic marketing planning III. Strategic foresight and scenario analysis Objectives and challenges of strategic foresight, scenario analysis, Delgmethod IV. User innovations Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014), Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th editic McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Causter al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London	Lecturer	Prof. Christian Lüthje		
I. Introduction I. Introduction Innovation and service marketing (importance of innovative products as services, model, objectives and examples of innovation marketin characteristics of services, challenges of service marketing) II. Methods and approaches of strategic marketing planning patterns of industrial development, patent and technology portfolios III. Strategic foresight and scenario analysis objectives and challenges of strategic foresight, scenario analysis, Delpmethod IV. User innovations Role of users in the innovation process, user communities, user innovatio toolkits, lead users analysis Content Content Content Contine Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p. 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boste et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London	Language	EN		
Innovation and service marketing (importance of innovative products an services, model, objectives and examples of innovation marketin characteristics of services, challenges of service marketing) II. Methods and approaches of strategic marketing planning patterns of industrial development, patent and technology portfolios III. Strategic foresight and scenario analysis objectives and challenges of strategic foresight, scenario analysis, Delpmethod IV. User innovations Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGraw Hill, Boston et al., 2008 Christensen, C. M. (197). Innovator's Dilemma: When New Technologies Caus Graet Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p. 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boste et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London	Cycle	SoSe		
services, model, objectives and examples of innovation marketin characteristics of services, challenges of service marketing) II. Methods and approaches of strategic marketing planning • patterns of industrial development, patent and technology portfolios III. Strategic foresight and scenario analysis • objectives and challenges of strategic foresight, scenario analysis, Delgmethod IV. User innovations • Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering • Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing • Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management • Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications • Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christenen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boste et al., McGraw Hill Tidd: J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		I. Introduction		
patterns of industrial development, patent and technology portfolios III. Strategic foresight and scenario analysis objectives and challenges of strategic foresight, scenario analysis, Delpmethod IV. User innovations Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p. 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bosto et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		 Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing) 		
III. Strategic foresight and scenario analysis • objectives and challenges of strategic foresight, scenario analysis, Delp method IV. User innovations • Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering • Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing • Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management • Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications • Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-11292040335 . Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boste et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		II. Methods and approaches of strategic marketing planning		
Objectives and challenges of strategic foresight, scenario analysis, Delpmethod IV. User innovations Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boste et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London				
Tontent Content Content Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-11292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boste et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		III. Strategic foresight and scenario analysis		
Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis V. Customer-oriented Product and Service Engineering Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bosto et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		 objectives and challenges of strategic foresight, scenario analysis, Delphi method 		
toolkits, lead users analysis V. Customer-oriented Product and Service Engineering • Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing • Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management • Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications • Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bosto et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		IV. User innovations		
 Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Literature Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boston et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London 	Content	 Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis 		
VII. Pricing Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Literature Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p. 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boston et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		V. Customer-oriented Product and Service Engineering		
 Basics of Pricing, Value-based pricing, Pricing models VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bostet al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London 		Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting		
VIII. Sales Management Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bostet al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		VII. Pricing		
 Basics of Sales Management, Assessing Customer Value, Planning Custom Visits IX. Communications Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bosto et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London 		Basics of Pricing, Value-based pricing, Pricing models		
Visits IX. Communications • Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bosto et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		VIII. Sales Management		
Diffusion of Innovations, Communication Objectives, Communication Instruments Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technology products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Causes Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, p. 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boston et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		 Basics of Sales Management, Assessing Customer Value, Planning Customer Visits 		
Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technolog products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caus Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bosto et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		IX. Communications		
products and innovations, third edition, Pearson education. ISBN-1 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (35 365), Chapter 12 (419-426). Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Caustive Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boston et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London				
McGrw Hill, Boston et al., 2008 Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bosto et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technology products and innovations, third edition, Pearson education. ISBN-10: 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (352-365), Chapter 12 (419-426).		
Literature Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,p 3-24. Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Bosto et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition, McGrw Hill, Boston et al., 2008		
et al., McGraw Hill Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London	Literature			
		Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boston et al., McGraw Hill		
Van Hinnal E (2005) Damacratizing Innovation Cambridge MIT Dross		Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London		
von hipper, c.(2005). Democratizing innovation, Cambridge: Mili Press		Von Hippel, E.(2005). Democratizing Innovation, Cambridge: MIT Press		

Course L0862: PBL	Marketing of Innovations
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	SoSe
Content	This PBL course is seggregated into two afternoon sessions. This cours aims at enhancing the students' practical skills in (1) forecasting the future development of markets and (2) making appropriate market-related decisions (particularly segmentation, managing the marketing mix). The students will be prompted to use the knowledge gathered in the lecture of this module and will be invited to (1) Conduct a scenario analysis for an innovative product category and (2) Engage in decision making within a market simulation game.
Literature	

Module M1143: Applied Design Methodology in Mechatronics				
Courses				
	dology in Mechatronics (L1523) dology in Mechatronics (L1524)	Typ Lecture Project-/problem-	Hrs/wk 2 3	CP 2
Applied Design Method	aciogy in Mechationies (L1324)	based Learning		<u> </u>
Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of mechanical design, elect	rical design or computer-	-sciences	
Educational Objectives	After taking part successfully, stud	lents have reached the fo	ollowing learn	ing results
Professional Competence	Science-based working on interc	lisciplinary product desi	ian consideri	ng targete
Knowledge	application of specific product des	ign techniques		
Skills	Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.			
Personal Competence				
Social Competence	In small design-teams with application of common, creative methodologies.			
Autonomy	the target and topic of the design			
	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and scale	30 min Presentation for a group design-work			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation implants and Endoprostheses: Elective			

Compulsory

Course L1523: App	lied Design Methodology in Mechatronics		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Thorsten Kern		
Language	EN		
Cycle	SoSe		
Content	 Systematic analysis and planning of the design process for products combining a multitude of disciplines Structure of the engineering process with focus on engineering steps (task-definition, functional decomposition, physical principles, elements for solution, combination to systems and products, execution of design, component-tests, system-tests, product-testing and qualification/validation) Creative methods (Basics, methods like lead-user-method, 6-3-5, BrainStorming, Intergalactic Thinking, Applications in examples all around mechatronics topics) Several design-supporting methods and tools (functional strcutures, GALFMOS, AEIOU-method, GAMPFT, simulation and its application, TRIZ, design for SixSigma, continous integration and testing,) Evaluation and final selection of solution (technical and business-considerations, preference-matrix, pair-comparision), dealing with uncertainties, decision-making Value-analysis Derivation of architectures and architectural management Project-tracking and -guidance (project-lead, guiding of employees, organization of multidisciplinary R&D departments, idea-identification, responsibilities and communication) Project-execution methods (Scrum, Kanbaan,) Presentation-skills Questions of aesthetic product design and design for subjective requirements (industrial design, color, haptic/optic/acoustic interfaces) Evaluation of selected methods at practical examples in small teams 		
Literature	 Definition folgt Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, KH.: Konstruktionslehre: Grundlage erfolgreicher Produktentwicklung, Methoden und Anwendung, 7. Auflage, Springer Verlag, Berlin 2007 VDI-Richtlinien: 2206; 2221ff 		

Course L1524: Applied Design Methodology in Mechatronics		
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Thorsten Kern	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0938	B: Bioprocess Engineering -	Fundamentals		
Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering	g - Fundamentals (L0841)	Lecture	2	3
Bioprocess Engineering	g- Fundamentals (L0842)	Recitation Section (large)	12	1
Bioprocess Engineering	g - Fundamental Practical Course (L0843)	Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
Recommended Previous Knowledge	none, module "organic chemistry", modu	ule "fundamentals for	process er	ngineering"
Educational Objectives	After taking part successfully, students h	nave reached the follo	wing learn	ing results
Professional Competence				
Knowledge	Students are able to describe the basic concepts of bioprocess engineering. They are able to classify different types of kinetics for enzymes and microorganisms, as well as to differentiate different types of inhibition. The parameters of stoichiometry and rheology can be named and mass transport processes in bioreactors can be explained. The students are capable to explain fundamental bioprocess management, sterilization technology and downstream processing in detail.			
Skills	 After successful completion of this module, students should be able to describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parameters predict qualitatively the influence of energy generation, regeneration of redox equivalents and growth inhibition on the fermentation process analyze bioprocesses on basis of stoichiometry and to set up / solve metabolic flux equations distinguish between scale-up criteria for different bioreactors and bioprocesses (anaerobic, aerobic as well as microaerobic) to compare them as well as to apply them to current biotechnical problem propose solutions to complicated biotechnological problems and to deduce the corresponding models to explore new knowledge resources and to apply the newly gained contents identify scientific problems with concrete industrial use and to formulate solutions. to document and discuss their procedures as well as results in a scientific manner 			
Personal Competence Social Competence	After completion of this module participants should be able to debate technical questions in small teams to enhance the ability to take position to their own			
Autonomy	After completion of this module participants will be able to solve a technical problem in a team independently by organizing their workflow and to present their results in a plenum.			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		

Credit points	6		
Course	CompulsorBonus	Form	Description
achievement	Yes 5 %	Subject theoretical practical work	and
Examination	Written exam		
Examination duration and scale			
the Following	General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory Bioprocess Engineering: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core qualification: Compulsory		

Course L0841: Biop	process Engineering - Fundamentals
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng
Language	DE
Cycle	SoSe
Content	 Introduction: state-of-the-art and development trends in the biotechnology, introduction to the lecture Enzyme kinetics: Michaelis-Menten, differnt types of enzyme inhibition, linearization, conversion, yield, selectivity (Prof. Liese) Stoichiometry: coefficient of respiration, electron balance, degree of reduction, coefficient of yield, theoretical oxygen demand (Prof. Liese) Microbial growth kinetic: batch- and chemostat culture (Prof. Zeng) Kinetic of subtrate consumption and product formation (Prof. Zeng) Rheology: non-newtonian fluids, viscosity, agitators, energy input (Prof. Liese) Transport process in a bioreactor (Prof. Zeng) Technology of sterilization (Prof. Zeng) Fundamentals of bioprocess management: bioreactors and calculation of batch, fed-batch and continuouse bioprocesses (Prof. Zeng/Prof. Liese) Downstream technology in biotechnology: cell breakdown, zentrifugation, filtration, aqueous two phase systems (Prof. Liese)
Literature	 K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012 H. Chmiel: Bioprozeßtechnik, Elsevier, 2006 R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010 H.W. Blanch, D. Clark: Biochemical Engineering, Taylor & Francis, 1997 P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013

Course L0842: Bioprocess Engineering- Fundamentals		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng	
Language	DE	
Cycle	SoSe	
	1. Introduction (Prof. Liese, Prof. Zeng)	
	2. Enzymatic kinetics (Prof. Liese)	
	3. Stoichiometry I + II (Prof. Liese)	
	4. Microbial Kinetics I+II (Prof. Zeng)	
Content	5. Rheology (Prof. Liese)	
Content	6. Mass transfer in bioprocess (Prof. Zeng)	
	7. Continuous culture (Chemostat) (Prof. Zeng)	
	8. Sterilisation (Prof. Zeng)	
	9. Downstream processing (Prof. Liese)	
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)	
Literature	siehe Vorlesung	

Course L0843: Biop	process Engineering - Fundamental Practical Course
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng
Language	DE
Cycle	SoSe
Content	In this course fermentation and downstream technologies on the example of the production of an enzyme by means of a recombinant microorganism is learned. Detailed characterization and simulation of enzyme kinetics as well as application of the enzyme in a bioreactor is carried out. The students document their experiments and results in a protocol.
Literature	Skript

Module M1277	7: MED I: Introduction t	o Anatomy	
Courses			
Title Introduction to Anatom	ny (L0384)	Typ Lecture	Hrs/wk CP 2 3
Admission Requirements	None		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully, stu	dents have reached the	following learning results
Professional Competence			
Knowledge	The students can describe basal musculoskeletal system. The students can describe the ba		J
Skills	The students can recognize the redevelopment of some common structures and their functions in t	n diseases; they can	explain the relevance of
Personal Competence			
Social Competence	The students can participate in medicine on a professional level.	current discussions in	n biomedical research and
Autonomy	The students are able to acc participate in conversations on themselves.		
Workload in Hours	Independent Study Time 62, Stud	ly Time in Lecture 28	
Credit points			
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 minutes		
	General Engineering Science Biomedical Engineering: Compuls General Engineering Science Mechanical Engineering, Focus Bi Data Science: Specialisation Med Electrical Engineering: Specialisation Engineering Science: Specialisation	ory (German program, 7 omechanics: Compulsor icine: Compulsory tion Medical Technology	semester): Specialisation y : Elective Compulsory
the Following	General Engineering Science Mechanical Engineering, Focus Bi General Engineering Science Biomedical Engineering: Compuls General Engineering Science Biomedical Engineering: Compuls Mechanical Engineering: Specialis Biomedical Engineering: Special Elective Compulsory Biomedical Engineering: Specialis	(English program, 7 omechanics: Compulsor (English program, 7 sory (English program, 7 sory sation Biomechanics: Co isation Medical Techno	semester): Specialisation y semester): Specialisation semester): Specialisation mpulsory logy and Control Theory:

Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0384: Introduction to Anatomy			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study	Time 62, Study Time in Lecture 28	
	Prof. Tobias Lange		
Language			
Cycle			
	General Anatomy 1 st week:	The Eucaryote Cell	
	2 nd week: 3 rd week:	The Tissues Cell Cycle, Basics in Development	
	4 th week:	Musculoskeletal System	
	5 th week:	Cardiovascular System	
	6 th week:	Respiratory System	
	7 th week:	Genito-urinary System	
Content	8 th week:	Immune system	
	9 th week:	Digestive System I	
	10 th week:	Digestive System II	
	11 th week:	Endocrine System	
	12 th week:	Nervous System	
	13 th week:	Exam	
Literature	Adolf Faller/Michae Stuttgart, 2016	l Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag	

Module M127 Therapy	8: MED I: Introduction to Radiology and Radiation	
Courses		
Title Introduction to Radiolo	Typ Hrs/wk CP gy and Radiation Therapy (L0383) Lecture 2 3	
	Prof. Ulrich Carl	
Admission Requirements	None	
Recommended Previous Knowledge	None	
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	Therapy The students can distinguish different types of currently used equipment with respect to its use in radiation therapy. The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine). The students can describe the patients' passage from their initial admittance through to follow-up care. Diagnostics The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, as well as sectional imaging techniques (CT, MRT, US). The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for those techniques. The students can choose the right treatment method depending on the patient's clinical history and needs. The student can explain the influence of technical errors on the imaging techniques. The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.	
Skills	The student can assess what an individual psychosocial service should look like	
	(e.g. follow-up treatment, sports, social help groups, self-help groups, social services, psycho-oncology). Diagnostics	

	The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.		
	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of anatomy, pathology and pathophysiology.		
Personal Competence			
	The students can assess the special social situation of tumor patients and interact with them in a professional way. The students are aware of the special, often fear-dominated behavior of sick people caused by diagnostic and therapeutic measures and can meet them appropriately.		
	The students can apply their new knowledge and skills to a concrete therapy case. The students can introduce younger students to the clinical daily routine.		
Autonomy	The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the topic and acquire the relevant knowledge themselves.		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points	3		
Course achievement			
Examination	Written exam		
Examination			
duration and			
scale			
the Following	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Engineering Science: Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering: Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering: Compulsory General Engineering: Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory		

Course L0383: Introduction to Radiology and Radiation Therapy		
Typ Lecture		
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ulrich Carl, Prof. Thomas Vestring	
Language	DE	

Cycle	
Content	The students will be given an understanding of the technological possibilities in the field of medical imaging, interventional radiology and radiation therapy/radiation oncology. It is assumed, that students in the beginning of the course have heard the word "X-ray" at best. It will be distinguished between the two arms of diagnostic (Prof. Dr. med. Thomas Vestring) and therapeutic (Prof. Dr. med. Ulrich Carl) use of X-rays. Both arms depend on special big units, which determine a predefined sequence in their respective departments
	• "Technik der medizinischen Radiologie" von T. + J. Laubenberg –
	7. Auflage – Deutscher Ärzteverlag – erschienen 1999
	 "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr –
	4. Auflage - Verlag Urban & Fischer - erschienen 02.03.2006
	ISBN: 978-3-437-23960-1
	"Strahlentherapie und Onkologie für MTA-R" von R. Sauer –
	5. Auflage 2003 - Verlag Urban & Schwarzenberg – erschienen 08.12.2009
	ISBN: 978-3-437-47501-6
Literature	 "Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus-
	8. Auflage – Georg Thieme Verlag - erschienen 19.09.2012
	ISBN: 978-3-13-567708-8
	• "Der Körper des Menschen " von A. Faller u. M. Schünke -
	16. Auflage 2004 – Georg Thieme Verlag – erschienen 18.07.2012
	ISBN: 978-3-13-329716-5
	"Praxismanual Strahlentherapie" von Stöver / Feyer –
	1. Auflage - Springer-Verlag GmbH - erschienen 02.06.2000

Module M1280): MED II: Introduction	on to Physiology		
Courses				
Title Introduction to Physiol	ogy (L0385)	Typ Lecture	Hrs/wk CP 2 3	
Module Responsible	Dr. Roger Zimmermann			
Admission Requirements				
Recommended Previous				
Knowledge Educational Objectives	After taking part successfully	, students have reached the	e following learning results	
Professional Competence				
Knowledge	 describe physiological 	• describe the basics of the energy metabolism:		
Skills	The students can describe transmission and processing functions) and relate them to	g of information, develop		
Personal Competence				
Social Competence	The students can conduct dis The students can find solu analytical and metrological.			
Autonomy	The students can derive an physiological areas, using tec			
Workload in Hours	Independent Study Time 62,	Study Time in Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following	General Engineering Science Biomedical Engineering: Com General Engineering Science Mechanical Engineering, Focus Data Science: Specialisation I Electrical Engineering: Special Engineering Science: Speciali General Engineering Science Mechanical Engineering, Focus General Engineering: Com General Engineering: Com General Engineering: Com General Engineering: Specialisation I Biomedical Engineering: Spec	pulsory ce (German program, 7 us Biomechanics: Compulsory dedicine: Compulsory disation Medical Technology sation Biomedical Engineer ce (English program, 7 us Biomechanics: Compulsor ce (English program, 7 pulsory ce (English program, 7 cive Compulsory cialisation Biomechanics: Co	semester): Specialisation ry /: Elective Compulsory ing: Elective Compulsory semester): Specialisation ry semester): Specialisation semester): Specialisation ompulsory	

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0385: Introduction to Physiology		
Тур	ecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Gerhard Engler, Dr. Gerhard Engler	
Language	DE	
Cycle	SoSe	
Content		
Literature	Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier	

Module M1332	2: BIO I: Experimental M	ethods in Biom	echanics	
Courses				
Title Experimental Methods	in Biomechanics (L0377)	Typ Lecture	Hrs/wk	CP 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
	It is recommended to participa attending "Experimentelle Methodo		nd Frakturheilu	ung" before
Educational Objectives	After taking part successfully, stud	ents have reached the	following learr	ing results
Professional Competence				
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence. The students can name different treatments for the spine and hollow bones under given fracture morphologies.			
	The students can describe differ movements, and choose the adequ		•	forces and
Skills	The students can describe the basic handling of several experimental techniques used in biomechanics.			
Personal Competence				
Social Competence	The students can, in groups, solve	basic experimental tas	sks.	
Autonomy	The students can, in groups, solve basic experimental tasks.			
	Independent Study Time 62, Study	Time in Lecture 28		
Credit points				
Course achievement	None			
Examination				
Examination duration and scale				
the Following	General Engineering Science (Comechanical Engineering, Focus Bio General Engineering Science (Comedical Engineering): Compulso Engineering Science: Specialisation General Engineering Science (Mechanical Engineering, Focus Bio General Engineering, Focus Bio General Engineering: Compulso General Engineering: Compulso General Engineering: Science (Mechanical Engineering: Elective Compulsory Biomedical Engineering: Specialisa Elective Compulsory Biomedical Engineering: Specialisa Elective Compulsory Biomedical Engineering: Specialisa Compulsory Biomedical Engineering: Specialisa Specialisa Engineering: Specialisa Compulsory	mechanics: Compulsor German program, 7 ry n Biomedical Engineeri English program, 7 mechanics: Compulsor English program, 7 ry English program, 7 ompulsory stion Biomechanics: Costion Artificial Organs a sation Implants and	semester): S ng: Elective Co semester): S y semester): S semester): S mpulsory and Regenerative Endoprosthes	pecialisation mpulsory pecialisation pecialisation pecialisation ve Medicines

Elective Compulsory
Biomedical Engineering: Specialisation Management and Business Administration:
Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0377: Experimental Methods in Biomechanics	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE
Cycle	SoSe
Content	
Literature	Wird in der Veranstaltung bekannt gegeben

Module M1335	5: BIO II: Artificial Joint Replac	cement		
Courses				
Title Artificial Joint Replacer		yp ecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the follow	wing learni	ng results
Professional Competence <i>Knowledge</i>	The students can name the different kinds of artificial limbs.			
	The students can explain the advantages and disadvantages of different kinds of endoprotheses.			
Personal Competence				
Social Competence	The students are able to discuss issues related to endoprothese with student mates and the teachers.			
Autonomy	The students are able to acquire information on their own. They can also judge the information with respect to its credibility.			
Workload in Hours	Independent Study Time 62, Study Time in	Lecture 28		
Credit points	3			
Course achievement	none			
	Written exam			
Examination duration and scale	90 min			
the Following	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Orientierungsstudium: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory			

Course L1306: Arti	ficial Joint Replacement	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
	Inhalt (deutsch)	
	 EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenker-satzes) 	
	2. FUNKTIONSANALYSE (Der menschliche Gang, die menschliche Arbeit, die sportliche Aktivität)	
	3. DAS HÜFTGELENK (Anatomie, Biomechanik, Gelenkersatz Schaftseite und Pfannenseite, Evolution der Implantate)	
Content	4. DAS KNIEGELENK (Anatomie, Biomechanik, Bandersatz, Gelenkersatz femorale, tibiale und patelläre Komponenten)	
	5. DER FUß (Anatomie, Biomechanik, Gelen-kersatz, orthopädische Verfahren)	
	6. DIE SCHULTER (Anatomie, Biomechanik, Gelenkersatz)	
	7. DER ELLBOGEN (Anatomie, Biomechanik, Gelenkersatz)	
	8. DIE HAND (Anatomie, Biomechanik, Ge-lenkersatz)	
	9. TRIBOLOGIE NATÜRLICHER UND KÜNST-LICHER GELENKE (Korrosion, Reibung, Verschleiß)	
	Literatur:	
	Kapandji, I: Funktionelle Anatomie der Gelenke (Band 1-4), Enke Verlag, Stuttgart, 1984.	
Literature	Nigg, B., Herzog, W.: Biomechanics of the musculo-skeletal system, John Wiley&Sons, New York 1994	
	Nordin, M., Frankel, V.: Basic Biomechanics of the Musculoskeletal System, Lea&Febiger, Philadelphia, 1989.	
	Czichos, H.: Tribologiehandbuch, Vieweg, Wiesbaden, 2003.	
	Sobotta und Netter für Anatomie der Gelenke	

Module M0845	5: Feedback Control in Medical Technology				
Courses					
Title Feedback Control in M	Typ Hrs/wk CP edical Technology (L0664) Lecture 2 3				
Module Responsible	Jonannes Kreuzer				
Admission Requirements	None				
Recommended Previous Knowledge	Basics in Control, Basics in Physiology				
Educational Objectives					
Professional Competence					
	The lecture will introduce into the fascinating area of medical technology with the engineering point of view. Fundamentals in human physiology will be similarly introduced like knowledge in control theory.				
Knowledge	Internal control loops of the human body will be discussed in the same way like the design of external closed loop system fo example in for anesthesia control.				
	The handling of PID controllers and modern controller like predictive controller or fuzzy controller or neural networks will be illustrated. The operation of simple equivalent circuits will be discussed.				
Skills	Application of modeling, identification, control technology in the field of medical technology.				
Personal Competence					
Social Competence	Students can develop solutions to specific problems in small groups and present their results				
Autonomy	Students are able to find necessary literature and to set it into the context of the lecture. They are able to continuously evaluate their knowledge and to take control of their learning process. They can combine knowledge from different courses to form a consistent whole.				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28				
Credit points					
Course achievement					
Examination	Oral exam				
Examination duration and scale	20 min				
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:				

Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory

Course L0664: Fee	dback Control in Medical Technology
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	 Always viewed from the engineer's point of view, the lecture is structured as follows: Introduction to the topic Fundamentals of physiological modelling Introduction to Breathing and Ventilation Physiology and Pathology in Cardiology Introduction to the Regulation of Blood Glucose kidney function and renal replacement therapy Representation of the control technology on the concrete ventilator Excursion to a medical technology company Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.
Literature	 Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Courses				
Title Advanced Topics in Co	ontrol (L0661)	Typ Lecture	Hrs/wk 2	CP 3
Advanced Topics in Co	ontrol (L0662)	Recitation (small)	Section 2	3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended	H-infinity optimal control, mixed-se	ensitivity design, line	ar matrix inequal	ities
Educational Objectives	After taking part successfully, stud	ents have reached t	he following learn	ing results
Professional Competence				
Knowledge	 Students can explain the adscheduling approach They can explain the repress LPV systems They can explain how stabic can be formulated as LMI completed as the complete synthesis problems for LPV some of the basic synthesis structures Students can explain how go communication topology of they can explain the comprotocols They can explain analysis as involving either LTI or LPV and the representations. 	entation of nonlinear lity and performance anditions ing techniques can be systems opic and LFT represe techniques associate traph theoretic conceut multiagent systems avergence properties and synthesis condition	r systems in the free conditions for I be used to solve and the contact of LPV steed with each of the contact o	orm of quase PV systems analysis and systems and these mode epresent the consensus
	 Students can explain the sign distributed systems that are They can explain (in outlin such distributed systems distributed controllers 	discretized accordire) the extension of	ng to an actuator/ the bounded rea	sensor arra al lemma to
	 Students are capable of concarry out a mixed-sensitivity do this using polytopic, LFT They are able to use standation these tasks 	y design of gain-scl or general LPV mode	neduled controlle els	rs; they ca
Skills	Students are able to desig agents with either LTI or LP\			

	 Students are able to design distributed controllers for spatially interconnected systems, using the Matlab MD-toolbox
Personal Competence Social Competence Autonomy	Students can work in small groups and arrive at joint results. Students are able to find required information in sources provided (lecture notes, literature, software documentation) and use it to solve given problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
Examination	Oral exam
Examination duration and scale	
Assignment for the Following Curricula	IBIOMERICAL Engineering: Specialisation Medical Jechnology and Control Theory: L

Course L0661: Adv	anced Topics in Control
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	
Cycle	WiSe
Content	 Linear Parameter-Varying (LPV) Gain Scheduling Linearizing gain scheduling, hidden coupling Jacobian linearization vs. quasi-LPV models Stability and induced L2 norm of LPV systems Synthesis of LPV controllers based on the two-sided projection lemma Simplifications: controller synthesis for polytopic and LFT models Experimental identification of LPV models Controller synthesis based on input/output models Applications: LPV torque vectoring for electric vehicles, LPV control of a robotic manipulator Control of Multi-Agent Systems Communication graphs Spectral properties of the graph Laplacian First and second order consensus protocols Formation control, stability and performance LPV models for agents subject to nonholonomic constraints Application: formation control for a team of quadrotor helicopters Control of Spatially Interconnected Systems Multidimensional signals, I2 and L2 signal norm Multidimensional systems in Roesser state space form Extension of real-bounded lemma to spatially interconnected systems LMI-based synthesis of distributed controllers Spatial LPV control of spatially varying systems Applications: control of temperature profiles, vibration damping for an actuated beam
Literature	 Werner, H., Lecture Notes "Advanced Topics in Control" Selection of relevant research papers made available as pdf documents via StudIP

Course L0662: Advanced Topics in Control			
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Herbert Werner		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0548	8: Bioelectromagnetics:	Principles	and App	olicatio	ns
Courses					
Title Bioelectromagnetics: F	Principles and Applications (L0371) Principles and Applications (L0373)	Typ Lecture Recitation (small)	Section	Hrs/wk	CP 5
Module Responsible	Prof. Christian Schuster	(Siliali)			
Admission Requirements	None				
Recommended Previous Knowledge					
Educational Objectives	After taking part successfully, stud	dents have reach	ed the follo	wing learn	ing results
Professional Competence					
Knowledge	Students can explain the basic principles, relationships, and methods of bioelectromagnetics, i.e. the quantification and application of electromagnetic fields in biological tissue. They can define and exemplify the most important physical phenomena and order them corresponding to wavelength and frequency of the fields. They can give an overview over measurement and numerical techniques for characterization of electromagnetic fields in practical applications. They can give examples for therapeutic and diagnostic utilization of electromagnetic fields in medical technology. Students know how to apply various methods to characterize the behavior of electromagnetic fields in biological tissue. In order to do this they can relate to and				
Skills	make use of the elementary solutions of Maxwell's Equations. They are able to assess the most important effects that these models predict for biological tissue, they can order the effects corresponding to wavelength and frequency, respectively, and they can analyze them in a quantitative way. They are able to develop validation strategies for their predictions. They are able to evaluate the effects of electromagnetic fields for therapeutic and diagnostic applications and make an appropriate choice.				
Personal Competence					
Social Competence	Students are able to work together on subject related tasks in small groups. They are able to present their results effectively in English (e.g. during small group exercises).				
Autonomy	Students are capable to gather information from subject related, professional publications and relate that information to the context of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content of other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communicate problems and effects in the field of bioelectromagnetics in English.				
Workload in Hours	Independent Study Time 110, Stu	dy Time in Lectur	e 70		
	[258]				

Credit points	6			
Course achievement	CompulsorBonus Yes 10 %	Form Presentation	Description	
Examination	Oral exam			
Examination duration and scale	45 min			
the Following	Electromagnetic Compa Electrical Engineering: International Managem Elective Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Compulsory Theoretical Mechanica Elective Compulsory	atibility: Elective Co Specialisation Medi ent and Engineering: Specialisation Arg: Specialisation Medi g: Specialisation Medi g: Specialisation Ing: Specialisation Ing: Specialisation	Microwave Engineering, ompulsory cal Technology: Elective Cong: Specialisation II. Electrical cificial Organs and Regeneral anagement and Business And Medical Technology and Complements and Medical cialisation Bio- and Medical chnical Complementary Compl	mpulsory al Engineering: ative Medicine: Administration: ontrol Theory: eses: Elective al Technology:

Course L0371: Bioe	electromagnetics: Principles and Applications
Тур	Lecture
Hrs/wk	3
СР	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
	Prof. Christian Schuster
Language	
Cycle	
	- Fundamental properties of electromagnetic fields (phenomena)
	- Mathematical description of electromagnetic fields (Maxwell's Equations)
	- Electromagnetic properties of biological tissue
	- Principles of energy absorption in biological tissue, dosimetry
	- Numerical methods for the computation of electromagnetic fields (especially FDTD)
	- Measurement techniques for characterization of electromagnetic fields
Content	- Behavior of electromagnetic fields of low frequency in biological tissue
	- Behavior of electromagnetic fields of medium frequency in biological tissue
	- Behavior of electromagnetic fields of high frequency in biological tissue
	- Behavior of electromagnetic fields of very high frequency in biological tissue
	- Diagnostic applications of electromagnetic fields in medical technology
	- Therapeutic applications of electromagnetic fields in medical technology
	- The human body as a generator of electromagnetic fields
	- C. Furse, D. Christensen, C. Durney, "Basic Introduction to Bioelectromagnetics",
	CRC (2009)
	- A. Vorst, A. Rosen, Y. Kotsuka, "RF/Microwave Interaction with Biological Tissues", Wiley (2006)
Literature	- S. Grimnes, O. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008)
	- F. Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnetic Fields", CRC (2006)
	-

Course L0373: Bioelectromagnetics: Principles and Applications				
Тур	Typ Recitation Section (small)			
Hrs/wk	2			
СР	1			
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28			
Lecturer	Prof. Christian Schuster			
Language	DE/EN			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

Specialization Management and Business Administration

Module M0623	3: Intellige	nt Sys	stems in Me	dicine		
Courses						
Title Intelligent Systems in Intelligent Systems in Intelligent Systems in	Medicine (L0334)			Typ Lecture Project Seminar Recitation (small)	Hrs/wk 2 2 Section 1	CP 3 2
Module Responsible	Prof. Alexander	Schlaef	er			
Admission Requirements	None					
Recommended Previous Knowledge	principleprinciple	 principles of math (algebra, analysis/calculus) principles of stochastics principles of programming, Java/C++ and R/Matlab advanced programming skills 				
Educational Objectives		t succes	sfully, students h	ave reached th	e following learn	ing results
Professional Competence						
Knowledge	The students are able to analyze and solve clinical treatment planning and decision support problems using methods for search, optimization, and planning. They are able to explain methods for classification and their respective advantages and disadvantages in clinical contexts. The students can compare different methods for representing medical knowledge. They can evaluate methods in the context of clinical data and explain challenges due to the clinical nature of the data and its acquisition and due to privacy and safety requirements.					
Skills	The students can give reasons for selecting and adapting methods for classification, regression, and prediction. They can assess the methods based on actual patient data and evaluate the implemented methods.					
Personal Competence						
Social Competence	The students di incoorporate fe	scuss thedback i	ne results of other nto their work.	groups, provid	de helpful feedb	ack and car
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.					
Workload in Hours	Independent St	udy Tim	e 110, Study Time	e in Lecture 70		
Credit points	6					
Course achievement	Yes 10	%	Form Written elaborati Presentation		scription	
Examination	Written exam					
Examination duration and scale						
	Electrical Engin	eering: 9	cialisation II: Intel Specialisation Med ation Intelligent S	lical Technolog	y: Elective Comp	oulsory

	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
Assignment for	
the Following	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
Curricula	Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective
	Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology:
	Elective Compulsory

Course L0331: Inte	lligent Systems in Medicine
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	WiSe
Content	 methods for search, optimization, planning, classification, regression and prediction in a clinical context representation of medical knowledge understanding challenges due to clinical and patient related data and data acquisition The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Russel & Norvig: Artificial Intelligence: a Modern Approach, 2012 Berner: Clinical Decision Support Systems: Theory and Practice, 2007 Greenes: Clinical Decision Support: The Road Ahead, 2007 Further literature will be given in the lecture

Course L0334: Intelligent Systems in Medicine		
Тур	Project Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0333: Intelligent Systems in Medicine		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP)

Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L1663)		Seminar	2	3
Introduction to Waveguides, Antennas, and Electromagnetic Compatibility (L1669)		Lecture	3	4
Introduction to Wavego Compatibility (L1877)	uides, Antennas, and Electromagnetic	Recitation (small)	Section 2	2
Development and Reg	ulatory Approval of Implants (L1588)	Lecture	2	3
Experimental Methods	for the Characterization of Materials (L1580)	Lecture	2	3
Numerical Methods in	Biomechanics (L1583)	Seminar	2	3
Seminar Biomedical Er	ngineering (L1890)	Seminar	2	3
Six Sigma (L1130)		Lecture	2	3
Fluid Mechanics II (L00		Lecture	2	4
System Simulation (L1	820)	Lecture	2	2
System Simulation (L1	821)	Recitation (large)	Section 1	2
Ceramics Technology ((L0379)	Lecture	2	3
Module				
Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended				
Previous Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached	the following learr	ning results
Professional Competence				
Knowledge				
Skills				
Personal				
Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation I Elective Compulsory Biomedical Engineering: Specialisation A Elective Compulsory	Medical Tec	chnology and Con	trol Theory:

Course L1663: Nature's Hierarchical Materials		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Gerold Schneider	
Language	EN	
Cycle	WiSe	
Content	Biological materials are omnipresent in the world around us. They are the main constituents in plant and animal bodies and have a diversity of functions. A fundamental function is obviously mechanical providing protection and support for the body. But biological materials may also serve as ion reservoirs (bone is a typical example), as chemical barriers (like cell membranes), have catalytic function (such as enzymes), transfer chemical into kinetic energy (such as the muscle), etc. This lecture will focus on materials with a primarily (passive) mechanical function: cellulose tissues (such as wood), collagen tissues (such as tendon or cornea), mineralized tissues (such as bone, dentin and glass sponges). The main goal is to give an introduction to the current knowledge of the structure in these materials and how these structures relate to their (mostly mechanical) functions.	
Literature	Peter Fratzl, Richard Weinkamer, Nature's hierarchical materialsProgress, in Materials Science 52 (2007) 1263-1334 Journal publications	

Course L1669: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and scale		
Lecturer	Prof. Christian Schuster	
Language		
Cycle		
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency / high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation and Electromagnetic Compatibility will be introduced and discussed. Topics: - Fundamental properties and phenomena of electrical circuits - Steady-state sinusoidal analysis of electrical circuits - Fundamental properties and phenomena of electromagnetic fields and waves - Steady-state sinusoidal description of electromagnetic fields and waves - Useful microwave network parameters - Transmission lines and basic results from transmission line theory - Plane wave propagation, superposition, reflection and refraction - General theory of waveguides - Most important types of waveguides and their properties - Radiation and basic antenna parameters - Most important types of antennas and their properties - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques	
Literature	 - Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999) - J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012) - D. M. Pozar, "Microwave Engineering", Wiley (2011) - Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008) - H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009) 	
	- A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)	

Course L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1588: Dev	Course L1588: Development and Regulatory Approval of Implants		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Dr. Roman Nassutt		
Language	DE		
Cycle	WiSe		
Content			
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik - Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html 		

Course L1580: Experimental Methods for the Characterization of Materials		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Patrick Huber	
Language	DE	
Cycle	WiSe	
Content	 Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry) 	
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).	

Course L1583: Numerical Methods in Biomechanics		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale	90 Minuten	
Lecturer	Prof. Michael Morlock	
Language	DE/EN	
Cycle	SoSe	
Content	 Vorkenntnisse aus " Diskretisierungsmethoden der Mechanik" sind empfohlen Ein Überblick über die gängigsten numerischen Verfahren im Bereich der Biomechanik und Medizintechnik wird vermittelt. Grundkenntnissen aus verschiedenen Disziplinen (Mechanik, Mathematik, Programmierung) werden kombiniert um eine geschlossene Beispielfragestellung zu beantworten Die Vorlesung umfasst analytische Ansätze, rheologische Modelle und Finite Elemente Methoden Die vermittelten theoretischen Ansätze werden im Laufe der Vorlesung und im Rahmen von Hausaufgaben in praktische Übungen angewandt. Der kritische Blick auf die Möglichkeiten und Limitationen der Modellrechnung im Bereich humaner Anwendungen wird geschult. 	
Literature	Hauger W., Schnell W., Gross D., Technische Mechanik, Band 3: Kinetik, Springer-Verlag Berlin Heidelberg, 12. Auflage, 2012 Huber G., de Uhlenbrock A., Götzen N., Bishop N., Schwieger K., Morlock MM., Modellierung, Simulation und Optimierung, Handbuch Sportbiomechanik, Gollhofer A., Müller E., Hofmann Verlag, Schorndorf, 148-69, 2009	

Course L1890: Seminar Biomedical Engineering		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Referat	
Examination duration and scale	schriftliche ausarbeitung und Vortrag (20 min)	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	WiSe	
Content		
Literature	Keine	

Course L1130: Six	Sigma
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Claus Emmelmann
Language	DE
Cycle	WiSe
Content	 Introduction and structuring Basic terms of quality management Measuring and inspection equipment Tools of quality management: FMEA, QFD, FTA, etc. Quality management methodology Six Sigma, DMAIC
Literature	Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008 Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996 Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008

Course L0001: Fluid	d Mechanics II		
Typ	Lecture		
Hrs/wk			
CP	-		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Examination Form			
Examination			
duration and			
scale	<u> </u>		
	Prof. Michael Schlüter		
Language			
Cycle	WiSe		
Content	 Differential equations for momentum-, heat and mass transfer Examples for simplifications of the Navier-Stokes Equations Unsteady momentum transfer Free shear layer, turbulence and free jets Flow around particles - Solids Process Engineering Coupling of momentum and heat transfer - Thermal Process Engineering Rheology - Bioprocess Engineering Coupling of momentum- and mass transfer - Reactive mixing, Chemical Process Engineering Flow threw porous structures - heterogeneous catalysis Pumps and turbines - Energy- and Environmental Process Engineering Wind- and Wave-Turbines - Renewable Energy Introduction into Computational Fluid Dynamics 		
Literature	 Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882. 		

Course L1820: Sys	tem Simulation	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Dr. Stefan Wischhusen	
Language	DE	
Cycle	WiSe	
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example: Hydraulic systems and heat transfer • Example: System with different subsystems	
Literature	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011. 	

Course L1821: System Simulation		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Dr. Stefan Wischhusen	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28	
Examination Form	Klausur		
Examination duration and scale	90 Minuten		
Lecturer	Dr. Rolf Janßen		
Language	DE/EN		
Cycle	WiSe		
	Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metauurgical techniques and sintering (soild state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.		
	Content:	1. Introduction	
	Inhalt:	2. Raw materials	
Content		3. Powder fabrication	
		4. Powder processing	
		5. Shape-forming processes	
		6. Densification, sintering	
		7. Glass and Cement technology	
		8. Ceramic-metal joining techniques	
	W.D. Kingery, "Introduction to	Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991		
Literature	ure D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992		
	Skript zur Vorlesung		

Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP)

Courses				
Title		Тур	Hrs/wk	CP
Nature's Hierarchical Materials (L1663)		Seminar	2	3
Introduction to Waveguides, Antennas, and Electromagnetic Compatibility (L1669)		Lecture	3	4
Introduction to Wavego Compatibility (L1877)	uides, Antennas, and Electromagnetic	Recitation (small)	Section 2	2
-	ulatory Approval of Implants (L1588)	Lecture	2	3
•	for the Characterization of Materials (L1580)	Lecture	2	3
Numerical Methods in	·	Seminar	2	3
Seminar Biomedical Er	igineering (L1890)	Seminar	2	3
Six Sigma (L1130)		Lecture	2	3
Fluid Mechanics II (L00	•	Lecture	2	4
System Simulation (L1	820)	Lecture	2	2
System Simulation (L1	821)	Recitation	Section 1	2
Ceramics Technology (L0379)	(large) Lecture	2	3
Module				
Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended				
Previous				
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached	the following learr	ning results
Professional Competence				
Knowledge				
Skills				
Personal				
Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	12			
Assignment for the Following Curricula	ing Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory			
	Elective Compulsory			

Course L1663: Nature's Hierarchical Materials			
Тур	Seminar		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Prof. Gerold Schneider		
Language	EN		
Cycle	WiSe		
Content	Biological materials are omnipresent in the world around us. They are the main constituents in plant and animal bodies and have a diversity of functions. A fundamental function is obviously mechanical providing protection and support for the body. But biological materials may also serve as ion reservoirs (bone is a typical example), as chemical barriers (like cell membranes), have catalytic function (such as enzymes), transfer chemical into kinetic energy (such as the muscle), etc. This lecture will focus on materials with a primarily (passive) mechanical function: cellulose tissues (such as wood), collagen tissues (such as tendon or cornea), mineralized tissues (such as bone, dentin and glass sponges). The main goal is to give an introduction to the current knowledge of the structure in these materials and how these structures relate to their (mostly mechanical) functions.		
Literature	Peter Fratzl, Richard Weinkamer, Nature's hierarchical materialsProgress, in Materials Science 52 (2007) 1263-1334 Journal publications		

Course L1669: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Examination Form	Mündliche Prüfung	
Examination duration and scale		
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	SoSe	
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency / high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation and Electromagnetic Compatibility will be introduced and discussed. Topics: - Fundamental properties and phenomena of electrical circuits - Steady-state sinusoidal analysis of electrical circuits - Fundamental properties and phenomena of electromagnetic fields and waves - Steady-state sinusoidal description of electromagnetic fields and waves - Useful microwave network parameters - Transmission lines and basic results from transmission line theory - Plane wave propagation, superposition, reflection and refraction - General theory of waveguides - Most important types of waveguides and their properties - Radiation and basic antenna parameters - Most important types of antennas and their properties - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques	
Literature	 - Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999) - J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012) - D. M. Pozar, "Microwave Engineering", Wiley (2011) - Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008) - H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009) - A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007) 	

Course L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1588: Development and Regulatory Approval of Implants		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale	90 Minuten	
Lecturer	Dr. Roman Nassutt	
Language	DE	
Cycle	WiSe	
Content		
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik – Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html 	

Course L1580: Experimental Methods for the Characterization of Materials		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Patrick Huber	
Language	DE	
Cycle	WiSe	
Content	 Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry) 	
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).	

Course L1583: Numerical Methods in Biomechanics		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale	90 Minuten	
Lecturer	Prof. Michael Morlock	
Language	DE/EN	
Cycle	SoSe	
Content	 Vorkenntnisse aus " Diskretisierungsmethoden der Mechanik" sind empfohlen Ein Überblick über die gängigsten numerischen Verfahren im Bereich der Biomechanik und Medizintechnik wird vermittelt. Grundkenntnissen aus verschiedenen Disziplinen (Mechanik, Mathematik, Programmierung) werden kombiniert um eine geschlossene Beispielfragestellung zu beantworten Die Vorlesung umfasst analytische Ansätze, rheologische Modelle und Finite Elemente Methoden Die vermittelten theoretischen Ansätze werden im Laufe der Vorlesung und im Rahmen von Hausaufgaben in praktische Übungen angewandt. Der kritische Blick auf die Möglichkeiten und Limitationen der Modellrechnung im Bereich humaner Anwendungen wird geschult. 	
Literature	Hauger W., Schnell W., Gross D., Technische Mechanik, Band 3: Kinetik, Springer-Verlag Berlin Heidelberg, 12. Auflage, 2012 Huber G., de Uhlenbrock A., Götzen N., Bishop N., Schwieger K., Morlock MM., Modellierung, Simulation und Optimierung, Handbuch Sportbiomechanik, Gollhofer A., Müller E., Hofmann Verlag, Schorndorf, 148-69, 2009	

Course L1890: Seminar Biomedical Engineering		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Referat	
Examination duration and scale	schriftliche ausarbeitung und Vortrag (20 min)	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	WiSe	
Content		
Literature	Keine	

Course L1130: Six Sigma			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Prof. Claus Emmelmann		
Language	DE		
Cycle	WiSe		
Content	 Introduction and structuring Basic terms of quality management Measuring and inspection equipment Tools of quality management: FMEA, QFD, FTA, etc. Quality management methodology Six Sigma, DMAIC 		
Literature	Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008 Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996 Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008		

Course L0001: Flui	d Mechanics II	
Тур	Lecture	
Hrs/wk		
СР		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Examination Form		
Examination		
duration and		
scale		
	Prof. Michael Schlüter	
Language		
Cycle	WiSe	
Content	 Differential equations for momentum-, heat and mass transfer Examples for simplifications of the Navier-Stokes Equations Unsteady momentum transfer Free shear layer, turbulence and free jets Flow around particles - Solids Process Engineering Coupling of momentum and heat transfer - Thermal Process Engineering Rheology - Bioprocess Engineering Coupling of momentum- and mass transfer - Reactive mixing, Chemical Process Engineering Flow threw porous structures - heterogeneous catalysis Pumps and turbines - Energy- and Environmental Process Engineering Wind- and Wave-Turbines - Renewable Energy Introduction into Computational Fluid Dynamics 	
Literature	 Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882. 	

Course L1820: Sys	tem Simulation
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example: Hydraulic systems and heat transfer • Example: System with different subsystems
Literature	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.

Course L1821: System Simulation	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale	90 Minuten		
Lecturer	Dr. Rolf Janßen		
Language	DE/EN		
Cycle	WiSe		
	Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder metauurgical techniques and sintering (soild state and liquid phase). Also, som aspects of glass and cement science as well as new developments in powderles forming techniques of ceramics and ceramic composites will be addressed Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.		
	Content:	1. Introduction	
	Inhalt:	2. Raw materials	
Content		3. Powder fabrication	
		4. Powder processing	
		5. Shape-forming processes	
		6. Densification, sintering	
		7. Glass and Cement technology	
		8. Ceramic-metal joining techniques	
	W.D. Kingery, "Introduction to	Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991		
Literature D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker		mic Engineering", Marcel Decker, New York, 1992	
	Skript zur Vorlesung		

Module M0629	9: Intelligent Autonomous	Agents and	d Cog	nitive F	Robotics
Courses					
Title Intelligent Autonomous	s Agents and Cognitive Robotics (L0341) s Agents and Cognitive Robotics (L0512)	Typ Lecture Recitation (small)	Section	Hrs/wk 2 2	CP 4 2
Module Responsible	Rainer Marrone	(0			
Admission Requirements					
Recommended Previous Knowledge	Vectors, matrices, Calculus				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	Students can explain the agent abstract behavior, and give details about agent can describe the main features of en cooperation can be discussed in term solving these problems. For dealing students can summarize how Bayesian representation and reasoning formalist students can define decision making pwith and with complete access to the students can describe techniques for sproblems, and they can recall technic Students can identify techniques for can explain planning techniques for can explain planning techniques for accordination problems and decision different types of equilibria, social choid design techniques.	t design (goals, vironments. The ms of decision with uncertain networks can min static and procedures in sign e state of the solving (partially ques for measure simultaneous localization of making in a medicalization.	utilities, e notion problem nty in be emp dynamic mple an environr observing the ocalizatio I states. ulti-ager	, environm of adver real-world loyed as a settings. d sequent ment. In t able) Mark value of on and ma Students nt setting	nents). The sarial agen gorithms for scenarios a knowledg In addition cial settings his context (sov decision information can explaid in term of sorial setmos can explaid in term of sorial agent can explaid the sorial agent can be sorial agent can explaid the sorial agent can explaid the sorial agent can be sorial agent can be sorial agent can explaid the sorial agent can be s
Skills	Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent application students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesian networks/dynamic Bayesian networks and apply bayesian reasoning for simple queries. Students can also name and apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situations students will apply techniques for finding different equilibria states,e.g., Nash equilibria. For multi-agent decision making students will apply different voting protocols and compare and explain the results.				
Personal Competence	Students are able to discuss their communicate in English	solutions to	problem	s with o	thers. The
	Students are able of checking their ur varaints of concrete problems	nderstanding of	complex	x concepts	s by solvin
Workload in Hours	Independent Study Time 124, Study Ti	me in Lecture 5	6		
Credit points	6				
Course					

achievement	None
Examination	Written exam
Examination duration and scale	90 minutes
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Numerics and Computer Science: Elective Compulsory

Course L0341: Inte	Iligent Autonomous Agents and Cognitive Robotics	
Тур	Lecture	
Hrs/wk		
CP	!	
	Independent Study Time 92, Study Time in Lecture 28	
	Rainer Marrone	
Language		
Cycle	wise	
Content	 Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference by enumeration), typical-case complexity, pragmatics: reasoning from effect (that can be perceived by an agent) to cause (that cannot be directly perceived). Probabilistic reasoning over time: Environmental state may change even without the agent performing actions, dynamic Bayesian networks, Markov assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation, special cases: hidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decision networks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteration, MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks Simultaneous Localization and Mapping Planning Game theory (Golden Balls: Split or Share) Decisions with multiple agents, Nash equilibrium, Bayes-Nash equilibrium Social Choice Voting protocols, preferences, paradoxes, Arrow's Theorem, Mechanism Design Fundamentals, dominant strategy implementation, Revelation Principle, Gibbard-Satterthwaite Imp	
Literature	 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Norvig, Prentice Hall, 2010, Chapters 2-5, 10-11, 13-17 Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005 Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press, 2009 	

Course L0512: Intelligent Autonomous Agents and Cognitive Robotics		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Rainer Marrone	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0746	6: Microsystem I	Engineering			
Courses					
Title Microsystem Engineering (L0680)			Typ Lecture Project-/problem-	Hrs/wk 2 2	CP 4
Microsystem Engineeri			based Learning	2	2
	! <u></u>				
Admission Requirements	INODE				
Recommended Previous Knowledge	Basic courses in physic	s, mathematics ar	nd electric engineer	ing	
Educational Objectives	Latter taking nart slicce	ssfully, students h	ave reached the fol	lowing learn	ing results
Professional Competence					f MEMC
Knowledge	The students know abo well as their application	ns in sensors and a	actuators.		
Skills		Students are able to analyze and describe the functional behaviour of MEMS components and to evaluate the potential of microsystems.			
Personal Competence		olvo spocific probl	oms alono or in a g	roup and to	procent the
Social Competence	Students are able to solve specific problems alone or in a group and to present the results accordingly.				
Autonomy	Students are able to ac integrate and associate			cialized liter	ature and to
Workload in Hours	Independent Study Tim	ne 124, Study Time	e in Lecture 56		
Credit points	6				
Course achievement	CompulsorBonus No 10 %	Form Presentation	Descri	ption	
	Written exam				
Examination duration and scale	2h				
	Electrical Engineering: International Managem Elective Compulsory International Managem Compulsory Mechanical Engineerin Compulsory Mechatronics: Specialis	nent and Engineerinent and Engineering and Managem Sation System Des	ing: Specialisation II ing: Specialisation II ent: Specialisation ign: Elective Compu	I. Mechatron Mechatroni Ilsory	ics: Elective
Assignment for the Following Curricula	Biomedical Engineerin	ng: Specialisation ng: Specialisation g: Specialisation	Implants and Er Medical Technolog Management and E	ndoprostheso y and Cont Business Adi	es: Elective rol Theory: ministration:

Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0680: Mici	Course L0680: Microsystem Engineering			
Тур	Lecture			
Hrs/wk	2			
СР	4			
	Independent Study Time 92, Study Time in Lecture 28			
	Prof. Manfred Kasper			
Language				
Cycle				
	Object and goal of MEMS			
	Scaling Rules			
	Lithography			
	Film deposition			
	Structuring and etching			
	Energy conversion and force generation			
	Electromagnetic Actuators			
	Reluctance motors			
Content	Piezoelectric actuators, bi-metal-actuator			
	Transducer principles			
	Signal detection and signal processing			
	Mechanical and physical sensors			
	Acceleration sensor, pressure sensor			
	Sensor arrays			
	System integration			
	Yield, test and reliability			
	M. Kasper: Mikrosystementwurf, Springer (2000)			
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press (1997)			
1				

Course L0682: Micr	Course L0682: Microsystem Engineering		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Manfred Kasper		
Language	EN		
Cycle	WiSe		
	Examples of MEMS components		
	Layout consideration		
Content	Electric, thermal and mechanical behaviour		
	Design aspects		
Literature	Wird in der Veranstaltung bekannt gegeben		

Module M075	L: Vibration Theory
Courses	
Title Vibration Theory (L070	Typ Hrs/wk CP Integrated Lecture 4 6
Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	Linear Algebra
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	tnem furtner.
	Students are able to denote methods of Vibration Theory and develop them further.
Personal Competence	
Social Competence	Students can reach working results also in groups.
Autonomy	Students are able to approach individually research tasks in Vibration Theory.
	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	
the Following	Energy Systems: Core qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core qualification: Compulsory Naval Architecture and Ocean Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L0701: Vibr	ation Theory
Тур	Integrated Lecture
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	WiSe
	Linear and Nonlinear Single and Multiple Degree of Freedom Oscillations and Waves.
Literature	K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen. Springer Verlag, 2013.

Courses					
Title Finite Element Method	s (L0291)		Typ Lecture	Hrs/wk	CP 3
Finite Element Method	s (L0804)		Recitation (large)	Section 2	3
Module Responsible	Prof. Otto von Estorff				
Admission Requirements	None				
Recommended Previous Knowledge	Kinematics, Dynamics)				Hydrostatic
Educational Objectives	After taking part succe	ssfully, students	have reached	the following learn	ing results
Professional Competence					
Knowledge	The students possess element method and a basis of the method.	•		_	
Skills	The students are capa finite elements, assen resulting system of equ	nbling the corre			
Personal Competence					
Social Competence	Students can work in s	mall groups on s	pecific problem	is to arrive at joint	solutions.
	The students are able and develop own finite are critically scrutinized	element routine			
Autonomy					
Workload in Hours	Independent Study Tim	ne 124, Study Tir	ne in Lecture 5	6	
Credit points	6				
Course achievement	CompulsorBonus No 20 %	Form Midterm	D	escription	
Examination	Written exam				
Examination duration and scale					
	Civil Engineering: Core Energy Systems: Core Aircraft Systems Engine Aircraft Systems Engine	qualification: Ele eering: Specialis	ctive Compulso ation Aircraft S	ystems: Elective C	

Assignment for the Following Curricula	Mechatronics: Core qualification: Compulsory
--	--

Course L0291: Fini	Course L0291: Finite Element Methods			
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Otto von Estorff			
Language	EN			
Cycle	WiSe			
Content	 General overview on modern engineering Displacement method Hybrid formulation Isoparametric elements Numerical integration Solving systems of equations (statics, dynamics) Eigenvalue problems Non-linear systems Applications Programming of elements (Matlab, hands-on sessions) Applications 			
Literature	Bathe, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin			

Course L0804: Finite Element Methods		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Otto von Estorff	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Title			Тур	Hrs/wk	СР
Microsystems Technolo	ogy (L0724)		Lecture	2	4
Microsystems Technolo	ogy (L0725)		Project-/problem- based Learning	2	2
Module Responsible	Prof. Hoc Khiem Trieu				
Admission Requirements	None				
Recommended Previous Knowledge	Basics in physics, che	mistry, mechar	nics and semiconductor	technology	
Educational Objectives	I ATTER TAKING NATT SLICCE	essfully, studer	nts have reached the fo	llowing learr	ning results
Professional					
Competence	Students are able				
	 to present and to 	or the fabrication	ot fabrication techniques on of microsensors and omplex systems		
Knowledge	• to explain in def and	tails operation	principles of microsen	sors and mi	croactuato
	to discuss the pot	ential and limi	tation of microsystems	in applicatio	n.
	Students are capable				
	to analyze the fea	sibility of micr	osystems,		
	to develop proces	s flows for the	fabrication of microstru	uctures and	
Skills	to apply them.				
Personal Competence					
			perform their lab exper esults in front of audiend		eam work a
Autonomy	None				
Workload in Hours	Independent Study Tir	ne 124, Study	Time in Lecture 56		
Credit points					
	Compulsor ÿ onus	Form	Descri Studier	-	ühren i

Course achievement	Yes	None	Subject practical	theoretical work	and Laborpraktikum durch. Jede Gruppe präsentiert und diskutiert die Theorie sowie die Ergebniise ihrer Labortätigkeit. vor dem gesamten Kurs.
Examination	Oral exam				
Examination duration and scale	30 min				
Assignment for the Following Curricula	Technology: Electrical Er Internationa Compulsory Biomedical Elective Cor Biomedical Compulsory Biomedical Elective Cor Biomedical Elective Cor	Elective Congineering: Soll Managemering Engineering Engineering Engineering Engineering Engineering Engineering	mpulsory specialisate ent and Ent : Specialis g: Special g: Special : Special	cion Medical ngineering: S sation Artific disation Implisation Med sation Mana	Nanoelectronics and Microsystems Technology: Elective Compulsory Especialisation II. Mechatronics: Elective ial Organs and Regenerative Medicine: clants and Endoprostheses: Elective ical Technology and Control Theory: ingement and Business Administration: lification: Elective Compulsory

]	neroelectronics and therosystems, core qualification. Elective compaisor,			
Course L0724: Microsystems Technology				
Тур	Lecture			
Hrs/wk	2			
СР	4			
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28			
Lecturer	Prof. Hoc Khiem Trieu			
Language	EN			
Cycle	WiSe			
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano imprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD PECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching RIE, Bosch process, cryo process, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor Pt-100, spreading resistance sensor, pn junction, NTC and PTC; therma anemometer, mass flow sensor, photometry, radiometry, IR sensor thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) Magnetic Sensors (galvanomagnetic sensors: spinning current Hall senson and magneto-transistor; magnetoresistive sensors: magneto resistance, AMF and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: pellistor and therma 			

conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip)

- Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics)
- MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration)
- Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship)
- System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)

M. Madou: Fundamentals of Microfabrication, CRC Press, 2002

N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009

Literature

T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010

G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L0725: Microsystems Technology		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Hoc Khiem Trieu	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
echnology Manageme	ent (L0849)	Project-/problem- based Learning	3	3
echnology Manageme	ent Seminar (L0850)	Project-/problem- based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous Knowledge	Bachelor knowledge in business ma	anagement		
Educational Objectives	After taking part successfully, stud	ents have reached the fol	lowing learn	ing results
Professional Competence	Students will gain deep insights int	o:		
Knowledge	 International R&D-Managem Technology Timing Strategies Technology Strategies Technology Intelligence Technology Portfolio Manages Technology Portfolio Notation Technology Acquisition IP Management Organizing Technology Development Technology Organization Technology Funding & 	s s and Lifecycle Managemer ce and Planning ement Methodology n and Exploitation lopment ion & Management	ent (I/II)	
Skills	 Develop an understanding of the importance of Technology Management - or a national as well as international level Equip students with an understanding of important elements of Technology Management (strategic, operational, organizational and process-related aspects) Foster a strategic orientation to problem-solving within the innovation process as well as Technology Management and its importance for corporal strategy Clarify activities of Technology Management (e.g. technology sourcin maintenance and exploitation) Strengthen essential communication skills and a basic understanding managerial, organizational and financial issues concerning Technology Innovation- and R&D-management. Further topics to be discussed include: Basic concepts, models and tools, relevant to the management 			
Personal Competence	technology, R&D and innovaInnovation as a process (step			
Social Competence	Interact within a teamRaise awareness for globabl	iccuoc		

Autonomy	 Discuss recent research debates in the context of Technology and Innovation Management Develop presentation skills Discussion of international cases in R&D-Management
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	90 minutes
the Following	Global Innovation Management: Core qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory

Γ	
Course L0849: Tecl	nnology Management
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	The role of technology for the competitive advantage of the firm and industries; Basic concepts, models and tools for the management of technology; managerial decision making regarding the identification, selection and protection of technology (make or buy, keep or sell, current and future technologies). Theories, practical examples (cases), lectures, interactive sessions and group study. This lecture is part of the Module Technology Management and can not separately choosen.
Literature	Leiblein, M./Ziedonis, A.: Technology Strategy and Inoovation Management, Elgar Research Collection, Northhampton (MA) 2011

Course L0850: Tech	nnology Management Seminar
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Beside the written exam at the end of the module, students have to give one presentation (RE) on a research paper and two presentations as part of a group discussion (GD) in the seminar in order to pass. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.
Literature	see lecture Technology Management.

Courses				
Title Control Systems Theor		Typ Lecture Recitation	Hrs/wk 2 Section 2	CP 4
Control Systems Theor	ry and Design (L0657)	(small)	2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	INONE			
Recommended Previous Knowledge	Introduction to Control Systems			
Educational Objectives		nts have reached	the following lear	ning results
Professional Competence				
Knowledge	 Students can explain how lir space models; they can interest external excitation as trajected. They can explain the system their relationship to state fee They can explain the significated. They can explain observer-beachieve tracking and disturbed. They can extend all of the abeachieve tracking and the zetral transform. They can explain state space time systems. They can explain the experior systems, and how the iden normal equation. They can explain how a state of the control of t	erpret the system ories in state space properties control dback and state earce of a minimal ased state feedback and erejection ove to multi-input msform and its models and trans mental identification problem eate space model	n response to inite e illability and obsestimation, respect realisation ck and how it ca multi-output systelationship with fer function mode on of ARX model can be solved	ervability, and tively and the used to the Laplace and the Lap
Skills	 Students can transform transvice versa They can assess controllabrealisations They can design LQG controll They can carry out a control time domain, and decide white They can identify transfer dynamic systems from exper They can carry out all thes Control Toolbox, System Iden 	ility and observa ers for multivarial ler design both in th is appropriate function models imental data e tasks using sta	ability and const ole plants continuous-time for a given sampl and state spac	and discrete ing rate e models o
Personal Competence				
Social Competence	Students can work in small groups o	n specific problen	ns to arrive at joir	nt solutions.
	Students can obtain information f documentation, experiment guides)			

Autonomy	They can assess their knowledge in weekly on-line tests and thereby control their learning progress.
Workland in House	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
Examination	Written exam
Examination duration and scale	
Assignment for the Following Curricula	Electrical Engineering: Core qualification: Compulsory Energy Systems: Core qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Compulsory Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory Computational Science and Engineering: Specialisation II. Engineering Science: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Compulsory

Course L0656: Con	trol Systems Theory and Design
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	State space methods (single-input single-output) State space models and transfer functions, state feedback Coordinate basis, similarity transformations Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem Controllability and pole placement State estimation, observability, Kalman decomposition Observer-based state feedback control, reference tracking Transmission zeros Optimal pole placement, symmetric root locus Multi-input multi-output systems Transfer function matrices, state space models of multivariable systems, Gilbert realization Poles and zeros of multivariable systems, minimal realization Closed-loop stability Pole placement for multivariable systems, LQR design, Kalman filter Digital Control Discrete-time systems: difference equations and z-transform Discrete-time state space models, sampled data systems, poles and zeros Frequency response of sampled data systems, choice of sampling rate System identification and model order reduction Least squares estimation, ARX models, persistent excitation Identification of state space models, subspace identification Balanced realization and model order reduction Case study Modelling and multivariable control of a process evaporator using Matlab and Simullink Software tools
Literature	 Matlab/Simulink Werner, H., Lecture Notes "Control Systems Theory and Design" T. Kailath "Linear Systems", Prentice Hall, 1980 K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall 1997 L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999

Course L0657: Control Systems Theory and Design		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

	T	Hara foods	CD
(1.0932)			CP 2
nd Control (L0929)	Lecture	2	2
	Recitation	Section ₁	1
ia control (2000)		Soction	-
nterprise (L0933)	(small)	1	1
Prof. Hermann Lödding			
None			
	Quality Management	t	
After taking part successfully, stu	dents have reached	the following learn	ning results
Students can explain the contents to them.	s of the module in de	etail and take a crit	tical positio
Students are capable of choosing and applying models and methods from the			
Students can develop joint solution	ons in mixed teams a	and present them t	o others.
İ-			
Independent Study Time 96, Stud	y Time in Lecture 84	4	
6			
None			
Written exam			
180 Minuten			
International Management and E	ngineering: Speciali	sation II. Product D	Developme
		on Droduckie	المالمالم
	obility: Specialisation	on Production an	a Logistic
	ation Artificial Orga	ns and Regenerativ	ve Medicin
Elective Compulsory			=1
	lisation Implants a	and Endoprosthes	es: Electiv
	isation Medical Tec	hnology and Cont	trol Theor
Elective Compulsory			
Diomicalcal Engineering. Special	sation Management	and Business Ad	ministratio
	als and Product	tion: Specialisation	on Produ
Development: Elective Compulsor	Y	•	
	ls and Production	n: Specialisation	Productio
	and Production: Sn	ecialisation Materi	als: Flectiv
I btudilet i jeveluument iviateriais			
Product Development, Materials Compulsory	and Froduction. Sp	recidiffactori materi	ais. Liccti
	·		
	Prof. Hermann Lödding None Fundamentals of Production and General Students can explain the contents to them. Students are capable of choosis module to industrial problems. Students can develop joint solutions and General Students are capable of choosis module to industrial problems. Students can develop joint solutions and General Study Time 96, Students are capable of choosis module to industrial problems. Students can develop joint solutions are capable of choosis module to industrial problems. Students can develop joint solutions are capable of choosis module to industrial problems. Independent Study Time 96, Students are capable of compulsions and productions Elective Compuls Logistics, Infrastructure and Melective Compulsory Biomedical Engineering: Special Elective Compulsory Biomedical Engineering: Special Elective Compulsory Biomedical Engineering: Special Compulsory Product Development, Materia Compulsory Product Development, Materia Compulsory	Interprise (L093) Prof. Hermann Lödding None Fundamentals of Production and Quality Management and Engineering: Specialisation and Production: Elective Compulsory Biomedical Engineering: Specialisation Artificial Orga Biomedical Engineering: Specialisation Artonusory Product Development, Materials and Production Materials and Production Production Production Production Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory Product Development, Materials and Production Compulsory	After taking part successfully, students have reached the following learn to them. Students can explain the contents of the module in detail and take a crit to them. Students are capable of choosing and applying models and methomodule to industrial problems. Students can develop joint solutions in mixed teams and present them to landependent Study Time 96, Study Time in Lecture 84 Mone Written exam 180 Minuten International Management and Engineering: Specialisation II. Product Eand Production: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprosthes Compulsory Biomedical Engineering: Specialisation Medical Technology and Compellective Compulsory Biomedical Engineering: Specialisation Medical Technology and Compelective Compulsory Biomedical Engineering: Specialisation Medical Technology and Compulsory Biomedical Engineering: Specialisation Medical Technology and Compulsory Biomedical Engineering: Specialisation Medical Technology and Compulsory Biomedical Engineering: Specialisation Management and Business Ad Compulsory Product Development, Materials and Production: Specialisation Development: Elective Compulsory Product Development, Materials and Production: Specialisation Compulsory

Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0932: The	Digital Enterprise
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
	Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered.
Content	 Business Process Management and Data Modelling, Simulation Knowledge and Competence Management Process Management (PPC, Workflow Management) Computer Aided Planning (CAP) and NC-Programming Virtual Reality (VR) and Augmented Reality (AR) Computer Aided Quality Management (CAQ) Industry 4.0
Literature	Scheer, AW.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002 Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag. Berlin 3. Auflage 2006 Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004 Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007 Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006

Course L0929: Production Planning and Control		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Hermann Lödding	
Language	DE	
Cycle	WiSe	
Content	 Models of Production and Inventory Management Production Programme Planning and Lot Sizing Order and Capacity Scheduling Selected Strategies of PPC Manufacturing Control Production Controlling Supply Chain Management 	
Literature	 Vorlesungsskript Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002 	

Course L0930: Production Planning and Control		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Hermann Lödding	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0933: Exercise: The Digital Enterprise		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Axel Friedewald	
Language	DE	
Cycle		
Content	See interlocking course	
Literature	Siehe korrespondierende Vorlesung See interlocking course	

Module MU92.	1: Electronic Circuits for	месісаі Аррііс	cations	
Courses				
Title Electronic Circuits for I	Medical Applications (L0696)	Typ Lecture	Hrs/wk	CP 3
Electronic Circuits for I	Medical Applications (L1056)	Recitation S (small)	Section 1	2
Electronic Circuits for I	Medical Applications (L1408)	Practical Course	1	1
Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of electrical enginee	ring		
Educational Objectives	After taking part successfully, stude	ents have reached the	e following lear	ning results
Professional Competence				
Knowledge	 Students can explain the basic functionality of the information transfer by the central nervous system Students are able to explain the build-up of an action potential and it propagation along an axon Students can exemplify the communication between neurons and electroni devices Students can describe the special features of low-noise amplifiers for medical applications Students can explain the functions of prostheses, e. g. an artificial hand Students are able to discuss the potential and limitations of cochlea implant and artificial eyes 			
Skills	 Students can calculate the potential Students can give scenarios power signal acquisition. Students can develop the bl Students can define the buil eye. 	s for further improve	ment of low-no	oise and lov
Personal Competence				
Social Competence	 Students are trained to solv teams together with experts Students are able to recognifor assistance to the right tir Students can document their results in a way that others of 	with different professize their specific limit ne. ir work in a clear mar	sional backgrou ations, so that nner and comm	ind. they can as iunicate the
	 Students are able to realistic define actions for improvement Students can break down 	ents when necessary.		

Autonomy	 schedule their work in a realistic way. Students can handle the complex data structures of bioelectrical experiments without needing support. Students are able to act in a responsible manner in all cases and situations of experimental work. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
	CompulsorBonus Form Description		
Course achievement	res None practical work		
	No None Excercises		
Examination	Written exam		
Examination duration and scale	90 min		
_	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Microelectronics and Microsystems: Specialisation Microelectronics Complements: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory		

Course L0696: Electronic Circuits for Medical Applications			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Matthias Kuhl		
Language			
Cycle	WiSe		
Content	 Market for medical instruments Membrane potential, action potential, sodium-potassium pump Information transfer by the central nervous system Interface tissue - electrode Amplifiers for medical applications, analog-digital converters Examples for electronic implants Artificial eye, cochlea implant 		
Literature	Kim E. Barret, Susan M. Barman, Scott Boitano and Heddwen L. Brooks Ganong's Review of Medical Physiology, 24nd Edition, McGraw Hill Lange, 2010 Tier- und Humanphysiologie: Eine Einführung von Werner A. Müller (Author), Stephan Frings (Author), 657 p., 4. editions, Springer, 2009 Robert F. Schmidt (Editor), Hans-Georg Schaible (Editor) Neuro- und Sinnesphysiologie (Springer-Lehrbuch) (Paper back), 488 p., Springer, 2006, 5. Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springer, 4th ed., 616 p., 2007 Vorlesungen der Universität Heidelberg zur Tier- und Humanphysiologie: http://www.sinnesphysiologie.de/gruvo03/gruvoin.htm Internet: http://butler.cc.tut.fi/~malmivuo/bem/bembook/		

Course L1056: Elec	Course L1056: Electronic Circuits for Medical Applications		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Matthias Kuhl		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1408: Electronic Circuits for Medical Applications			
Тур	Practical Course		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Matthias Kuhl		
Language	EN		
Cycle	WiSe		
Content	 Market for medical instruments Membrane potential, action potential, sodium-potassium pump Information transfer by the central nervous system Interface tissue - electrode Amplifiers for medical applications, analog-digital converters Examples for electronic implants Artificial eye, cochlea implant 		
Literature	Kim E. Barret, Susan M. Barman, Scott Boitano and Heddwen L. Brooks Ganong's Review of Medical Physiology, 24nd Edition, McGraw Hill Lange, 2010 Tier- und Humanphysiologie: Eine Einführung von Werner A. Müller (Author), Stephan Frings (Author), 657 p., 4. editions, Springer, 2009 Robert F. Schmidt (Editor), Hans-Georg Schaible (Editor) Neuro- und Sinnesphysiologie (Springer-Lehrbuch) (Paper back), 488 p., Springer, 2006, 5. Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springer, 4th ed., 616 p., 2007 Vorlesungen der Universität Heidelberg zur Tier- und Humanphysiologie: http://www.sinnesphysiologie.de/gruvo03/gruvoin.htm Internet: http://butler.cc.tut.fi/~malmivuo/bem/bembook/		

Module M1150	D: Continuum Mechanics			
Courses				
Title Continuum Mechanics Continuum Mechanics		Typ Lecture Recitation	Hrs/wk 2 Section 2	CP 3
Module Responsible	Prof. Christian Cyron	(small)		
Admission Requirements				
Recommended Previous Knowledge	Basics of linear continuum mechanics a (forces and moments, stress, linear constitutive laws, strain energy).			
Educational Objectives	After taking part successfully, students h	ave reached t	he following learr	ning results
Professional Competence				
Knowledge	The students can explain the fundame behavior of materials.	ntal concepts	to calculate the	mechanical
Skills	The students can set up balance laws specific aspects, both in applied contexts			on theory to
Personal Competence Social Competence	The students are able to develop solutio form and to develop ideas further.	ns, to present	them to specialis	sts in written
Autonomy	The students are able to assess their independently and on their own iden continuum mechanics and acquire the kr	ntify and solv	ve problems in	
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 50	6	
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	45 min			
	Materials Science: Specialisation Modelin Mechanical Engineering and Manage Compulsory Mechatronics: Technical Complementary Biomedical Engineering: Specialisation A Elective Compulsory Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation	ement: Special Course: Elect artificial Organ Implants ar Medical Tech	alisation Materia ive Compulsory s and Regeneration and Endoprosthes anology and Conf	ve Medicine: es: Elective trol Theory:

Elective Compulsory Product Developmen Compulsory	t, Materials	and Product	tion: Core	qualification:	Elective
Theoretical Mechanic	al Engineerir	ng: Technical	Compleme	ntary Course:	Elective
Compulsory Theoretical Mechanica	l Engineering	: Core qualific	ation: Elect	ive Compulsory	,

Course L1533: Con	tinuum Mechanics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	 kinematics of undeformed and deformed bodies balance equations (balance of mass, balance of energy,) stress states material modelling
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Course L1534: Con	tinuum Mechanics Exercise
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	 kinematics of undeformed and deformed bodies balance equations (balance of mass, balance of energy,) stress states material modelling
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Module M115	L: Material Modeling			
Courses				
Title		Тур	Hrs/wk	СР
Material Modeling (L15	35)	Lecture	2	3
Material Modeling (L15	336)	Recitation (small)	Section 2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
	Basics of linear and nonlinear continu Mechanics II and Continuum Mechar nonlinear strain, free-body principle, energy)	nics (forces and	moments, stress	, linear and
Educational Objectives	After taking part successfully, student	s have reached	the following learn	ing results
Professional Competence				
Knowledge	The students can explain the fundame laws	entals of multidin	mensional consitut	tive material
Skills	The students can implement their or particular, the students can apply the science and evaluate the corresponding	eir knowledge to	various problems	
Personal Competence				
Social Competence	The students are able to develop sol develop ideas further.	utions, to prese	ent them to specia	alists and to
Autonomy	The students are able to assess the independently and on their own identi modeling and acquire the knowledge i	fy and solve pro	blems in the area	
Workload in Hours	Independent Study Time 124, Study T	ime in Lecture 5	6	
Credit points		c III Lecture 3	<u> </u>	
Course achievement				
Examination duration and scale				
Assignment for the Following Curricula	Materials Science: Specialisation Mode Mechanical Engineering and Mana Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Elective Compulsory	agement: Speci n Artificial Orgar ion Implants a on Medical Tech	alisation Materians and Regenerative and Endoprosthese and Conf	ve Medicine: es: Elective crol Theory:

Product Development, Materials and Production: Core qualification: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L1535: Material Modeling		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Christian Cyron	
Language	DE	
Cycle	WiSe	
Content	One of the most important questions when modeling mechanical systems in practice is how to model the behavior of the materials of their different components. In addition to simple isotropic elasticity in particular the following phenomena play key roles - anisotropy (material behavior depending on direction, e.g., in fiber-reinforced materials) - plasticity (permanent deformation due to one-time overload, e.g., in metal forming) - viscoelasticity (absorption of energy, e.g., in dampers) - creep (slow deformation under permanent load, e.g., in pipes) This lecture briefly introduces the theoretical foundations and mathematical modeling of the above phenomena. It is complemented by exercises where simple examples problems are solved by calculations and where the implementation of the content of the lecture in computer simulations is explained. It will also briefly discussed how important material parameters can be determined from experimental data.	
Literature		

Course L1536: Material Modeling	
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1199	9: Advanced Functiona	l Materials		
Courses				
Title Advanced Functional N	Materials (L1625)	Typ Seminar	Hrs/wk 2	CP 6
11000010101010	Prof. Patrick Huber			
Admission Requirements	None			
Recommended Previous Knowledge		ence, e.g. Materials Scie	nce I/II	
Educational Objectives	LATTER TAKING NART SLICCESSTILLIV STI	udents have reached the	following learn	ing results
Professional Competence				
Knowledge	The students will be able to explorations in technolousemiconductor, modern composi	ogy, in particular met	allic, ceramic,	polymeric
Skills	The students will be able to technical needs and, if necessary principles from the micro- to overview on modern materials materials combinations dependir	 to design new material the macroscale. The s science, which enables 	lls considering a tudents will a s them to sele	architectura Iso gain ar
Personal Competence				
Social Competence	The students are able to prese further.	ent solutions to special	ists and to de	velop ideas
Autonomy	The students are able to assess their own strengths gather new necessary exp			
Workload in Hours	Independent Study Time 152, St	udy Time in Lecture 28		
Credit points				
Course achievement	None			
Examination				
Examination duration and scale	30 min			
Assignment for the Following Curricula	Biomedical Engineering: Specia	Management: Specialist sation Artificial Organs a alisation Implants and lisation Medical Technolisation Management an	end Regenerative Endoprosthese Blogy and Cont d Business Adi	ve Medicine: es: Elective crol Theory: ministration:

Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L1625: Adv	anced Functional Materials
Тур	Seminar
Hrs/wk	2
СР	6
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	 Porous Solids - Preparation, Characterization and Functionalities Fluidics with nanoporous membranes Thermoplastic elastomers Optimization of polymer properties by nanoparticles Fiber composites in automotive Modeling of materials based on quantum mechanics Biomaterials
Literature	Aktuelle Publikationen aus der Fachliteratur werden während der Veranstaltung bekanntgegeben.

Module M127 Biology	9: MED II: Introduction	to Biochemistry	y and Molecula
Courses			
Title Introduction to Biocher	mistry and Molecular Biology (L0386)	Typ Lecture	Hrs/wk CP 2 3
Module Responsible	Prof. Hans-Jürgen Kreienkamp		
Admission Requirements	INONE		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully, studer	nts have reached the fo	llowing learning results
Professional Competence	The students can		
Knowledge	explain now genetic informati explain the connection between		
Skills	 The students can recognize the importance of disease; describe selected moleculared explain the relevance of these 	iagnostic procedures;	
Personal			
Competence	: :		
Social Competence	The students can participate in discillevel.	ussions in research and	medicine on a technic
Autonomy	The students can develop understar literature, by themselves.	nding of topics from the	e course, using technic
Workload in Hours	Independent Study Time 62, Study T	ime in Lecture 28	
Credit points			
Course achievement	None		
	Written exam		
Examination duration and scale	60 minutes		
	General Engineering Science (Ge Biomedical Engineering: Compulsory General Engineering Science (Ge Mechanical Engineering, Focus Biom Data Science: Specialisation Medicin Electrical Engineering: Specialisation Engineering Science: Specialisation I General Engineering Science (Er Biomedical Engineering: Compulsory	erman program, 7 se echanics: Compulsory e: Compulsory n Medical Technology: E Biomedical Engineering nglish program, 7 se	emester): Specialisation lective Compulsory : Compulsory emester): Specialisation
the Following	General Engineering Science (En Mechanical Engineering, Focus Biom Mechanical Engineering: Specialisati	echanics: Compulsory	

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0386: Introduction to Biochemistry and Molecular Biology		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Hans-Jürgen Kreienkamp	
Language	DE	
Cycle	WiSe	
Content		
	Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage	
	Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008	
Literature		

Module M1333	3: BIO I: Implants and	d Fracture Healing	
Courses			
Title Implants and Fracture	Healing (L0376)	Typ Lecture	Hrs/wk CP 2 3
	Prof. Michael Morlock		
Admission Requirements	None		
	It is recommended to particip "Implants and Fracture Healing		natomie" before attending
Educational Objectives	After taking part successfully,	students have reached the f	following learning results
Professional Competence			
Knowledge	The students can describe the for their existence. The students can name differ given fracture morphologies.	-	•
Skills	The students can determine t static situations under specific		human body under quasi-
Personal Competence			
Social Competence	The students can, in group calculation of internal forces.	os, solve basic numerical	modeling tasks for the
Autonomy	The students can, in group calculation of internal forces.	os, solve basic numerical	modeling tasks for the
Workload in Hours	Independent Study Time 62, S	itudy Time in Lecture 28	
Credit points			
Course achievement			
	Written exam		
Examination duration and scale	90 min		
	General Engineering Science Mechanical Engineering, Focus General Engineering Science Biomedical Engineering: Comp Engineering Science: Specialis General Engineering Science Biomedical Engineering: Comp General Engineering: Comp General Engineering Science Mechanical Engineering, Focus Mechanical Engineering: Spec Biomedical Engineering: Spec Elective Compulsory Biomedical Engineering: Spec Compulsory Biomedical Engineering: Spec Elective Compulsory Biomedical Engineering: Spec Elective Compulsory Biomedical Engineering: Spec Elective Compulsory	s Biomechanics: Compulsory e (German program, 7 solulsory sation Biomedical Engineering e (English program, 7 solulsory e (English program, 7 solulsory e (English program, 7 solulsory is Biomechanics: Compulsory ialisation Biomechanics: Compulsory ialisation Artificial Organs are ecialisation Implants and cialisation Medical Technology	semester): Specialisation g: Compulsory semester): Specialisation semester): Specialisation npulsory nd Regenerative Medicine: Endoprostheses: Elective ogy and Control Theory:

Orientierungsstudium: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0376: Imp	lants and Fracture Healing
Тур	Lecture
Hrs/wk	2
СР	
	Independent Study Time 62, Study Time in Lecture 28
Lecturer Language	Prof. Michael Morlock
Cycle	
	Topics to be covered include:
	Introduction (history, definitions, background importance)
	2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)
	3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)
	3.1 The spine in its entirety
	3.2 Cervical spine
	3.3 Thoracic spine
	3.4 Lumbar spine
	3.5 Injuries and diseases
Content	4. Pelvis (anatomy, biomechanics, fracture treatment)
Content	5 Fracture Healing
	5.1 Basics and biology of fracture repair
	5.2 Clinical principals and terminology of fracture treatment
	5.3 Biomechanics of fracture treatment
	5.3.1 Screws
	5.3.2 Plates
	5.3.3 Nails
	5.3.4 External fixation devices
	5.3.5 Spine implants
	6.0 New Implants
	Cochran V.B.: Orthopädische Biomechanik
	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine
	Nigg, B.: Biomechanics of the musculo-skeletal system
Literature	Schiebler T.H., Schmidt W.: Anatomie
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat

Module M1334	1: BIO II: Biomaterials
Courses	
Title Biomaterials (L0593)	TypHrs/wkCPLecture23
Module Responsible	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of orthopedic and surgical techniques is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can describe the materials of the human body and the materials being used in medical engineering, and their fields of use.
Skills	The students can explain the advantages and disadvantages of different kinds of biomaterials.
Personal Competence	
Social Competence	The students are able to discuss issues related to materials being present or being used for replacements with student mates and the teachers.
Autonomy	The students are able to acquire information on their own. They can also judge the information with respect to its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0593: Bior	naterials
Тур	Lecture
Hrs/wk	2

Workload III Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	
Cycle	WiSe Topics to be covered include:
	, , , , , , , , , , , , , , , , , , , ,
	.
	2.1 Basics (components, testing methods)
	2.2 Bone (composition, development, properties, influencing factors)
	2.3 Cartilage (composition, development, structure, properties, influencing factors
	2.4 Fluids (blood, synovial fluid)
	3 Biological structures
	3.1 Menisci of the knee joint
	3.2 Intervertebral discs
	3.3 Teeth
	3.4 Ligaments
Content	3.5 Tendons
Content	3.0 3KIII
	3.7 Nervs
	3.8 Muscles
	4. Replacement materials
	4.1 Basics (history, requirements, norms)
	4.2 Steel (alloys, properties, reaction of the body)
	4.3 Titan (alloys, properties, reaction of the body)
	4.4 Ceramics and glas (properties, reaction of the body)
	4.5 Plastics (properties of PMMA, HDPE, PET, reaction of the body)
	4.6 Natural replacement materials
	Knowledge of composition, structure, properties, function and changes/adaptation of biological and technical materials (which are used for replacements in-vivo Acquisition of basics for theses work in the area of biomechanics.
	Hastings G and Ducheyne P.: Natural and living biomaterials. Boca Raton: CROPress, 1984.
	Williams D.: Definitions in biomaterials. Oxford: Elsevier, 1987.
	Hastings G.: Mechanical properties of biomaterials: proceedings held at Kee University, September 1978. New York: Wiley, 1998.
Literature	Black J.: Orthopaedic biomaterials in research and practice. New York: Church Livingstone, 1988.

Wintermantel, E. und Ha, SW : Biokompatible Werkstoffe und Bauweisen. Berli Springer, 1996.	١,

Courses				
•	es of Polymers (L0389) with polymers (L1892)	Typ Lecture Lecture	Hrs/wk 2 2	CP 3 3
Module Responsible	Dr. Hans Wittich			
Admission Requirements	None			
Recommended Previous Knowledge	Basics: chemistry / physics / mater	ial science		
Educational Objectives	After taking part successfully, stud	lents have reached th	e following learr	ning results
Professional Competence	Students can use the knowledge analysis.	of plastics and defin	e the necessary	testing an
Knowledge	They can explain the complex rela the interactions of chemical st neighboring contexts (e.g. sustain	ructure of the poly	mers, including	
Skills	Students are capable of - using standardized calculation methods in a given context to mechan properties (modulus, strength) to calculate and evaluate the different materials. - selecting appropriate solutions for mechanical recycling problems and si example stiffness, corrosion resistance.			aterials.
Personal Competence				
Social Competence	 - arrive at funded work results in h - provide appropriate feedback a constructively. 			
Autonomy	Students are able to - assess their own strengths and w - assess their own state of learn steps on this basis assess possible consequences of	ing in specific terms		further woi
	Independent Study Time 124, Stud	ly Time in Lecture 56		
Credit points Course achievement	6 None			
Examination	Written exam			
Examination duration and				

scale	
Assignment for the Following Curricula	Materials Science: Specialisation Engineering Materials: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L0389: Structure and Properties of Polymers			
Тур	Typ Lecture		
Hrs/wk	Hrs/wk 2		
СР	CP 3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Hans Wittich		
Language	DE		
Cycle	WiSe		
	- Structure and properties of polymers		
	- Structure of macromolecules		
	Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution		
	- Morphology		
	amorph, crystalline, blends		
Content	- Properties		
	Elasticity, plasticity, viscoelacity		
	- Thermal properties		
	- Electrical properties		
	- Theoretical modelling		
	- Applications		
Literature	Literature Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag		

Course L1892: Prod	Course L1892: Processing and design with polymers		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bodo Fiedler, Dr. Hans Wittich		
Language	DE/EN		
Cycle WiSe			
Content	Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining Designing with Polymers: Materials Selection; Structural Design; Dimensioning		
Literature	Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag Crawford: Plastics engineering, Pergamon Press Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag Konstruieren mit Kunststoffen, Gunter Erhard, Hanser Verlag		

Module M0632	2: Regenerative	e Medicine			
Courses					
Title Regenerative Medicine Lecture Tissue Enginee	e (L0347) ering - Regenerative Med	licine (L1664)	Typ Seminar Seminar	Hrs/wk 2 2	CP 3 3
Module Responsible	Prof. Ralf Pörtner				
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part succe	essfully, students h	nave reached the f	following learn	ing results
Professional Competence					
Knowledge	The students can regenerative medicin discussed topics.	enerative medicine tissue engineering vation of animal and outline the actua ie and can expla	and to explain the . They are able to d human cells. al concepts of in the basic udn	e use of the tis give a basic Tissue Engin	ssue cells for overview of eering and
Skills	 After successful completion of the module students are able to use medical databases for acquirierung and presentation of relevant up-to-date data independently able to present their work results in the form of presentations able to carry out basic cell culture methods and the corresponding analysis independently able to analyse and evaluate current research topics for Tissue Engineering and regenerative medicine. 				
Personal Competence Social Competence	Students are able to wand discuss their resustudents are able to reachers.	Its in the plenary a	nd to defend then	n.	
Autonomy	After completion of a problem in teams of a the results.	approx. 2-4 person	s independently i		
	Independent Study Tir	ne 124, Study IIM	e in Lecture 56		
Credit points		F			
Course achievement	Yes 20 %	Form Written elaborat	ion Ausar	ription beitung zu Rir ocol for lecture	
Examination	Presentation				

Examination duration and scale	Oral presentation + discussion (30 min)
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory

Course L0347: Regenerative Medicine			
Тур	Seminar		
Hrs/wk	Hrs/wk 2		
CP 3			
Workload in Hours Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Ralf Pörtner, Dr. Frank Feyerabend		
Language	DE		
Cycle	WiSe		
Content	The course deals with the application of biotechnological engineering principles for re-generation of human tissues. The main topics are "tissue engineering" for the generation of "artificial organs" such as cartilage, liver, blood vessel etc., and their applications: • Introduction (historical development, examples for medical and technical applications, commercial aspets) • Cell specific fundamentals (cell physiology, biochemistry, metabolism, special requirements for cell cultivation "in vitro") • Process specific fundamentals (requirements for culture systems, examples for reactor design, mathematical modelling, process and control strategies) • Examples for applications for clinical applications, drug testing and material testing The fundamentals will be presented by the lecturers. The "state of the art" of specific applications will be exploited by the students based on selected papers and presented during the course.		
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Academic Pr Inc; ISBN-10: 0123693713, ISBN-13: 978-0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-3540777540		

Course L1664: Lecture Tissue Engineering - Regenerative Medicine			
Тур	Seminar		
Hrs/wk	/k 2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Ralf Pörtner, Prof. Michael Morlock		
Language	DE		
Cycle WiSe			
Content	Discussion of current research topics for tissue engineering and regenerative medicine by invited experts		
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Academic Pr Inc; ISBN-10: 0123693713, ISBN-13: 978-0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-3540777540		

Module M0630: Robotics and Navigation in Medicine					
_					
Courses					
Title Robotics and Navigation	on in Modicino (LO225)		Typ Lecture	Hrs/wk 2	CP 3
Robotics and Navigation			Project Seminar	2	2
_	on in Medicine (L0336)		Recitation Section (small)	ⁿ 1	1
Module Responsible	IPINI DIEVANNEI SCHIAE	efer			
Admission Requirements	None				
Recommended Previous Knowledge	 principles of pro 	ath (algebra, analys ogramming, e.g., in b skills			
Educational Objectives	After taking part succe	essfully, students h	ave reached the follo	owing learn	ing results
Professional					
Competence	<u> </u>				
Knowledge	The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.				
Skills	The students are able to design and evaluate navigation systems and robotic systems for medical applications.				
Personal Competence					
Social Competence	The students discuss incoorporate feedback		r groups, provide he	lpful feedb	ack and car
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.				
Workload in Hours	Independent Study Tir	ne 110, Study Time	e in Lecture 70		
Credit points	6				
Course achievement	CompulsorBonus Yes 10 % Yes 10 %	Form Written elaborati Presentation	Descrip on	tion	
Examination	n Written exam				
Examination duration and scale					
	Computer Science: Sp Electrical Engineering: International Manager Elective Compulsory International Manager and Biotechnology: Ele Mechatronics: Special Biomedical Engineerin Elective Compulsory Biomedical Engineeri	Specialisation Med ment and Engineeri ment and Engineer ective Compulsory sation Intelligent S ig: Specialisation A	dical Technology: Ele ng: Specialisation II. ring: Specialisation I ystems and Robotics rtificial Organs and I	ctive Comp Electrical I II. Process s: Elective C Regenerativ	oulsory Engineering Engineering Compulsory ve Medicine

the Following	Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
Curricula	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory Product Development, Materials and Production: Specialisation Product
	Development: Elective Compulsory
	Product Development, Materials and Production: Specialisation Production: Elective
	Compulsory
	Product Development, Materials and Production: Specialisation Materials: Elective
	Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0335: Robotics and Navigation in Medicine		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	SoSe	
Content	 kinematics calibration tracking systems navigation and image guidance motion compensation The seminar extends and complements the contents of the lecture with respect to recent research results. 	
Literature	Spong et al.: Robot Modeling and Control, 2005 Troccaz: Medical Robotics, 2012 Further literature will be given in the lecture.	

Course L0338: Robotics and Navigation in Medicine			
Тур	Project Seminar		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Alexander Schlaefer		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0336: Robotics and Navigation in Medicine			
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Alexander Schlaefer		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M138 Engineering	4: Case Studies for Rege	nerative Me	dicine and	d Tissue
Courses				
Title		Тур	Hrs/wk	СР
Case Studies for Reger (L1963)	nerative Medicine and Tissue Engineering	Seminar	3	6
Module Responsible	Prof. Ralf Pörtner			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students	have reached the	following learn	ning results
Professional Competence Knowledge Skills				
Personal Competence Social Competence				
Autonomy				
Workload in Hours Credit points	Independent Study Time 138, Study Tir	ne in Lecture 42		
Course achievement	None			
Examination	Presentation			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Elective Compulsory	n Implants and Management and	Endoprosthes d Business Ad	es: Elective

Course L1963: Case	Course L1963: Case Studies for Regenerative Medicine and Tissue Engineering			
Тур	Seminar			
Hrs/wk	3			
СР	6			
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42			
Lecturer	Prof. Ralf Pörtner, Prof. Michael Morlock			
Language	DE			
Cycle	SoSe			
Content				
Literature				

Module M0634	4: Introduction i	into Medical	Technology an	d Syst	ems	
Courses						
Courses			_	, .		
Title Introduction into Medical Technology and Systems (L0342) Introduction into Medical Technology and Systems (L0343)			Typ Lecture Project Seminar	Hrs/wk 2 2	CP 3 2	
Introduction into Medic	cal Technology and Syster	ms (L1876)	Recitation Section (large)	1	1	
Module Responsible	Prof. Alexander Schlae	fer				
Admission Requirements	None					
Recommended Previous Knowledge	principles of math (alg principles of stochasti principles of programm	CS	ulus)			
Educational Objectives	After taking part succe	essfully, students h	ave reached the follow	wing learn	ing results	
Professional Competence						
Knowledge	systems, computer aid	The students can explain principles of medical technology, including imaging systems, computer aided surgery, and medical information systems. They are able to give an overview of regulatory affairs and standards in medical technology.				
Skills	The students are able to evaluate systems and medical devices in the context of clinical applications.					
Personal Competence						
Social Competence	The students describe a problem in medical technology as a project, and define tasks that are solved in a joint effort.					
Autonomy		The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.				
Workload in Hours	Independent Study Tin	ne 110, Study Time	e in Lecture 70			
Credit points	6					
Course achievement	CompulsorBonus Yes 10 % Yes 10 %	Form Written elaborati Presentation	Descript ion	ion		
Examination	Written exam					
Examination duration and scale						
Assignment for the Following	General Engineering Biomedical Engineering Computer Science: Sp Compulsory Computer Science: Sp Compulsory Data Science: Core qua Electrical Engineering: Engineering Science: S General Engineering Biomedical Engineering Computational Science Engineering Science: E	g: Compulsory pecialisation Comp ecialisation II. Math alification: Elective Core qualification: specialisation Biom Science (English g: Compulsory ce and Enginee	couter and Software nematics and Engineer Compulsory Elective Compulsory edical Engineering: Compulsory program, 7 semi	Engineering Scienompulsoryester): Sp	ng: Elective nce: Elective necialisation	
<u> </u>	1					

Curricula	Computational Science and Engineering: Specialisation Computer Science: Elective
	Compulsory
	Computational Science and Engineering: Specialisation Engineering Sciences:
	Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
	Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
	Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
	Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0342: Introduction into Medical Technology and Systems			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Alexander Schlaefer		
Language	DE		
Cycle	SoSe		
Content	 imaging systems computer aided surgery medical sensor systems medical information systems regulatory affairs standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning. 		
Literature	Wird in der Veranstaltung bekannt gegeben.		

Course L0343: Introduction into Medical Technology and Systems			
Тур	Project Seminar		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Alexander Schlaefer		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1876: Intro	oduction into Medical Technology and Systems
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	 imaging systems computer aided surgery medical sensor systems medical information systems regulatory affairs standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Wird in der Veranstaltung bekannt gegeben.

Module M0752	2: Nonlinear Dynamics
Courses	
Title Nonlinear Dynamics (L	Typ Hrs/wk CP 0702) Integrated Lecture 4 6
Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	Linear Algebra
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	to develop and research new terms and concepts.
Skills	Students are able to apply existing methods and procesures of Nonlinear Dynamics and to develop novel methods and procedures.
Personal Competence	
Social Competence	Students can reach working results also in groups.
Autonomy	Students are able to approach given research tasks individually and to identify and follow up novel research tasks by themselves.
	Independent Study Time 124, Study Time in Lecture 56
Credit points Course	
achievement	None
Examination	Written exam
Examination duration and scale	2 Hours
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L0702: Nonlinear Dynamics			
Тур	Integrated Lecture		
Hrs/wk	4		
СР	6		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Norbert Hoffmann		
Language	DE/EN		
Cycle	SoSe		
Content	Fundamentals of Nonlinear Dynamics.		
Literature	S. Strogatz: Nonlinear Dynamics and Chaos. Perseus, 2013.		

Module M076	1: Semiconductor	Technology			
Courses					
Title Semiconductor Technologemiconductor Te	= -	Ty p Lect Prac		Hrs/wk 4 2	CP 4 2
Module Responsible	Prof. Hoc Khiem Trieu				
Admission Requirements	LNIONA				
Recommended Previous Knowledge	Basics in physics, chemist	ry, material science	e and semicond	ductor device	2S
Educational Objectives	TATTOL LAKING NALL CHICCOCCI	ully, students have	reached the fo	llowing learn	ing results
Professional Competence					
Knowledge	Students are able to describe and to substrates, to discuss in details impact thereof on the fakand to present integrated	the relevant fabrica	ation processe	s, process fl	ows and the
Skills	Students are capable to analyze the impact to select and to evalu to develop process flo	ate processes and	·	_	
Personal Competence					
Social Competence	Students are able to prepresent and disc				am work a
Autonomy	None				
	Independent Study Time 9	96, Study Time in Le	ecture 84		
Credit points					
Course achievement	None				
Examination	ļ-				
Examination					

duration and											
scale											
	Electrical Engineering: Specialisation Nanoelectronics and Microsystems										
	echnology: Elective Compulsory										
	omedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:										
	Elective Compulsory										
Assignment for	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective										
the Following											
	Biomedical Engineering: Specialisation Medical Technology and Control Theory:										
	Elective Compulsory										
	Biomedical Engineering: Specialisation Management and Business Administration:										
	Elective Compulsory										
	Microelectronics and Microsystems: Core qualification: Elective Compulsory										

	There electronics and Theresystems, core qualification, Elective compaisory								
Course L0722: Sem	niconductor Technology								
	Lecture								
Hrs/wk									
СР									
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56								
	Prof. Hoc Khiem Trieu								
Language									
Cycle									
	 Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski, Bridgeman and float zone process) Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping profile, higher order effects and 								
Content	 process technology, ion implantation: theory, implantation profile, channeling, implantation damage, annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions, kinetics, influences on growth rate, process technology and equipment, anodic oxidation, plasma oxidation, thermal oxidation of GaAs) Deposition techniques (theory: nucleation, film growth and structure zone model, film growth process, reaction kinetics, temperature dependence and equipment; epitaxy; gas phase, liquid phase, molecular beam epitaxy; CVD 								
	 Structuring techniques (subtractive methods, photolithography: resist properties, printing techniques: contact, proximity and projection printing, resolution limit, practical issues and equipment, additive methods: liftoff technique and electroplating, improving resolution: excimer laser light source, immersion lithography and phase shift lithography, electron beam lithography, X-ray lithography, EUV lithography, ion beam lithography, wet chemical etching: isotropic and anisotropic, corner undercutting, compensation masks and etch stop techniques; dry etching: plasma enhanced etching, backsputtering, ion milling, chemical dry etching, RIE, sidewall passivation) Process integration (CMOS process, bipolar process) 								
	 Assembly and packaging technology (hierarchy of integration, packages, chip-on-board, chip assembly, electrical contact: wire bonding, TAB and flip 								

	chip, wafer level package, 3D stacking)
	S.K. Ghandi: VLSI Fabrication principles - Silicon and Gallium Arsenide, John Wiley & Sons
	S.M. Sze: Semiconductor Devices - Physics and Technology, John Wiley & Sons
	U. Hilleringmann: Silizium-Halbleitertechnologie, Teubner Verlag
Literature	H. Beneking: Halbleitertechnologie - Eine Einführung in die Prozeßtechnik von Silizium und III-V-Verbindungen, Teubner Verlag
	K. Schade: Mikroelektroniktechnologie, Verlag Technik Berlin
	S. Campbell: The Science and Engineering of Microelectronic Fabrication, Oxford University Press
	P. van Zant: Microchip Fabrication - A Practical Guide to Semiconductor Processing, McGraw-Hill

Course L0723: Semiconductor Technology					
Тур	Practical Course				
Hrs/wk	2				
СР	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Lecturer	Prof. Hoc Khiem Trieu				
Language	DE/EN				
Cycle	SoSe				
Content	See interlocking course				
Literature	See interlocking course				

Module M0835	5: Hu	ımano	id Robe	otics					
Courses									
Title Humanoid Robotics (LC)663)					Typ Seminar		Hrs/wk 2	CP 2
Module Responsible	Patricl	k Göttsch							
Admission Requirements	None								
Recommended Previous Knowledge			tion to cor heory and						
Educational Objectives	After t	taking pa	rt success	sfully, stu	udents ha	ave reached tl	he follo	wing learn	ing results
Professional Competence									
Knowledge						oots. ol concepts fo	or differ	ent tasks i	n humanoid
Skills	 Students acquire knowledge about selected aspects of humanoid robotics, based on specified literature Students generalize developed results and present them to the participants Students practice to prepare and give a presentation 								
Personal Competence									
Social Competence		present to	them	provid	ie appro	ng solutions ir			
Autonomy		presenta Students	ation for sp familiariz ow presen	pecific ta ze thems	asks and selves wi	and drawba select the bes th a scientific students, suc	st soluti field, a	ion are able of	introduce it
Workload in Hours		endent St	udy Time	32, Stu	dy Time i	n Lecture 28			
Credit points									
Course achievement		-b-b!							
Examination Examination duration and scale									
	Mecha Biome Electiv	atronics: S edical Eng ve Compu edical En	Specialisat gineering: ulsory	tion Syst Speciali	tem Desi isation Ar	stems and Rogn: Elective C tificial Organs Implants an	ompuls and R	ory egenerativ	ve Medicine:

Assignment for	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
the Following	Elective Compulsory
Curricula	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective
	Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science:
	Elective Compulsory

Course L0663: Hun	nanoid Robotics
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Patrick Göttsch
Language	DE
Cycle	SoSe
Content	 Grundlagen der Regelungstechnik Control systems theory and design
Literature	- B. Siciliano, O. Khatib. "Handbook of Robotics. Part A: Robotics Foundations", Springer (2008).

Module M083	8: Linear and Nonline	ar System Identifi	kation				
Courses							
Title Linear and Nonlinear S	System Identification (L0660)	Typ Lecture	Hrs/wk CP 2 3				
Module Responsible	Prof. Herbert Werner						
Admission Requirements	LNIONA						
Recommended Previous Knowledge	 Discrete-time systems 	value decomposition					
Educational Objectives	LATTER TAKING NART CHCCECCTIIIIV	students have reached the	following learning results				
Professional Competence							
Knowledge	 Students can explain the general framework of the prediction error method and its application to a variety of linear and nonlinear model structures They can explain how multilayer perceptron networks are used to model nonlinear dynamics They can explain how an approximate predictive control scheme can be based on neural network models They can explain the idea of subspace identification and its relation to Kalmar realisation theory 						
Skills	experimental identification systems They are capable of interest based on a neural network They are capable of a identification of linear management.	tion of linear and nonlinear ork model applying subspace algorith odels for dynamic systems using standard software	tion error method to the near models for dynamic predictive control scheme thms to the experimental stools (including the Matlab				
Personal Competence							
Social Competence	Students can work in mixed gro	oups on specific problems	to arrive at joint solutions.				
Autonomy	Students are able to find requirerature, software documenta						
Workload in Hours	Independent Study Time 62, St	cudy Time in Lecture 28					
Credit points	3						
Course achievement	LNODE						
Examination	Oral exam						
Examination duration and scale	30 min						
	Electrical Engineering: Special Elective Compulsory Mechatronics: Specialisation In		-				

	Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory								
Assignment for	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective								
the Following									
Curricula	Biomedical Engineering: Specialisation Medical Technology and Control Theory:								
	Compulsory								
	Biomedical Engineering: Specialisation Management and Business Administration:								
	Elective Compulsory								
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective								
	Compulsory								
	Theoretical Mechanical Engineering: Core qualification: Elective Compulsory								

Course L0660: Line	ear and Nonlinear System Identification
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	 Prediction error method Linear and nonlinear model structures Nonlinear model structure based on multilayer perceptron network Approximate predictive control based on multilayer perceptron network model Subspace identification
Literature	 Lennart Ljung, System Identification - Theory for the User, Prentice Hall 1999 M. Norgaard, O. Ravn, N.K. Poulsen and L.K. Hansen, Neural Networks for Modeling and Control of Dynamic Systems, Springer Verlag, London 2003 T. Kailath, A.H. Sayed and B. Hassibi, Linear Estimation, Prentice Hall 2000

Courses										
Title Optimal and Robust Co Optimal and Robust Co						Typ Lecture Recitat		Sectio	Hrs/wk 2	CP 3
		L0039)				(small)				
Module Responsible	PIOI. I	Herbert W	Verner							
Admission Requirements	None									
Recommended Previous Knowledge	•	Classica State sp Linear a	ace met	hods				5)		
Educational Objectives	After	taking pa	rt succes	ssfully,	students	have rea	ached t	he follo	wing learr	ing results
Professional Competence										
Knowledge	•	solution They ca state es They ca stability They ca case of a They ca lends its They ca can gua They ur	of LQ prin explain explain and perin explain an H2 de an explain explain explain explain explain explain explain explain explain rantee sinderstand	oblems in the c in how formand n how a esign pro in how bust cor n how - tability a d how a	the H2 ce construction LQG coblem. model untroller coand perfanalysis	etween of and H-in raints. design pr ncertaint lesign n the sma ormance	optima finity oblem y can all gair for an thesis	state norms can be be repr theore uncerta condition	feedback are used formulate resented in am - a robusin plant.	ation for the and optime to represe to as special as way the list controlled the desired to the controlled the controlled the desired to a second to the controlled the con
Skills	•	multivar They ar form of it. They are control carrying They are system, They are matrix in They ca	riable plate capable capable loops in out a me capable and of decapable capable ant mod le of re alized p e of trai ito cons ixed-se e of con lesignin le of for es (LMI) out all	els. presenti lant, and nslating straints nsitivity nstructin g a mixe rmulatin l, and of	ng a H2 d of using time and on closed design. g an LFT d-objecti g analysis	or H-i g stand freque d-loop uncer ve rob s and ndard	nfinity lard sof ency do sensiti tainty r ust con synthes LMI-sol	design pro tware tool main spec vity functi model for a troller. sis condition vers for so	ntrollers for solving ifications of one, and one one one one one of the one o	
Personal Competence										
Social Competence				_	-				-	
Autonomy	literat								rovided (le problems.	cture note

Course L0658: Opti	mal and Robust Control		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	dependent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Herbert Werner		
Language	EN		
Cycle	SoSe		
Content	 Optimal regulator problem with finite time horizon, Riccati differential equation Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system Kalman's identity, phase margin of LQR controllers, spectral factorization Optimal state estimation, Kalman filter, LQG control Generalized plant, review of LQG control Signal and system norms, computing H2 and H∞ norms Singular value plots, input and output directions Mixed sensitivity design, H∞ loop shaping, choice of weighting filters Case study: design example flight control Linear matrix inequalities, design specifications as LMI constraints (H2, H∞ and pole region) Controller synthesis by solving LMI problems, multi-objective design Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty 		
Literature	 Werner, H., Lecture Notes: "Optimale und Robuste Regelung" Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 Skogestad, S. and I. Postlewhaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998 		

Course L0659: Optimal and Robust Control		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title Marketing of Innovations (L2009)		Typ Lecture Project-/problem-	Hrs/wk	CP 4
BL Marketing of Innov	ations (LU862)	based Learning	1	2
	Prof. Christian Lüthje			
Admission Requirements	None			
Recommended Previous Knowledge	 Module International Busin Basic understanding of busin decision theory, project material business of the important	siness administration princ anagement, international b Knowledge (Marketing In sics of Buying Behavior) ces beweetn B2B and B2C r ortance of managing innov	ousiness) astruments, marketing	Market an
Educational Objectives	After taking part successfully, stu	idents have reached the fo	llowing learr	ing results
Professional Competence	Students will have gained a deep	o understanding of		
Knowledge	 Specific characteristics in the specific characteristics in the specific characteristics in the specific characteristics. Approaches for analyzing development. The gathering of information concepts and approaches product and service development. Approaches and tools for of new products and innov. Marketing mix elements requirements and challeng. Pricing methods for new products and complete communication concepts and concepts are communication. 	on about future customer rest to integrate lead user opment processes ensuring customer-oriental stive services is that take into considers of innovative products aroducts and services ex sales forces and personal	on and the function and their tion in the disideration to the following	uture marke quirements needs in levelopmer the specif
Skills	 Design and to evaluate strategies Analyze markets by applyi Conduct forecasts and deplanning Translate customer needs and successfully apply adviservice development Use adequate methods to services Choose suitable pricing innovations Make strategic sales decisales channels) Apply methods of sales for 	decisions regarding many market and technology velop compelling scenarios into concepts, prototypes vanced methods for custon foster efficient diffusion of strategies and communications for products and second	portfolios s as a basis s and marke ner-oriented innovative punication are ervices (i.e.	for strateg stable offer product an products an ctivities for selection
	- Apply Hichidas Of Saics IOI	a management (n.c. cubic	c. value a	,

Competence					
	The students will be able to				
Social Competence	 have fruitful discussions and exchange arguments develop original results in a group present results in a clear and concise way carry out respectful team work 				
Autonomy	 Acquire knowledge independently in the specific context and to map this knowledge on other new complex problem fields. Consider proposed business actions in the field of marketing and reflect on them. 				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points					
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and scale	Written elaboration, excercises, presentation, oral participation				
Assignment for the Following Curricula	Elective Compulsory				

Course L2009: Mar	keting of Innovations
Тур	Lecture
Hrs/wk	4
СР	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	SoSe
	I. Introduction
	 Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing)
	II. Methods and approaches of strategic marketing planning
	patterns of industrial development, patent and technology portfolios
	III. Strategic foresight and scenario analysis
	 objectives and challenges of strategic foresight, scenario analysis, Delphi method
	IV. User innovations
Content	 Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis
	V. Customer-oriented Product and Service Engineering
	 Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting
	VII. Pricing
	Basics of Pricing, Value-based pricing, Pricing models
	VIII. Sales Management
	 Basics of Sales Management, Assessing Customer Value, Planning Customer Visits
	IX. Communications
	 Diffusion of Innovations, Communication Objectives, Communication Instruments
	Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technology products and innovations, third edition, Pearson education. ISBN-10: 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (352-365), Chapter 12 (419-426).
	Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition, McGrw Hill, Boston et al., 2008
	Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,pp. 3-24.
	Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boston et al., McGraw Hill
	Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London
	Von Hippel, E.(2005). Democratizing Innovation, Cambridge: MIT Press

Course L0862: PBL	Marketing of Innovations
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	SoSe
Content	This PBL course is seggregated into two afternoon sessions. This cours aims at enhancing the students' practical skills in (1) forecasting the future development of markets and (2) making appropriate market-related decisions (particularly segmentation, managing the marketing mix). The students will be prompted to use the knowledge gathered in the lecture of this module and will be invited to (1) Conduct a scenario analysis for an innovative product category and (2) Engage in decision making within a market simulation game.
Literature	

Module M0938	8: Bioprocess Engineering	- Fundamental	S	
Courses				
Title Bioprocess Engineering	g - Fundamentals (L0841) g- Fundamentals (L0842)	Typ Lecture Recitation Secti	Hrs/wk 2	CP 3
	g - Fundamental Practical Course (L0843)	(large) Practical Course	2	2
	Prof Andreas Liese	Tractical course		-
Admission Requirements				
Recommended Previous Knowledge	none, module "organic chemistry", mod	dule "fundamentals fo	r process er	ngineering"
Educational Objectives	After taking part successfully, students	have reached the fol	lowing learn	ing results
Professional Competence				
Knowledge	Students are able to describe the basic concepts of bioprocess engineering. They are able to classify different types of kinetics for enzymes and microorganisms, as well as to differentiate different types of inhibition. The parameters of stoichiometry and rheology can be named and mass transport processes in bioreactors can be explained. The students are capable to explain fundamental bioprocess management, sterilization technology and downstream processing in detail.			
Skills	 After successful completion of this module, students should be able to describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parameters predict qualitatively the influence of energy generation, regeneration of redox equivalents and growth inhibition on the fermentation process analyze bioprocesses on basis of stoichiometry and to set up / solve metabolic flux equations distinguish between scale-up criteria for different bioreactors and bioprocesses (anaerobic, aerobic as well as microaerobic) to compare them as well as to apply them to current biotechnical problem propose solutions to complicated biotechnological problems and to deduce the corresponding models to explore new knowledge resources and to apply the newly gained contents identify scientific problems with concrete industrial use and to formulate solutions. to document and discuss their procedures as well as results in a scientific manner 			
Personal Competence Social Competence	After completion of this module parti questions in small teams to enhance	e the ability to take	position to	their own
Autonomy	After completion of this module par problem in a team independently by or results in a plenum.			
Workload in Hours	Independent Study Time 96, Study Tim	e in Lecture 84		

Credit points	6		
Course achievement	Compulsor Fonus Yes 5 %	Form Subject theoretical	Description and
Examination		practical work	
Examination duration and scale	90 min		
the Following	Engineering: Compulsor General Engineering Bioprocess Engineering Bioprocess Engineering General Engineering Bioprocess Engineering General Engineering General Engineering Compulsory Biomedical Engineering Compulsory Biomedical Engineering Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory	Science (German pro : Compulsory : Core qualification: Cor Science (English pro : Compulsory :ience (English program ry : Specialisation Artificia g: Specialisation Impl g: Specialisation Medic g: Specialisation Manag	gram, 7 semester): Specialisation 1, 7 semester): Specialisation Process 21 Organs and Regenerative Medicine: 22 ants and Endoprostheses: Elective 23 Technology and Control Theory: 24 jement and Business Administration: 25 ering Science: Elective Compulsory

Course L0841: Biop	process Engineering - Fundamentals		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng		
Language	DE		
Cycle	SoSe		
Content	 Introduction: state-of-the-art and development trends in the biotechnology, introduction to the lecture Enzyme kinetics: Michaelis-Menten, differnt types of enzyme inhibition, linearization, conversion, yield, selectivity (Prof. Liese) Stoichiometry: coefficient of respiration, electron balance, degree of reduction, coefficient of yield, theoretical oxygen demand (Prof. Liese) Microbial growth kinetic: batch- and chemostat culture (Prof. Zeng) Kinetic of subtrate consumption and product formation (Prof. Zeng) Rheology: non-newtonian fluids, viscosity, agitators, energy input (Prof. Liese) Transport process in a bioreactor (Prof. Zeng) Technology of sterilization (Prof. Zeng) Fundamentals of bioprocess management: bioreactors and calculation of batch, fed-batch and continuouse bioprocesses (Prof. Zeng/Prof. Liese) Downstream technology in biotechnology: cell breakdown, zentrifugation, filtration, aqueous two phase systems (Prof. Liese) 		
Literature	 K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012 H. Chmiel: Bioprozeßtechnik, Elsevier, 2006 R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010 H.W. Blanch, D. Clark: Biochemical Engineering, Taylor & Francis, 1997 P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013 		

Course L0842: Bioprocess Engineering- Fundamentals			
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	1		
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28		
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng		
Language			
Cycle			
	1. Introduction (Prof. Liese, Prof. Zeng)		
	2. Enzymatic kinetics (Prof. Liese)		
	3. Stoichiometry I + II (Prof. Liese)		
	4. Microbial Kinetics I+II (Prof. Zeng)		
Content	5. Rheology (Prof. Liese)		
	6. Mass transfer in bioprocess (Prof. Zeng)		
	7. Continuous culture (Chemostat) (Prof. Zeng)		
	8. Sterilisation (Prof. Zeng)		
	9. Downstream processing (Prof. Liese)		
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)		
Literature	siehe Vorlesung		

Course L0843: Biop	process Engineering - Fundamental Practical Course
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng
Language	DE
Cycle	SoSe
Content	In this course fermentation and downstream technologies on the example of the production of an enzyme by means of a recombinant microorganism is learned. Detailed characterization and simulation of enzyme kinetics as well as application of the enzyme in a bioreactor is carried out. The students document their experiments and results in a protocol.
Literature	Skript

Module M1143	3: Applied Design Metho	odology in Mecha	atronics	
Courses				
Title Applied Design Methodology in Mechatronics (L1523) Applied Design Methodology in Mechatronics (L1524)		Typ Lecture Project-/problem-	Hrs/wk 2 3	CP 2
	Prof. Thorsten Kern	based Learning		
Responsible Admission				
Requirements				
Recommended Previous Knowledge	Basics of mechanical design, elect	rical design or computer	-sciences	
Educational Objectives	After taking part successfully, stud	ents have reached the fo	ollowing learn	ing results
Professional Competence				
Knowledge	Science-based working on interdisciplinary product design considering targeted application of specific product design techniques			
Skills	Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.			
Personal Competence				
Social Competence	Students will solve and execute technical-scientific tasks from an industrial context in small design-teams with application of common, creative methodologies.			
Autonomy	Students are enabled to optimize the design and development process according to the target and topic of the design			
	Independent Study Time 110, Stud	ly Time in Lecture 70		
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical w	ork		
Examination duration and scale	30 min Presentation for a group de	esign-work		
Assignment for the Following Curricula	Biomedical Engineering: Specialisation implants and Endoprostheses: Elective Compulsory			

Compulsory

Course L1523: Applied Design Methodology in Mechatronics		
Typ Lecture		
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Thorsten Kern	
Language	EN	
Cycle	SoSe	
Content	 Systematic analysis and planning of the design process for products combining a multitude of disciplines Structure of the engineering process with focus on engineering steps (task-definition, functional decomposition, physical principles, elements for solution, combination to systems and products, execution of design, component-tests, system-tests, product-testing and qualification/validation) Creative methods (Basics, methods like lead-user-method, 6-3-5, BrainStorming, Intergalactic Thinking, Applications in examples all around mechatronics topics) Several design-supporting methods and tools (functional structures, GALFMOS, AEIOU-method, GAMPFT, simulation and its application, TRIZ, design for SixSigma, continous integration and testing,) Evaluation and final selection of solution (technical and business-considerations, preference-matrix, pair-comparision), dealing with uncertainties, decision-making Value-analysis Derivation of architectures and architectural management Project-tracking and -guidance (project-lead, guiding of employees, organization of multidisciplinary R&D departments, idea-identification, responsibilities and communication) Project-execution methods (Scrum, Kanbaan,) Presentation-skills Questions of aesthetic product design and design for subjective requirements (industrial design, color, haptic/optic/acoustic interfaces) Evaluation of selected methods at practical examples in small teams 	
Literature	 Definition folgt Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, KH.: Konstruktionslehre: Grundlage erfolgreicher Produktentwicklung, Methoden und Anwendung, 7. Auflage, Springer Verlag, Berlin 2007 VDI-Richtlinien: 2206; 2221ff 	

Course L1524: Applied Design Methodology in Mechatronics		
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Thorsten Kern	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1277	7: MED I: Introduction to Anatomy		
Courses			
Title Introduction to Anatom	my (L0384) Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Udo Schumacher		
Admission Requirements	INONE		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully, students have reached the fo	ollowing lear	ning results
Professional Competence	1		
Knowledge	The students can describe basal structures and functions of musculoskeletal system. The students can describe the basic macroscopy and micro		
Skills	The students can recognize the relationship between given development of some common diseases; they can exstructures and their functions in the context of widespread	kplain the	
Personal Competence	1		
Social Competence	The students can participate in current discussions in temperature on a professional level.	oiomedical ı	research and
Autonomy	participate in conversations on the topic and acquire	The students are able to access anatomical knowledge by themselves, can participate in conversations on the topic and acquire the relevant knowledge themselves.	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points	s 3		
Course achievement			
	Written exam		
Examination duration and scale	90 minutes		
	General Engineering Science (German program, 7 semblemedical Engineering: Compulsory General Engineering Science (German program, 7 semblemedical Engineering, Focus Biomechanics: Compulsory Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: E	emester): S	Specialisation
the Following	Engineering Science: Specialisation Biomedical Engineering General Engineering Science (English program, 7 so Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 so Biomedical Engineering: Compulsory General Engineering: Compulsory General Engineering Science (English program, 7 so Biomedical Engineering: Compulsory Mechanical Engineering: Specialisation Biomechanics: Com Biomedical Engineering: Specialisation Medical Technological Engineering: Specialisation Medical Technological Engineering: Specialisation Management and	emester): Semester): S	Ty Specialisation Specialisation Specialisation ontrol Theory:

Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0384: Intr	oduction to Anato	omy
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study	Time 62, Study Time in Lecture 28
Lecturer	Prof. Tobias Lange	
Language	DE	
Cycle		
	General Anatomy 1 st week: 2 nd week:	The Eucaryote Cell The Tissues
	3 rd week:	Cell Cycle, Basics in Development Musculoskeletal System
	5 th week: 6 th week:	Cardiovascular System
Content	7 th week:	Respiratory System Genito-urinary System
	8 th week: 9 th week:	Immune system Digestive System I
	10 th week:	Digestive System II
	11 th week: 12 th week:	Endocrine System
	13 th week:	Nervous System Exam
Literature	Adolf Faller/Michae Stuttgart, 2016	el Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag

Module M127 Therapy	8: MED I: Introduction to Radiology and Radiation	
Courses		
Title Introduction to Radiolo	Typ Hrs/wk CP gy and Radiation Therapy (L0383) Lecture 2 3	
	Prof. Ulrich Carl	
Admission Requirements	None	
Recommended Previous Knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	Therapy The students can distinguish different types of currently used equipment with respect to its use in radiation therapy. The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine). The students can describe the patients' passage from their initial admittance through to follow-up care. Diagnostics The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, as well as sectional imaging techniques (CT, MRT, US). The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for those techniques. The students can choose the right treatment method depending on the patient's clinical history and needs. The student can explain the influence of technical errors on the imaging techniques. The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.	
	Therapy The students can distinguish curative and palliative situations and motivate why they came to that conclusion. The students can develop adequate therapy concepts and relate it to the radiation biological aspects. The students can use the therapeutic principle (effects vs adverse effects) The students can distinguish different kinds of radiation, can choose the best one depending on the situation (location of the tumor) and choose the energy needed in	
Skills	that situation (irradiation planning). The student can assess what an individual psychosocial service should look like (e.g. follow-up treatment, sports, social help groups, self-help groups, social services, psycho-oncology). Diagnostics	

	The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.
	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of anatomy, pathology and pathophysiology.
Personal Competence	
Social Competence	The students can assess the special social situation of tumor patients and interact with them in a professional way. The students are aware of the special, often fear-dominated behavior of sick people caused by diagnostic and therapeutic measures and can meet them appropriately.
	The students can apply their new knowledge and skills to a concrete therapy case. The students can introduce younger students to the clinical daily routine.
Autonomy	The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the topic and acquire the relevant knowledge themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	
Examination duration and scale	
the Following	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Engineering Science: Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering: Compulsory General Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0383: Introduction to Radiology and Radiation Therapy	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ulrich Carl, Prof. Thomas Vestring
Language	DE
_	

Cycle	Isoso		
·	The students will be given an understanding of the technological possibilities in the field of medical imaging, interventional radiology and radiation therapy/radiation oncology. It is assumed, that students in the beginning of the course have heard the word "X-ray" at best. It will be distinguished between the two arms of diagnostic (Prof. Dr. med. Thomas Vestring) and therapeutic (Prof. Dr. med. Ulrich Carl) use of X-rays. Both arms depend on special big units, which determine a predefined sequence in their respective departments		
Literature	 "Technik der medizinischen Radiologie" von T. + J. Laubenberg - 7. Auflage - Deutscher Ärzteverlag - erschienen 1999 "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr - 4. Auflage - Verlag Urban & Fischer - erschienen 02.03.2006 ISBN: 978-3-437-23960-1 "Strahlentherapie und Onkologie für MTA-R" von R. Sauer - 5. Auflage 2003 - Verlag Urban & Schwarzenberg - erschienen 08.12.2009 ISBN: 978-3-437-47501-6 "Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus- 8. Auflage - Georg Thieme Verlag - erschienen 19.09.2012 ISBN: 978-3-13-567708-8 "Der Körper des Menschen " von A. Faller u. M. Schünke - 16. Auflage 2004 - Georg Thieme Verlag - erschienen 18.07.2012 ISBN: 978-3-13-329716-5 		
	 "Praxismanual Strahlentherapie" von Stöver / Feyer – 1. Auflage - Springer-Verlag GmbH – erschienen 02.06.2000 		

Module M1280	0: MED II: Introductio	n to Physiology	
Courses			
Title		Тур	Hrs/wk CP
Introduction to Physiol	ogy (L0385)	Lecture	2 3
-			
Admission Requirements	None		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully,	students have reached the	e following learning results
Professional Competence			
Knowledge	 The students can describe the basics of the describe physiological reference and sensory physiological reference 	elations in selected fields	of muscle, heart/circulatior
Skills	The students can describe transmission and processing functions) and relate them to s	of information, develop	
Personal Competence			
Social Competence	The students can conduct disc The students can find soluti analytical and metrological.		
Autonomy	The students can derive ans physiological areas, using tech	•	_
Workload in Hours	Independent Study Time 62, St	tudy Time in Lecture 28	
Credit points			
Course achievement	None		
Examination	Written exam		
Examination duration and scale	60 minutes		
the Following	General Engineering Science Biomedical Engineering: Comp General Engineering Science Mechanical Engineering, Focus Data Science: Specialisation Melectrical Engineering: Specialise Engineering Science: Specialise General Engineering Science Mechanical Engineering, Focus General Engineering Science Biomedical Engineering: Comp General Engineering: Science Biomedical Engineering: Science Biomedical Engineering: Specialise Mechanical Engineering: Specialise Biomedical Engineering: Specialise Biomedical Engineering: Specialise Biomedical Engineering: Specialise Elective Compulsory	ulsory e (German program, 7 Biomechanics: Compulso edicine: Compulsory sation Medical Technology ation Biomedical Engineer e (English program, 7 Biomechanics: Compulso e (English program, 7 ulsory e (English program, 7 ve Compulsory alisation Biomechanics: Compulsory	semester): Specialisatio ry y: Elective Compulsory ing: Elective Compulsory semester): Specialisatio ry semester): Specialisatio semester): Specialisatio ompulsory

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0385: Introduction to Physiology		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Gerhard Engler, Dr. Gerhard Engler	
Language	DE	
Cycle	SoSe	
Content		
Literature	Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier	

Module M1332	2: BIO I: Experimental	Methods in Bion	nechanics
Courses			
Title Experimental Methods	in Biomechanics (L0377)	Typ Lecture	Hrs/wk CP 2 3
Module Responsible	Prof. Michael Morlock		
Admission Requirements	None		
	It is recommended to participattending "Experimentelle Metho		nd Frakturheilung" before
Educational Objectives	After taking part successfully, stu	udents have reached the	e following learning results
Professional Competence			
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence. The students can name different treatments for the spine and hollow bones under given fracture morphologies. The students can describe different measurement techniques for forces and		
Skills	movements, and choose the adequate technique for a given task. The students can describe the basic handling of several experimental techniques used in biomechanics.		
Personal Competence	The students can, in groups, solv	o basis ovnorimental ta	cke
Social Competence	The students can, in groups, solv	·	
Autonomy Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points	3		
Course achievement			
Examination	Written exam		
Examination duration and scale			
the Following	General Engineering Science Mechanical Engineering, Focus B General Engineering Science Biomedical Engineering: Compuls Engineering Science: Specialisati General Engineering Science Mechanical Engineering, Focus B General Engineering Science Biomedical Engineering: Compuls General Engineering: Compuls General Engineering: Elective Mechanical Engineering: Speciali Biomedical Engineering: Speciali Biomedical Engineering: Speciali Elective Compulsory Biomedical Engineering: Speciali Compulsory	iomechanics: Compulso (German program, 7 sory on Biomedical Engineer (English program, 7 iomechanics: Compulso (English program, 7 sory (English program, 7 Compulsory sation Biomechanics: Cosation Artificial Organs	ry semester): Specialisation ing: Elective Compulsory semester): Specialisation ry semester): Specialisation semester): Specialisation ompulsory and Regenerative Medicine

Elective Compulsory
Biomedical Engineering: Specialisation Management and Business Administration:
Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0377: Experimental Methods in Biomechanics		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content		
Literature	Wird in der Veranstaltung bekannt gegeben	

Module M1335	5: BIO II: Artificial Joint	Replacement		
Courses				
Title Artificial Joint Replacer	ment (L1306)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of orthopedic and surgical techniques is recommended.			
Educational Objectives	After taking part successfully, stu	dents have reached the f	following learn	ing results
Professional Competence <i>Knowledge</i>		ent kinds of artificial limb	os.	
	The students can explain the advantages and disadvantages of different kinds of endoprotheses.			
Personal Competence				
Social Competence	The students are able to discuss and the teachers.	issues related to endopro	othese with stu	ident mates
Autonomy	The students are able to acquire information on their own. They can also judge the information with respect to its credibility.			
Workload in Hours	Independent Study Time 62, Stud	y Time in Lecture 28		
Credit points	3			
Course achievement	None			
	Written exam			
Examination duration and scale	90 min			
the Following	International Management and E and Biotechnology: Elective Comp Materials Science: Specialisation Biomedical Engineering: Specialis Elective Compulsory Biomedical Engineering: Specialis Biomedical Engineering: Special Elective Compulsory Biomedical Engineering: Specialis Elective Compulsory Orientierungsstudium: Core qualit Theoretical Mechanical Engineer Compulsory Theoretical Mechanical Engineer Elective Compulsory	nulsory Nano and Hybrid Materia sation Artificial Organs ar ation Implants and Endo isation Medical Technolo sation Management and fication: Elective Compuls ring: Technical Compler	ls: Elective Cond nd Regenerative prostheses: Co ogy and Cont I Business Adr sory mentary Cours	mpulsory re Medicine: empulsory rol Theory: ministration: se: Elective

Course L1306: Arti	ficial Joint Replacement
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
L anguage	
Cycle	SoSe
	Inhalt (deutsch)
	 EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenker-satzes)
	2. FUNKTIONSANALYSE (Der menschliche Gang, die menschliche Arbeit, die sportliche Aktivität)
	3. DAS HÜFTGELENK (Anatomie, Biomechanik, Gelenkersatz Schaftseite und Pfannenseite, Evolution der Implantate)
Content	4. DAS KNIEGELENK (Anatomie, Biomechanik, Bandersatz, Gelenkersatz femorale, tibiale und patelläre Komponenten)
	5. DER FUß (Anatomie, Biomechanik, Gelen-kersatz, orthopädische Verfahren)
	6. DIE SCHULTER (Anatomie, Biomechanik, Gelenkersatz)
	7. DER ELLBOGEN (Anatomie, Biomechanik, Gelenkersatz)
	8. DIE HAND (Anatomie, Biomechanik, Ge-lenkersatz)
	9. TRIBOLOGIE NATÜRLICHER UND KÜNST-LICHER GELENKE (Korrosion, Reibung, Verschleiß)
	Literatur:
	Kapandji, I: Funktionelle Anatomie der Gelenke (Band 1-4), Enke Verlag, Stuttgart, 1984.
Literature	Nigg, B., Herzog, W.: Biomechanics of the musculo-skeletal system, John Wiley&Sons, New York 1994
Literature	Nordin, M., Frankel, V.: Basic Biomechanics of the Musculoskeletal System, Lea&Febiger, Philadelphia, 1989.
	Czichos, H.: Tribologiehandbuch, Vieweg, Wiesbaden, 2003.
	Sobotta und Netter für Anatomie der Gelenke

Module M084	5: Feedback Control in I	Medical Technol	ogy	
Courses				
Title Feedback Control in Ma	edical Technology (L0664)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Johannes Kreuzer			
Admission Requirements	None			
Recommended Previous Knowledge	Basics in Control, Basics in Physio	logy		
Educational Objectives	After taking part successfully, stud	dents have reached the	following learn	ing results
Professional Competence				
	The lecture will introduce into the engineering point of view. Fund introduced like knowledge in cont	amentals in human ph		
Knowledge	Internal control loops of the huma design of external closed loop sys			
	The handling of PID controllers a fuzzy controller or neural netwo equivalent circuits will be discusse	orks will be illustrated.		
Skills	Application of modeling, identification, control technology in the field of medical technology.			
Personal Competence				
Social Competence	Students can develop solutions t their results	o specific problems in	small groups	and present
Autonomy	Students are able to find necessary literature and to set it into the context of the lecture. They are able to continuously evaluate their knowledge and to take control of their learning process. They can combine knowledge from different courses to form a consistent whole.			
Workload in Hours	Independent Study Time 62, Study	y Time in Lecture 28		
Credit points				
Course achievement	None			
Examination	Oral exam			
Examination duration and scale				
Assignment for the Following Curricula	Biomedical Engineering: Specialis	ation Control and Pov lisation Implants and ation Artificial Organs a	ver Systems Endoprosthese Ind Regenerativ	Engineering: es: Elective ve Medicine:

Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory

Course L0664: Fee	dback Control in Medical Technology
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	 Always viewed from the engineer's point of view, the lecture is structured as follows: Introduction to the topic Fundamentals of physiological modelling Introduction to Breathing and Ventilation Physiology and Pathology in Cardiology Introduction to the Regulation of Blood Glucose kidney function and renal replacement therapy Representation of the control technology on the concrete ventilator Excursion to a medical technology company Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.
Literature	 Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Module M0832	2: Advanced Topics in	Control		
Courses				
Title Advanced Topics in Co Advanced Topics in Co		Typ Lecture Recitation	Hrs/wk 2 Section 2	CP 3
·	_	(small)		
1105 01151010				
Admission Requirements	Inone			
Recommended Previous Knowledge	H-infinity optimal control, mixed	l-sensitivity design, line	ear matrix inequal	lities
Educational Objectives	After taking part successfully, st	cudents have reached t	the following learn	ning results
Professional Competence				
Knowledge	communication topology They can explain the oprotocols They can explain analysis involving either LTI or LPN Students can explain the distributed systems that a they can explain (in out	resentation of nonlinear ability and performance conditions adding techniques can every systems allytopic and LFT represents techniques associated associated as and synthesis conditionally agent models are discretized accordiction, the extension of	the systems in the force conditions for label used to solve the sentations of LPV solved with each of the sentation of spatiang to an actuator, of the bounded reserved to the sounded reserved to the sounded reserved to the sentation of spatiang to an actuator, of the sounded reserved to the sentation of spatiang to an actuator, of the sentation of spatiang to an actuator, of the sentation of spatiang to an actuator, of the sentation of spatiang to an actuator, of the sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation of spatiang to an actuator, or sentation or se	form of quasi LPV systems analysis and systems and these mode epresent the r consensus control loops ally invariant /sensor array al lemma to
Skills	 such distributed system distributed controllers Students are capable of carry out a mixed-sensit do this using polytopic, LI They are able to use star for these tasks Students are able to deagents with either LTI or in 	constructing LPV mo ivity design of gain-sc FT or general LPV mode ndard software tools (I sign distributed forma	odels of nonlinear heduled controlle els Matlab robust con	r plants and ers; they car atrol toolbox; or groups of
	[37	41		

	 Students are able to design distributed controllers for spatially interconnected systems, using the Matlab MD-toolbox
Personal Competence Social Competence	Students can work in small groups and arrive at joint results.
Autonomy	Students are able to find required information in sources provided (lecture notes, literature, software documentation) and use it to solve given problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Oral exam
Examination duration and scale	
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Course L0661: Adv	anced Topics in Control
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	_
Cycle	WiSe
Content	 Linear Parameter-Varying (LPV) Gain Scheduling Linearizing gain scheduling, hidden coupling Jacobian linearization vs. quasi-LPV models Stability and induced L2 norm of LPV systems Synthesis of LPV controllers based on the two-sided projection lemma Simplifications: controller synthesis for polytopic and LFT models Experimental identification of LPV models Controller synthesis based on input/output models Applications: LPV torque vectoring for electric vehicles, LPV control of a robotic manipulator Control of Multi-Agent Systems Communication graphs Spectral properties of the graph Laplacian First and second order consensus protocols Formation control, stability and performance LPV models for agents subject to nonholonomic constraints Application: formation control for a team of quadrotor helicopters Control of Spatially Interconnected Systems Multidimensional signals, I2 and L2 signal norm Multidimensional systems in Roesser state space form Extension of real-bounded lemma to spatially interconnected systems LMI-based synthesis of distributed controllers Spatial LPV control of spatially varying systems Applications: control of temperature profiles, vibration damping for an actuated beam
Literature	 Werner, H., Lecture Notes "Advanced Topics in Control" Selection of relevant research papers made available as pdf documents via StudIP

Course L0662: Adv	Course L0662: Advanced Topics in Control		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Herbert Werner		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0548	8: Bioelectromagnetics: P	rinciples an	d Applicatio	ns
Courses				
Title Bioelectromagnetics: F	Principles and Applications (L0371) Principles and Applications (L0373)	Typ Lecture Recitation (small)	Hrs/wk 3 Section 2	CP 5
Module Responsible	Prof. Christian Schuster	(0.1.0.1)		
Admission Requirements				
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, studen	ts have reached t	he following learn	ing results
Professional Competence				
Knowledge	Students can explain the basic bioelectromagnetics, i.e. the quantific in biological tissue. They can define phenomena and order them correspields. They can give an overview over characterization of electromagnetic examples for therapeutic and diagramedical technology.	cation and applicate and exemplify ponding to wave er measurement fields in practical	ation of electroma the most importa length and freque and numerical ted applications . Th	gnetic fields ant physical ency of the chniques for ey can give
Skills	Students know how to apply vario electromagnetic fields in biological tis make use of the elementary solution assess the most important effects that they can order the effects correspectively, and they can analyzed develop validation strategies for the effects of electromagnetic fields for make an appropriate choice.	ssue. In order to ons of Maxwell's nat these models responding to v them in a quanti eir predictions. Th	do this they can r Equations. They predict for biolo wavelength and tative way. They ney are able to e	elate to and are able to gical tissue, frequency, are able to evaluate the
Personal Competence Social Competence	Students are able to work together are able to present their results ef	-		
Autonomy	Students are capable to gather in publications and relate that informati to make a connection between their content of other lectures (e.g. theo electrical engineering / physics). They field of bioelectromagnetics in English	ion to the context r knowledge obta ry of electromag / can communicat	of the lecture. The ined in this lecture in this lecture. The inerties in the	ney are able are with the amentals of
Workload in Hours	Independent Study Time 110, Study T	Time in Lecture 70)	

Credit points	6			
Course achievement	CompulsorBonus Yes 10 %	Form Presentation	Description	
Examination				
Examination duration and scale	45 min			
the Following	Electromagnetic Compa Electrical Engineering: International Managem Elective Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Compulsory Theoretical Mechanical Elective Compulsory	atibility: Elective Co Specialisation Med ent and Engineering: Specialisation Arg: Specialisation Med g: Specialisation Med g: Specialisation Medicalisation Ing: Specialisation Ing: Specialisation		Engineering: ve Medicine: Iministration: trol Theory: ses: Elective Technology:

Course L0371: Bioe	electromagnetics: Principles and Applications
Тур	Lecture
Hrs/wk	3
СР	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
	Prof. Christian Schuster
Language	
Cycle	
	- Fundamental properties of electromagnetic fields (phenomena)
	- Mathematical description of electromagnetic fields (Maxwell's Equations)
	- Electromagnetic properties of biological tissue
	- Principles of energy absorption in biological tissue, dosimetry
	- Numerical methods for the computation of electromagnetic fields (especially FDTD)
	- Measurement techniques for characterization of electromagnetic fields
Content	- Behavior of electromagnetic fields of low frequency in biological tissue
	- Behavior of electromagnetic fields of medium frequency in biological tissue
	- Behavior of electromagnetic fields of high frequency in biological tissue
	- Behavior of electromagnetic fields of very high frequency in biological tissue
	- Diagnostic applications of electromagnetic fields in medical technology
	- Therapeutic applications of electromagnetic fields in medical technology
	- The human body as a generator of electromagnetic fields
	- C. Furse, D. Christensen, C. Durney, "Basic Introduction to Bioelectromagnetics",
	CRC (2009)
	- A. Vorst, A. Rosen, Y. Kotsuka, "RF/Microwave Interaction with Biological Tissues", Wiley (2006)
Literature	- S. Grimnes, O. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008)
	- F. Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnetic Fields", CRC (2006)

Course L0373: Bioelectromagnetics: Principles and Applications		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	1	
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Specialization Medical Technology and Control Theory

Module M0623	3: Intellig	ent Sy	stems in Me	dicine		
Courses						
Title Intelligent Systems in Intelligent Systems in Intelligent Systems in	Medicine (L033	34)		Typ Lecture Project Seminar Recitation S (small)	Hrs/wk 2 2 Section 1	CP 3 2
Module Responsible	Prof. Alexano	ler Schlae	fer			
Admission Requirements	None					
Recommended Previous Knowledge	principprincip	oles of sto oles of pro	th (algebra, analys chastics gramming, Java/C- amming skills		b	
Educational Objectives		oart succe	ssfully, students h	ave reached the	e following learn	ing results
Professional Competence						
Knowledge	The students are able to analyze and solve clinical treatment planning and decision support problems using methods for search, optimization, and planning. They are able to explain methods for classification and their respective advantages and disadvantages in clinical contexts. The students can compare different methods for representing medical knowledge. They can evaluate methods in the context of clinical data and explain challenges due to the clinical nature of the data and its acquisition and due to privacy and safety requirements.					
Skills	The students can give reasons for selecting and adapting methods for classification, regression, and prediction. They can assess the methods based on actual patient data and evaluate the implemented methods.					
Personal Competence						
Social Competence	The students incoorporate	discuss t feedback	the results of other into their work.	groups, provid	le helpful feedb	ack and car
Autonomy			ect their knowledg esults in an approp		nt the results of	f their work
Workload in Hours	Independent	Study Tin	ne 110, Study Time	in Lecture 70		
Credit points	6					
Course achievement	Yes	Bonus 10 % 10 %	Form Written elaborati Presentation		cription	
Examination	Written exan	า				
Examination duration and scale						
	Electrical Eng	gineering:	ecialisation II: Intell Specialisation Mec sation Intelligent S	lical Technology	: Elective Comp	oulsory

	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Assignment for	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
Curricula	Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective
	Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0331: Inte	lligent Systems in Medicine
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	WiSe
Content	 methods for search, optimization, planning, classification, regression and prediction in a clinical context representation of medical knowledge understanding challenges due to clinical and patient related data and data acquisition The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Russel & Norvig: Artificial Intelligence: a Modern Approach, 2012 Berner: Clinical Decision Support Systems: Theory and Practice, 2007 Greenes: Clinical Decision Support: The Road Ahead, 2007 Further literature will be given in the lecture

Course L0334: Intelligent Systems in Medicine		
Тур	Project Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0333: Intelligent Systems in Medicine		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP)

Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L1663)		Seminar	2	3
Introduction to Waveg Compatibility (L1669)	uides, Antennas, and Electromagnetic	Lecture	3	4
Introduction to Waveg Compatibility (L1877)	uides, Antennas, and Electromagnetic	Recitation (small)	Section 2	2
Development and Reg	ulatory Approval of Implants (L1588)	Lecture	2	3
	for the Characterization of Materials (L1580) $$	Lecture	2	3
Numerical Methods in		Seminar	2	3
Seminar Biomedical Er	ngineering (L1890)	Seminar	2	3
Six Sigma (L1130)		Lecture	2	3
Fluid Mechanics II (L00		Lecture	2	4
System Simulation (L1	820)	Lecture	2	2
System Simulation (L1	821)	Recitation (large)	Section 1	2
Ceramics Technology ((L0379)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached	the following learn	ing results
Professional Competence				
Knowledge				
Skills				
Personal				
Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation I Elective Compulsory Biomedical Engineering: Specialisation A Elective Compulsory	Medical Tec	chnology and Cont	trol Theory: ministration:

Course L1663: Nat	ure's Hierarchical Materials
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Gerold Schneider
Language	EN
Cycle	WiSe
Content	Biological materials are omnipresent in the world around us. They are the main constituents in plant and animal bodies and have a diversity of functions. A fundamental function is obviously mechanical providing protection and support for the body. But biological materials may also serve as ion reservoirs (bone is a typical example), as chemical barriers (like cell membranes), have catalytic function (such as enzymes), transfer chemical into kinetic energy (such as the muscle), etc. This lecture will focus on materials with a primarily (passive) mechanical function: cellulose tissues (such as wood), collagen tissues (such as tendon or cornea), mineralized tissues (such as bone, dentin and glass sponges). The main goal is to give an introduction to the current knowledge of the structure in these materials and how these structures relate to their (mostly mechanical) functions.
Literature	Peter Fratzl, Richard Weinkamer, Nature's hierarchical materialsProgress, in Materials Science 52 (2007) 1263-1334 Journal publications

Course L1669: Intr	oduction to Waveguides, Antennas, and Electromagnetic Compatibility
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency / high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation and Electromagnetic Compatibility will be introduced and discussed. Topics: - Fundamental properties and phenomena of electrical circuits - Steady-state sinusoidal analysis of electrical circuits - Fundamental properties and phenomena of electromagnetic fields and waves - Steady-state sinusoidal description of electromagnetic fields and waves - Useful microwave network parameters - Transmission lines and basic results from transmission line theory - Plane wave propagation, superposition, reflection and refraction - General theory of waveguides - Most important types of waveguides and their properties - Radiation and basic antenna parameters - Most important types of antennas and their properties - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques
Literature	 - Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999) - J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012) - D. M. Pozar, "Microwave Engineering", Wiley (2011) - Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008) - H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009) - A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)

Course L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility	
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1588: Dev	elopment and Regulatory Approval of Implants
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Dr. Roman Nassutt
Language	DE
Cycle	WiSe
Content	
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik – Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html

Course L1580: Exp	erimental Methods for the Characterization of Materials
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Patrick Huber
Language	DE
Cycle	WiSe
Content	 Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Course L1583: Nun	nerical Methods in Biomechanics
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	SoSe
Content	 Vorkenntnisse aus " Diskretisierungsmethoden der Mechanik" sind empfohlen Ein Überblick über die gängigsten numerischen Verfahren im Bereich der Biomechanik und Medizintechnik wird vermittelt. Grundkenntnissen aus verschiedenen Disziplinen (Mechanik, Mathematik, Programmierung) werden kombiniert um eine geschlossene Beispielfragestellung zu beantworten Die Vorlesung umfasst analytische Ansätze, rheologische Modelle und Finite Elemente Methoden Die vermittelten theoretischen Ansätze werden im Laufe der Vorlesung und im Rahmen von Hausaufgaben in praktische Übungen angewandt. Der kritische Blick auf die Möglichkeiten und Limitationen der Modellrechnung im Bereich humaner Anwendungen wird geschult.
Literature	Hauger W., Schnell W., Gross D., Technische Mechanik, Band 3: Kinetik, Springer-Verlag Berlin Heidelberg, 12. Auflage, 2012 Huber G., de Uhlenbrock A., Götzen N., Bishop N., Schwieger K., Morlock MM., Modellierung, Simulation und Optimierung, Handbuch Sportbiomechanik, Gollhofer A., Müller E., Hofmann Verlag, Schorndorf, 148-69, 2009

Course L1890: Seminar Biomedical Engineering	
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	schriftliche ausarbeitung und Vortrag (20 min)
Lecturer	Prof. Michael Morlock
Language	DE
Cycle	WiSe
Content	
Literature	Keine

Course L1130: Six Sigma		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Claus Emmelmann	
Language	DE	
Cycle	WiSe	
Content	 Introduction and structuring Basic terms of quality management Measuring and inspection equipment Tools of quality management: FMEA, QFD, FTA, etc. Quality management methodology Six Sigma, DMAIC 	
Literature	Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008 Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996 Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008	

Course L0001: Flui	d Mechanics II
Typ	Lecture
Hrs/wk	
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Klausur
Examination	
duration and scale	
	Prof. Michael Schlüter
Language Cycle	
Сусіе	Wise
Content	 Differential equations for momentum-, heat and mass transfer Examples for simplifications of the Navier-Stokes Equations Unsteady momentum transfer Free shear layer, turbulence and free jets Flow around particles - Solids Process Engineering Coupling of momentum and heat transfer - Thermal Process Engineering Rheology - Bioprocess Engineering Coupling of momentum- and mass transfer - Reactive mixing, Chemical Process Engineering Flow threw porous structures - heterogeneous catalysis Pumps and turbines - Energy- and Environmental Process Engineering Wind- and Wave-Turbines - Renewable Energy Introduction into Computational Fluid Dynamics
Literature	 Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.

Course L1820: System Simulation		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Dr. Stefan Wischhusen	
Language	DE	
Cycle	WiSe	
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems	
Literature	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011. 	

Course L1821: System Simulation	
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28	
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Dr. Rolf Janßen		
Language	DE/EN		
Cycle	WiSe		
	Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metauurgical techniques and sintering (soild state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.		
	Content:	1. Introduction	
	Inhalt:	2. Raw materials	
Content		3. Powder fabrication	
		4. Powder processing	
		5. Shape-forming processes	
		6. Densification, sintering	
		7. Glass and Cement technology	
		8. Ceramic-metal joining techniques	
	W.D. Kingery, "Introduction to C	Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991		
Literature	D.W. Richerson, "Modern Ceran	nic Engineering", Marcel Decker, New York, 1992	
	Skript zur Vorlesung		

Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP)

Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L1663)		Seminar	2	3
Introduction to Wavegu Compatibility (L1669)	Introduction to Waveguides, Antennas, and Electromagnetic Compatibility (L1669)		3	4
Introduction to Wavegu Compatibility (L1877)	uides, Antennas, and Electromagnetic	Recitation (small)	Section 2	2
Development and Regu	ulatory Approval of Implants (L1588)	Lecture	2	3
•	for the Characterization of Materials (L1580)		2	3
Numerical Methods in I	,	Seminar	2	3
Seminar Biomedical En	gineering (L1890)	Seminar	2	3
Six Sigma (L1130)		Lecture	2	3
Fluid Mechanics II (L00	•	Lecture	2	4
System Simulation (L18	320)	Lecture	2	2
System Simulation (L18	821)	Recitation (large)	Section 1	2
Ceramics Technology (L0379)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached	the following learr	ning results
Professional Competence				
Knowledge				
Skills				
Personal				
Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	12			
Assignment for the Following Curricula	ving Compulsory Riomedical Engineering: Specialisation Medical Technology and Control Theory			

Course L1663: Nature's Hierarchical Materials		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and scale		
Lecturer	Prof. Gerold Schneider	
Language	EN	
Cycle	WiSe	
Content	Biological materials are omnipresent in the world around us. They are the main constituents in plant and animal bodies and have a diversity of functions. A fundamental function is obviously mechanical providing protection and support for the body. But biological materials may also serve as ion reservoirs (bone is a typical example), as chemical barriers (like cell membranes), have catalytic function (such as enzymes), transfer chemical into kinetic energy (such as the muscle), etc. This lecture will focus on materials with a primarily (passive) mechanical function: cellulose tissues (such as wood), collagen tissues (such as tendon or cornea), mineralized tissues (such as bone, dentin and glass sponges). The main goal is to give an introduction to the current knowledge of the structure in these materials and how these structures relate to their (mostly mechanical) functions.	
Literature	Peter Fratzl, Richard Weinkamer, Nature's hierarchical materialsProgress, in Materials Science 52 (2007) 1263-1334 Journal publications	

Course L1669: Intr	oduction to Waveguides, Antennas, and Electromagnetic Compatibility
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency / high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation and Electromagnetic Compatibility will be introduced and discussed. Topics: - Fundamental properties and phenomena of electrical circuits - Steady-state sinusoidal analysis of electrical circuits - Steady-state sinusoidal description of electromagnetic fields and waves - Steady-state sinusoidal description of electromagnetic fields and waves - Useful microwave network parameters - Transmission lines and basic results from transmission line theory - Plane wave propagation, superposition, reflection and refraction - General theory of waveguides - Most important types of waveguides and their properties - Radiation and basic antenna parameters - Most important types of antennas and their properties - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques
Literature	 - Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999) - J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012) - D. M. Pozar, "Microwave Engineering", Wiley (2011) - Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008) - H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009) - A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)

Course L1877: Introduction to Waveguides, Antennas, and Electromagnetic Compatibility		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1588: Development and Regulatory Approval of Implants			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale	90 Minuten		
Lecturer	Dr. Roman Nassutt		
Language	DE		
Cycle	WiSe		
Content			
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik – Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html 		

Course L1580: Experimental Methods for the Characterization of Materials			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Prof. Patrick Huber		
Language	DE		
Cycle	WiSe		
Content	 Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry) 		
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).		

Course L1583: Nun	nerical Methods in Biomechanics
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	SoSe
Content	 Vorkenntnisse aus " Diskretisierungsmethoden der Mechanik" sind empfohlen Ein Überblick über die gängigsten numerischen Verfahren im Bereich der Biomechanik und Medizintechnik wird vermittelt. Grundkenntnissen aus verschiedenen Disziplinen (Mechanik, Mathematik, Programmierung) werden kombiniert um eine geschlossene Beispielfragestellung zu beantworten Die Vorlesung umfasst analytische Ansätze, rheologische Modelle und Finite Elemente Methoden Die vermittelten theoretischen Ansätze werden im Laufe der Vorlesung und im Rahmen von Hausaufgaben in praktische Übungen angewandt. Der kritische Blick auf die Möglichkeiten und Limitationen der Modellrechnung im Bereich humaner Anwendungen wird geschult.
Literature	Hauger W., Schnell W., Gross D., Technische Mechanik, Band 3: Kinetik, Springer-Verlag Berlin Heidelberg, 12. Auflage, 2012 Huber G., de Uhlenbrock A., Götzen N., Bishop N., Schwieger K., Morlock MM., Modellierung, Simulation und Optimierung, Handbuch Sportbiomechanik, Gollhofer A., Müller E., Hofmann Verlag, Schorndorf, 148-69, 2009

Course L1890: Seminar Biomedical Engineering		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form	Referat	
Examination duration and scale	schriftliche ausarbeitung und Vortrag (20 min)	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	WiSe	
Content		
Literature	Keine	

Course L1130: Six Sigma			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Prof. Claus Emmelmann		
Language	DE		
Cycle	WiSe		
Content	 Introduction and structuring Basic terms of quality management Measuring and inspection equipment Tools of quality management: FMEA, QFD, FTA, etc. Quality management methodology Six Sigma, DMAIC 		
Literature	Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008 Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996 Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008		

Course L0001: Fluid	d Mechanics II		
Typ	Lecture		
Hrs/wk			
СР	-		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Examination Form			
Examination			
duration and			
scale			
	Prof. Michael Schlüter		
Language			
Cycle	WiSe		
Content	 Differential equations for momentum-, heat and mass transfer Examples for simplifications of the Navier-Stokes Equations Unsteady momentum transfer Free shear layer, turbulence and free jets Flow around particles - Solids Process Engineering Coupling of momentum and heat transfer - Thermal Process Engineering Rheology - Bioprocess Engineering Coupling of momentum- and mass transfer - Reactive mixing, Chemical Process Engineering Flow threw porous structures - heterogeneous catalysis Pumps and turbines - Energy- and Environmental Process Engineering Wind- and Wave-Turbines - Renewable Energy Introduction into Computational Fluid Dynamics 		
Literature	 Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882. 		

Course L1820: Sys	tem Simulation		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Examination Form	Mündliche Prüfung		
Examination duration and scale			
Lecturer	Dr. Stefan Wischhusen		
Language	DE		
Cycle	WiSe		
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example: Hydraulic systems and heat transfer • Example: System with different subsystems		
Literature	 [1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011. 		

Course L1821: System Simulation		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Examination Form	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Dr. Stefan Wischhusen	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Dr. Rolf Janßen		
Language	DE/EN		
Cycle	WiSe		
	Introduction to ceramic processing with emphasis on advanced structural ce The course focus predominatly on powder-based processing, e.g. "p metauurgical techniques and sintering (soild state and liquid phase). Also aspects of glass and cement science as well as new developments in pow forming techniques of ceramics and ceramic composites will be add Examples will be discussed in order to give engineering students an underst of technology development and specific applications of ceramic components		
	Content:	1. Introduction	
	Inhalt:	2. Raw materials	
Content		3. Powder fabrication	
		4. Powder processing	
		5. Shape-forming processes	
		6. Densification, sintering	
		7. Glass and Cement technology	
		8. Ceramic-metal joining techniques	
	W.D. Kingery, "Introduction to 0	Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991		
Literature	D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992		
	Skript zur Vorlesung		

Module M0629	9: Intelligent Autonomous	Agents and Cog	nitive	Robotics
Courses				
	s Agents and Cognitive Robotics (L0341) s Agents and Cognitive Robotics (L0512)	Typ Lecture Recitation Section	Hrs/wk 2	CP 4
		(small)		
Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Vectors, matrices, Calculus			
Educational Objectives		have reached the follow	wing learn	ing results
Professional Competence				
Knowledge	behavior, and give details about agent can describe the main features of encooperation can be discussed in term solving these problems. For dealing students can summarize how Bayesiar representation and reasoning formalism students can define decision making p with and with complete access to the students can describe techniques for sproblems, and they can recall techniques for can explain planning techniques for accoordination problems and decision redifferent types of equilibria, social choice design techniques.	vironments. The notion is of decision problem with uncertainty in a networks can be empored in static and dynamic procedures in simple and estate of the environmentally observates for measuring the simultaneous localization in a multi-age ce functions, voting products of the simultaneous of the simultaneous localization in a multi-age ce functions, voting products of the simultaneous of the simultaneous localization in a multi-age ce functions, voting products of the simultaneous of the simultaneous localization in a multi-age ce functions, voting products of the simultaneous localization in a multi-age ce functions, voting products of the simultaneous localization in a multi-age ce functions, voting products of the simultaneous localization in the	of adverse and algorithms are allowed as a section and algorithms are allowed as a section and algori	sarial ager gorithms for d scenarios a knowledg In addition tial settings this contex kov decision information apping, an can explain in term of mechanism
Skills	Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent application students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesian networks/dynamic Bayesian networks and apply bayesian reasoning for simple queries. Students can also name and apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situations students will apply techniques for finding different equilibria states,e.g., Nash equilibria. For multi-agent decision making students will apply different voting protocols and compare and explain the results.			
Personal Competence				
Social Competence	Students are able to discuss their communicate in English	solutions to problem	s with o	thers. The
Autonomy	Students are able of checking their un varaints of concrete problems	derstanding of comple	x concept	s by solving
	Independent Study Time 124, Study Tir	me in Lecture 56		
Credit points	!			
Course				

achievement	None
Examination	Written exam
Examination duration and scale	
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Numerics and Computer Science: Elective Compulsory

Lecture 2 4 Independent Study Time 92, Study Time in Lecture 28 Rainer Marrone EN WiSe Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised
2 4 Independent Study Time 92, Study Time in Lecture 28 Rainer Marrone EN WiSe • Definition of agents, rational behavior, goals, utilities, environment types • Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance • Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions • Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised
Independent Study Time 92, Study Time in Lecture 28 Rainer Marrone EN WiSe Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised
Rainer Marrone EN WiSe Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised
Rainer Marrone EN WiSe Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised
 Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised
 Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised
 Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised
 (inference by enumeration), typical-case complexity, pragmatics: reasoning from effect (that can be perceived by an agent) to cause (that cannot be directly perceived). Probabilistic reasoning over time: Environmental state may change even without the agent performing actions, dynamic Bayesian networks, Markov assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation, special cases: hidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decision networks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteration, MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks Simultaneous Localization and Mapping Planning Game theory (Golden Balls: Split or Share) Decisions with multiple agents, Nash equilibrium, Bayes-Nash equilibrium Social Choice Voting protocols, preferences, paradoxes, Arrow's Theorem, Mechanism Design Fundamentals, dominant strategy implementation, Revelation Principle, Gibbard-Satterthwaite Impossibility Theorem, Direct mechanisms, incentive compatibility, strategy-proofness, Vickrey-Groves-Clarke mechanisms, expected externality mechanisms, participation constraints, individual rationality, budget balancedness, bilateral trade, Myerson-Satterthwaite Theorem
 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Norvig, Prentice Hall, 2010, Chapters 2-5, 10-11, 13-17 Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005 Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press, 2009

Course L0512: Inte	Course L0512: Intelligent Autonomous Agents and Cognitive Robotics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Rainer Marrone		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M0746	6: Microsystem	Engineering			
Courses					
Title Microsystem Engineeri	_		Typ Lecture Project-/problem-	Hrs/wk	CP 4
Microsystem Engineering (L0682) based Learning 2 2			2		
	! <u></u>				
Admission Requirements	None				
Knowledge	Basic courses in physic	cs, mathematics ar	nd electric engineer	ing	
Educational Objectives	LATTER TAKING NATT SHCCE	ssfully, students h	ave reached the fol	lowing learn	ing results
Professional Competence					
Knowledge	The students know about well as their application	The students know about the most important technologies and materials of MEMS as well as their applications in sensors and actuators.			
Skills	Students are able to analyze and describe the functional behaviour of MEMS components and to evaluate the potential of microsystems.				
Personal Competence		olvo sposifis probl	ome alone or in a g	roup and to	procent the
Social Competence	Students are able to solve specific problems alone or in a group and to present the results accordingly.				
Autonomy		Students are able to acquire particular knowledge using specialized literature and to integrate and associate this knowledge with other fields.			
	Independent Study Tim	ne 124, Study Timo	e in Lecture 56		
Credit points	i				
Course achievement	CompulsorBonus No 10 %	Form Presentation	Descrip	otion	
	Written exam				
Examination duration and scale	2h				
	Electrical Engineering: Core qualification: Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory				
Assignment for the Following Curricula	Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective				

Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0680: Mici	rosystem Engineering
Тур	Lecture
Hrs/wk	2
СР	4
	Independent Study Time 92, Study Time in Lecture 28
	Prof. Manfred Kasper
Language	
Cycle	
	Object and goal of MEMS
	Scaling Rules
	Lithography
	Film deposition
	Structuring and etching
	Energy conversion and force generation
	Electromagnetic Actuators
	Reluctance motors
Content	Piezoelectric actuators, bi-metal-actuator
	Transducer principles
	Signal detection and signal processing
	Mechanical and physical sensors
	Acceleration sensor, pressure sensor
	Sensor arrays
	System integration
	Yield, test and reliability
	M. Kasper: Mikrosystementwurf, Springer (2000)
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press (1997)
1	

Course L0682: Micr	osystem Engineering
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Manfred Kasper
Language	EN
Cycle	WiSe
	Examples of MEMS components
	Layout consideration
Content	Electric, thermal and mechanical behaviour
	Design aspects
Literature	Wird in der Veranstaltung bekannt gegeben

Module M075	L: Vibration Theory		
Courses			
Title Vibration Theory (L070)	Typ Hrs/wk CP Integrated Lecture 4 6		
Module Responsible	Prof. Norbert Hoffmann		
Admission Requirements	None		
Recommended Previous Knowledge	Linear Algebra		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Students are able to denote terms and concepts of Vibration Theory and develop them further.		
	Students are able to denote methods of Vibration Theory and develop them further.		
Personal Competence			
· ·	Students can reach working results also in groups.		
	Students are able to approach individually research tasks in Vibration Theory.		
Credit points	Independent Study Time 124, Study Time in Lecture 56		
Course			
achievement	None		
Examination	Written exam		
Examination duration and scale	2 Hours		
the Following	Energy Systems: Core qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration Elective Compulsory Product Development, Materials and Production: Core qualification: Compulsory Naval Architecture and Ocean Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory		

Course L0701: Vibr	ation Theory
Тур	Integrated Lecture
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	WiSe
Content	Linear and Nonlinear Single and Multiple Degree of Freedom Oscillations and Waves.
Literature	K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen. Springer Verlag, 2013.

Module M0814	4: Technology Manageme	ent		
Courses				
Title		Тур	Hrs/wk	СР
Technology Manageme	ent (L0849)	Project-/problem-	3	3
Technology Manageme		based Learning Project-/problem- based Learning	2	3
Module Responsible	I Prof. Cornellis Herstatt	3		
Admission Requirements	None			
Recommended Previous Knowledge	Bachelor knowledge in business ma	nagement		
Educational Objectives	After taking part successfully stude	nts have reached the fol	lowing learn	ing results
Professional Competence				
Knowledge	International R&D-Manageme Technology Timing Strategies Technology Strategies Technology Intelligenc Technology Portfolio Manage Technology Portfolio Manage Technology Portfolio M Technology Acquisition IP Management Organizing Technology Devel Technology Funding &	ent and Lifecycle Manageme e and Planning ment ethodology n and Exploitation opment on & Management	ent (I/II)	
Skills	 Develop an understanding of a national as well as internati Equip students with an under Management (strategic, of aspects) Foster a strategic oriental process as well as Technolog strategy Clarify activities of Technomaintenance and exploitation Strengthen essential commanagerial, organizational Innovation- and R&D-manage Basic concepts, models a technology, R&D and innovation as a process (step 	onal level erstanding of important erstanding of important erstanding of important erstanding organization tion to problem-solving y Management and its in logy Management (e.g. n) equivalent of the solution of the solution in the solution of the solution	elements of al and pro within the mportance for technolog basic under oncerning Toe discussed	Technology cess-related innovation or corporate y sourcing, estanding of Technology-, include:
Personal Competence		5, activities und results)		
Social Competence	Interact within a teamRaise awareness for globabl i	ssues		
	Gain access to knowledge so	urces		

Autonomy	 Discuss recent research debates in the context of Technology and Innovation Management Develop presentation skills Discussion of international cases in R&D-Management
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	
Assignment for the Following Curricula	Global Innovation Management: Core qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory

Course I 0940; Tool	hnology Management
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	The role of technology for the competitive advantage of the firm and industries; Basic concepts, models and tools for the management of technology; managerial decision making regarding the identification, selection and protection of technology (make or buy, keep or sell, current and future technologies). Theories, practical examples (cases), lectures, interactive sessions and group study. This lecture is part of the Module Technology Management and can not separately choosen.
Literature	Leiblein, M./Ziedonis, A.: Technology Strategy and Inoovation Management, Elgar Research Collection, Northhampton (MA) 2011

Course L0850: Tech	hnology Management Seminar
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Beside the written exam at the end of the module, students have to give one presentation (RE) on a research paper and two presentations as part of a group discussion (GD) in the seminar in order to pass. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.
Literature	see lecture Technology Management.

Courses						
Courses			T	11/		
Title Microsystems Technolo	oav (L0724)		Typ Lecture	Hrs/wk 2	CP 4	
Microsystems Technolo			Project-/problem-	2	2	
			based Learning			
Module Responsible	Prof. Hoc Khiem Trieu	I				
Admission Requirements	INODE					
Recommended	Pasies in physics, sho	mistry mechan	ics and semiconductor	r technology		
Previous Knowledge		inistry, mechan	ics and semiconductor	technology		
Educational		essfully studen	ts have reached the fo	llowing learn	ing result	
Objectives			ts have reached the it	niowing lean	ing result	
Professional Competence						
-	Students are able					
	especially methods for	• to present and to explain current fabrication techniques for microstructures a especially methods for the fabrication of microsensors and microactuators, as was the integration thereof in more complex systems				
Knowledge	• to explain in de	etails operation	principles of microser	nsors and mi	croactuat	
	to discuss the potential and limitation of microsystems in application.					
	Students are capable					
	to analyze the feature.	asibility of micro	systems,			
	 to develop proce 	ss flows for the	abrication of microstr	uctures and		
CL 'II	to apply them.					
Skills	a appry anemi					
Personal						
Competence	 					
	Ctudents are abla to	nronovo	orform their leb acce	rimanta ia ta	an war	
Social Competence	well as to present and		erform their lab expe		aiii WOFK	
	Ness					
Autonomy	None					
	Independent Study Ti	me 124, Study	Fime in Lecture 56			
Credit points	! !					
	CompulsorBonus	Form	Descr	-	ühron	
			Studie Kleingi		ühren	

Course achievement	Yes	None	Subject practical	theoretica work	I and Laborpraktikum durch. Jede Gruppe präsentiert und diskutiert die Theorie sowie die Ergebniise ihrer Labortätigkeit. vor dem gesamten Kurs.
Examination	Oral exam				
Examination duration and scale	30 min				
Assignment for the Following Curricula	Technology: Electrical En Internationa Compulsory Biomedical I Elective Con Biomedical Compulsory Biomedical Elective Con Biomedical Elective Con Biomedical Elective Con Elective E	Elective Congineering: Solution In Managemering In Managemerin	mpulsory specialisatent and En Specialis Special Special Special	cion Medical ngineering: sation Artific lisation Im isation Med sation Mana	Nanoelectronics and Microsystems Technology: Elective Compulsory Specialisation II. Mechatronics: Elective cial Organs and Regenerative Medicine: plants and Endoprostheses: Elective dical Technology and Control Theory: agement and Business Administration: elification: Elective Compulsory

	Microelectronics and Microsystems: Core qualification: Elective Compulsory
Course L0724: Micr	osystems Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nanoimprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: pellistor and thermal and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal

conductivity	sensor; metal	oxide	semico	nductor	gas	sensor,	organic
semiconductor	gas sensor, La	mbda pr	obe, Mo	OSFET ga	s sens	sor, pH-F	ET, SAW
sensor, principle							
Micro Actuators	s, Microfluidics	and TAS	S (drive	es: therm	al, ele	ectrostat	ic, piezo
electric and e	electromagnetic	c; light	modul	ators, D	MD,	adaptive	optics,
microscanner,	microvalves:	passive	and a	active, n	nicrop	umps, \	/alveless

- micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics)
 MEMS in medical Engineering (wireless energy and data transmission, smart pill implantable drug delivery system, stimulators; microelectrodes, cochlear
- pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration)
- Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship)
- System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)

M. Madou: Fundamentals of Microfabrication, CRC Press, 2002

N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009

Literature

T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010

G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L0725: Microsystems Technology		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Hoc Khiem Trieu	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title Control Systems Theor		Typ Lecture Recitation	Hrs/wk 2 Section ₂	4
Control Systems Theor	ry and Design (L0657)	(small)	2	2
Responsible	<u> </u>			
Admission Requirements	INONE			
Recommended Previous Knowledge	Introduction to Control Systems			
Educational Objectives		nts have reached	the following lea	rning results
Professional Competence				
Knowledge	 Students can explain how lir space models; they can interexternal excitation as trajected. They can explain the system their relationship to state feee They can explain the significated. They can explain observer-beachieve tracking and disturbed tracking and disturbed. They can extend all of the abeach time can explain the z-trated transform. They can explain state space time systems. They can explain the experification systems, and how the identity normal equation. They can explain how a state state space time impulse response. 	erpret the system ories in state space properties control dback and state eance of a minimal ased state feedback ance rejection ove to multi-input nsform and its models and transmental identification problem tate space mode	n response to infection of ARX mode to infection of ARX mode to infection of a can be solved.	ervability, ar tively an be used t tems the Laplace els of discret ls of dynam by solving
Skills	 Students can transform transvice versa They can assess controllabrealisations They can design LQG controll They can carry out a control time domain, and decide whi They can identify transfer dynamic systems from expering the control Toolbox, System Iden 	ers for multivarial ler design both in the is appropriate function models imental data e tasks using sta	ability and const ole plants continuous-time for a given sampl and state spac	and discrete ling rate ce models o
Personal Competence				
Social Competence	Students can work in small groups of	on specific problen	ns to arrive at joir	nt solutions.
	Students can obtain information f documentation, experiment guides)	rom provided sou	urces (lecture no	tes, softwai

Autonomy	They can assess their knowledge in weekly on-line tests and thereby control their learning progress.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	
Assignment for the Following Curricula	Electrical Engineering: Core qualification: Compulsory Energy Systems: Core qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Compulsory Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory Computational Science and Engineering: Specialisation II. Engineering Science: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Compulsory

Course L0656: Con	trol Systems Theory and Design
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	State space methods (single-input single-output) State space models and transfer functions, state feedback Coordinate basis, similarity transformations Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem Controllability and pole placement State estimation, observability, Kalman decomposition Observer-based state feedback control, reference tracking Transmission zeros Optimal pole placement, symmetric root locus Multi-input multi-output systems Transfer function matrices, state space models of multivariable systems, Gilbert realization Poles and zeros of multivariable systems, minimal realization Closed-loop stability Pole placement for multivariable systems, LQR design, Kalman filter Digital Control Discrete-time systems: difference equations and z-transform Discrete-time state space models, sampled data systems, poles and zeros Frequency response of sampled data systems, choice of sampling rate System identification and model order reduction Least squares estimation, ARX models, persistent excitation Identification of state space models, subspace identification Balanced realization and model order reduction Case study Modelling and multivariable control of a process evaporator using Matlab and Simulink Software tools Matlab/Simulink
Literature	 Werner, H., Lecture Notes "Control Systems Theory and Design" T. Kailath "Linear Systems", Prentice Hall, 1980 K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997 L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999

Course L0657: Con	Course L0657: Control Systems Theory and Design		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Herbert Werner		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
		T	Hara facilis	CD
Title The Digital Enterprise	(10932)	Typ Lecture	Hrs/wk 2	CP 2
Production Planning ar		Lecture	2	2
Production Planning ar		Recitation	Section ₁	1
roduction riamming at	Gold (2000)	(small) Recitation	Soction	-
Exercise: The Digital E	interprise (L0933)	(small)	Section 1	1
Module Responsible				
Admission Requirements	LINODA			
Recommended				
	Fundamentals of Production and Q	uality Management	t	
Knowledge	1			
Educational Objectives		lents have reached	the following learn	ning results
Professional	4			
Competence				
Knowledge	Students can explain the contents of the module in detail and take a critical necition			
Skills	Ctudents are comple of chaosing and applying models and mothods from the			
Personal Competence				
<u>-</u>	Students can develop joint solution	ns in mixed teams a	and present them t	o others.
Autonomy	•		·	
Workload in Hours	Independent Study Time 96, Study	Time in Lecture 84	4	
Credit points	6			
Course achievement				
	Written exam			
Examination duration and scale	180 Minuten			
Scale	International Management and En	gineering: Speciali	sation II Product C)evelonme
	and Production: Elective Compulso	ory		•
	Logistics, Infrastructure and Mo	bility: Specialisation	on Production an	d Logistic
	Elective Compulsory Biomedical Engineering: Specialisa	ation Artificial Orga	ns and Regenerativ	ve Medicine
	Elective Compulsory			
	Biomedical Engineering: Special	isation Implants a	and Endoprosthes	es: Electiv
	Compulsory Biomedical Engineering: Specialis	sation Medical Tec	hnology and Cont	trol Theor
	Elective Compulsory			
Assignment for Biomedical Engineering: Specialisation Management and Business Administra				ministratio
	Compulsory Product Development, Materia	als and Product	ion: Specialisatio	on Produ
	Development: Elective Compulsory		Jon. Specialisation	,, i i i i i u u
	Product Development, Material		n: Specialisation	Productio
	Compulsory	and Droduction: Co	ocialisation Materi	alc: Flacti
	Product Development, Materials a Compulsory	and Production. Sp	recialisation Materi	ais. Liecti
	Compulsory Theoretical Mechanical Engineer Production: Elective Compulsory	·		

Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0932: The	Digital Enterprise
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered. Content: Business Process Management and Data Modelling, Simulation Knowledge and Competence Management Process Management (PPC, Workflow Management) Computer Aided Planning (CAP) and NC-Programming Virtual Reality (VR) and Augmented Reality (AR) Computer Aided Quality Management (CAQ) Industry 4.0
Literature	Scheer, AW.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002 Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag. Berlin 3. Auflage 2006 Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004 Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007 Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006

Course L0929: Production Planning and Control			
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Hermann Lödding		
Language	DE		
Cycle	WiSe		
Content	 Models of Production and Inventory Management Production Programme Planning and Lot Sizing Order and Capacity Scheduling Selected Strategies of PPC Manufacturing Control Production Controlling Supply Chain Management 		
Literature	 Vorlesungsskript Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 Nyhuis, P.; Wiendahl, HP.: Logistische Kennlinien, Springer 2002 		

Course L0930: Prod	Course L0930: Production Planning and Control		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Hermann Lödding		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0933: Exercise: The Digital Enterprise	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	
Content	See interlocking course
Literature	Siehe korrespondierende Vorlesung See interlocking course

Module M092:	1: Electronic Circuits for	Medical Applic	ations	
Courses				
Title	Medical Applications (L0696)	Typ Lecture	Hrs/wk	CP 3
Electronic Circuits for I	Medical Applications (L1056)	Recitation S (small)	ection 1	2
Electronic Circuits for I	Medical Applications (L1408)	Practical Course	1	1
Кезропзыне				
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of electrical enginee	ring		
Educational Objectives	After taking part successfully, stude	ents have reached the	following lear	ning results
Professional Competence				
Knowledge	 Students can explain the base central nervous system Students are able to explain propagation along an axon Students can exemplify the devices Students can describe the spapplications Students can explain the fun Students are able to discuss and artificial eyes 	nin the build-up of a communication betwo decial features of low- actions of prostheses,	n action pote een neurons a noise amplifier e. g. an artificia	ntial and it nd electron s for medica al hand
Skills	 Students can calculate the potential Students can give scenarios power signal acquisition. Students can develop the bl Students can define the buil eye. 	s for further improver	ment of low-no	ise and low
Personal Competence				
Social Competence	 Students are trained to solv teams together with experts Students are able to recogni for assistance to the right tin Students can document their results in a way that others of 	with different profess ize their specific limita ne. r work in a clear man	ional backgrou ations, so that ner and comm	nd. they can as unicate the
	 Students are able to realisti define actions for improveme Students can break down 	ents when necessary.		

Autonomy	 schedule their work in a realistic way. Students can handle the complex data structures of bioelectrical experiments without needing support. Students are able to act in a responsible manner in all cases and situations of experimental work. 	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Credit points	6	
	CompulsorBonus Form Description	
Course achievement	practical work	
	No None Excercises	
	Written exam	
Examination duration and scale		
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Microelectronics and Microsystems: Specialisation Microelectronics Complements: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	

Course L0696: Elec	tronic Circuits for Medical Applications
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Matthias Kuhl
Language	EN
Cycle	WiSe
Content	 Market for medical instruments Membrane potential, action potential, sodium-potassium pump Information transfer by the central nervous system Interface tissue - electrode Amplifiers for medical applications, analog-digital converters Examples for electronic implants Artificial eye, cochlea implant
Literature	Kim E. Barret, Susan M. Barman, Scott Boitano and Heddwen L. Brooks Ganong's Review of Medical Physiology, 24nd Edition, McGraw Hill Lange, 2010 Tier- und Humanphysiologie: Eine Einführung von Werner A. Müller (Author), Stephan Frings (Author), 657 p., 4. editions, Springer, 2009 Robert F. Schmidt (Editor), Hans-Georg Schaible (Editor) Neuro- und Sinnesphysiologie (Springer-Lehrbuch) (Paper back), 488 p., Springer, 2006, 5. Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springer, 4th ed., 616 p., 2007 Vorlesungen der Universität Heidelberg zur Tier- und Humanphysiologie: http://www.sinnesphysiologie.de/gruvo03/gruvoin.htm Internet: http://butler.cc.tut.fi/~malmivuo/bem/bembook/

Course L1056: Electronic Circuits for Medical Applications		
Тур	Typ Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Matthias Kuhl	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1408: Elec	tronic Circuits for Medical Applications
Тур	Practical Course
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Matthias Kuhl
Language	EN
Cycle	WiSe
Content	 Market for medical instruments Membrane potential, action potential, sodium-potassium pump Information transfer by the central nervous system Interface tissue - electrode Amplifiers for medical applications, analog-digital converters Examples for electronic implants Artificial eye, cochlea implant
Literature	Kim E. Barret, Susan M. Barman, Scott Boitano and Heddwen L. Brooks Ganong's Review of Medical Physiology, 24nd Edition, McGraw Hill Lange, 2010 Tier- und Humanphysiologie: Eine Einführung von Werner A. Müller (Author), Stephan Frings (Author), 657 p., 4. editions, Springer, 2009 Robert F. Schmidt (Editor), Hans-Georg Schaible (Editor) Neuro- und Sinnesphysiologie (Springer-Lehrbuch) (Paper back), 488 p., Springer, 2006, 5. Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springer, 4th ed., 616 p., 2007 Vorlesungen der Universität Heidelberg zur Tier- und Humanphysiologie: http://www.sinnesphysiologie.de/gruvo03/gruvoin.htm Internet: http://butler.cc.tut.fi/~malmivuo/bem/bembook/

): Continuum Mechanics			
(L1533) Exercise (L1534)	Typ Lecture Recitation (small)	Hrs/wk 2 Section 2	CP 3
Prof. Christian Cyron			
None			
Basics of linear continuum mechanics as taught, e.g., in the module Mechanics II (forces and moments, stress, linear strain, free-body principle, linear-elastic constitutive laws, strain energy).			
After taking part successfully, students h	ave reached t	the following lear	ning results
The students can explain the fundame behavior of materials.	ntal concepts	to calculate the	mechanical
The students can set up balance laws and apply basics of deformation theory to specific aspects, both in applied contexts as in research contexts.			
The students are able to develop solution form and to develop ideas further.	ns, to present	them to speciali	sts in written
The students are able to assess their own strengths and weaknesses. They can independently and on their own identify and solve problems in the area of continuum mechanics and acquire the knowledge required to this end.			
Independent Study Time 124, Study Time	e in Lecture 5	6	
6			
None			
Written exam			
45 min			
Mechanical Engineering and Manage Compulsory Mechatronics: Technical Complementary Biomedical Engineering: Specialisation A Elective Compulsory Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Elective Compulsory	ement: Speci Course: Elect ertificial Organ Implants a Medical Tech	alisation Materialive Compulsory as and Regeneration and Endoprosthes anology and Con	ve Medicine: ses: Elective trol Theory:
	(L1533) Exercise (L1534) Prof. Christian Cyron None Basics of linear continuum mechanics a (forces and moments, stress, linear constitutive laws, strain energy). After taking part successfully, students he behavior of materials. The students can explain the fundame behavior of materials. The students are able to develop solution form and to develop ideas further. The students are able to assess their independently and on their own ider continuum mechanics and acquire the kroman language in the students of the study Time 124, Stud	(L1533) Exercise (L1534) Prof. Christian Cyron None Basics of linear continuum mechanics as taught, e.g. (forces and moments, stress, linear strain, freeconstitutive laws, strain energy). After taking part successfully, students have reached to the students can explain the fundamental concepts behavior of materials. The students can set up balance laws and apply baspecific aspects, both in applied contexts as in research form and to develop ideas further. The students are able to develop solutions, to present form and to develop ideas further. The students are able to assess their own strength independently and on their own identify and solutions and acquire the knowledge required independent Study Time 124, Study Time in Lecture 56 None Written exam 45 min Materials Science: Specialisation Modeling: Elective Compulsory Mechatronics: Technical Complementary Course: Elect Biomedical Engineering: Specialisation Implants a Compulsory Biomedical Engineering: Specialisation Implants a Compulsory Biomedical Engineering: Specialisation Implants a Compulsory Biomedical Engineering: Specialisation Medical Tech Elective Compulsory	(L1533) Exercise (L1534) Prof. Christian Cyron None Basics of linear continuum mechanics as taught, e.g., in the module (forces and moments, stress, linear strain, free-body principle, constitutive laws, strain energy). After taking part successfully, students have reached the following learn The students can explain the fundamental concepts to calculate the behavior of materials. The students can explain the fundamental concepts to calculate the behavior of materials. The students are able to develop solutions, to present them to specialis form and to develop ideas further. The students are able to assess their own strengths and weaknesse independently and on their own identify and solve problems in continuum mechanics and acquire the knowledge required to this end. Independent Study Time 124, Study Time in Lecture 56 None Written exam 45 min Materials Science: Specialisation Modeling: Elective Compulsory Mechanical Engineering and Management: Specialisation Materia Compulsory Biomedical Engineering: Specialisation Implants and Endoprosthes Compulsory Biomedical Engineering: Specialisation Implants and Endoprosthes Compulsory Biomedical Engineering: Specialisation Implants and Endoprosthes Compulsory Biomedical Engineering: Specialisation Implants and Endoprosthes Compulsory Biomedical Engineering: Specialisation Implants and Endoprosthes Compulsory Biomedical Engineering: Specialisation Medical Technology and Con

Elective Compulsory
Product Development, Materials and Production: Core qualification: Elective
Compulsory
Theoretical Mechanical Engineering: Technical Complementary Course: Elective
Compulsory
Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L1533: Continuum Mechanics		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Christian Cyron	
Language	DE	
Cycle	WiSe	
Content	 kinematics of undeformed and deformed bodies balance equations (balance of mass, balance of energy,) stress states material modelling 	
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer	

Course L1534: Con	tinuum Mechanics Exercise
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	 kinematics of undeformed and deformed bodies balance equations (balance of mass, balance of energy,) stress states material modelling
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Module M115	L: Material Modeling			
Courses				
Title		Тур	Hrs/wk	СР
Material Modeling (L15	35)	Lecture	2	3
Material Modeling (L15	36)	Recitation (small)	Section 2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of linear and nonlinear contin Mechanics II and Continuum Mecha nonlinear strain, free-body principle energy)	nics (forces and	moments, stress	, linear and
Educational Objectives	After taking part successfully, studen	ts have reached	the following learn	ing results
Professional Competence				
Knowledge	The students can explain the fundam laws	entals of multidi	mensional consitut	tive material
Skills	The students can implement their particular, the students can apply the science and evaluate the correspond	eir knowledge to	various problems	
Personal Competence				
Social Competence	The students are able to develop so develop ideas further.	olutions, to prese	ent them to specia	alists and to
Autonomy	The students are able to assess th independently and on their own iden modeling and acquire the knowledge	tify and solve pro	blems in the area	
Workload in Hours	Independent Study Time 124, Study	 Time in Lecture 5	6	
Credit points	,			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following		agement: Speci on Artificial Orgar tion Implants a ion Medical Tecl	alisation Materians and Regeneration and Endoprosthese noology and Cont	ve Medicine: es: Elective crol Theory:

Product Development, Materials and Production: Core qualification: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory
Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L1535: Mate	erial Modeling
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	One of the most important questions when modeling mechanical systems in practice is how to model the behavior of the materials of their different components. In addition to simple isotropic elasticity in particular the following phenomena play key roles - anisotropy (material behavior depending on direction, e.g., in fiber-reinforced materials) - plasticity (permanent deformation due to one-time overload, e.g., in metal forming) - viscoelasticity (absorption of energy, e.g., in dampers) - creep (slow deformation under permanent load, e.g., in pipes) This lecture briefly introduces the theoretical foundations and mathematical modeling of the above phenomena. It is complemented by exercises where simple examples problems are solved by calculations and where the implementation of the content of the lecture in computer simulations is explained. It will also briefly discussed how important material parameters can be determined from experimental data.
Literature	

Course L1536: Material Modeling	
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1199	9: Advanced Funct	ional Mate	rials		
Courses					
Title Advanced Functional N	Materials (L1625)		Typ Seminar	Hrs/wk 2	CP 6
Admission Requirements	None				
Recommended Previous Knowledge		als Science, e.g.	Materials Scie	ence I/II	
Educational Objectives	LATTAR TAKING NART SHCCASSTIL	ılly, students ha	ve reached th	e following learn	ing results
Professional Competence					
Knowledge	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.				
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.				
Personal Competence					
Social Competence	The students are able to present solutions to specialists and to develop ideas further.				
Autonomy	The students are able to • assess their own stre		ıknesses.		
	gather new necessa				
	Independent Study Time 1	52, Study Time	in Lecture 28		
Credit points					
Course achievement	None				
Examination	Presentation				
Examination duration and scale	30 min				
Assignment for the Following Curricula					

Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L1625: Adv	Course L1625: Advanced Functional Materials			
Тур	Seminar			
Hrs/wk	2			
СР	6			
	Independent Study Time 152, Study Time in Lecture 28			
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Christian Cyron			
Language	DE			
Cycle	WiSe			
Content	 Porous Solids - Preparation, Characterization and Functionalities Fluidics with nanoporous membranes Thermoplastic elastomers Optimization of polymer properties by nanoparticles Fiber composites in automotive Modeling of materials based on quantum mechanics Biomaterials 			
Literature	Aktuelle Publikationen aus der Fachliteratur werden während der Veranstaltung bekanntgegeben.			

Module M127 Biology	9: MED II: Introduction	to Biochemistr	y and N	1olecular
biology				
Courses				
Title Introduction to Biocher	mistry and Molecular Biology (L0386)	Typ Lecture	Hrs/wk	CP 3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, stude	ents have reached the fo	ollowing lear	ning results
Professional Competence				
Knowledge	 describe basic biomolecules; explain how genetic information is coded in the DNA; explain the connection between DNA and proteins; 			
Skills	 The students can recognize the importance of molecular parameters for the course of a disease; describe selected molecular-diagnostic procedures; explain the relevance of these procedures for some diseases 			
Personal Competence				
Social Competence	The students can participate in disc level.	cussions in research and	d medicine o	n a technical
Autonomy	The students can develop understa literature, by themselves.	inding of topics from th	e course, us	ing technical
Workload in Hours	Independent Study Time 62, Study	Time in Lecture 28		
Credit points	I i			
Course achievement				
	Written exam			
Examination duration and scale	60 minutes			
	General Engineering Science (G Biomedical Engineering: Compulsor General Engineering Science (G Mechanical Engineering, Focus Bion Data Science: Specialisation Medicin Electrical Engineering: Specialisation Engineering Science: Specialisation General Engineering Science (E Biomedical Engineering: Compulsor General Engineering Science (E	y erman program, 7 sonechanics: Compulsory ne: Compulsory n Medical Technology: E Biomedical Engineering nglish program, 7 so	emester): S Elective Com I: Compulsor emester): S	Specialisation pulsory y Specialisation
the Following	Mechanical Engineering Science (E Mechanical Engineering, Focus Bion Mechanical Engineering: Specialisat	nechanics: Compulsory		opecialisation

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0386: Introduction to Biochemistry and Molecular Biology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Hans-Jürgen Kreienkamp		
Language	DE		
Cycle	WiSe		
Content			
	Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage		
	Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008		
Literature			

Module M1333	3: BIO I: Implants and	Fracture Healing		
Courses				
Title Implants and Fracture	Healing (L0376)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
	It is recommended to participal "Implants and Fracture Healing		natomie" befo	re attending
Educational Objectives	After taking part successfully, s	students have reached the	following learn	ning results
Professional Competence				
Knowledge	The students can describe the for their existence. The students can name differe given fracture morphologies.	-		•
Skills	The students can determine the static situations under specific		human body	under quasi-
Personal Competence				
Social Competence	The students can, in groups calculation of internal forces.	s, solve basic numerical	l modeling ta	isks for the
Autonomy	The students can, in groups calculation of internal forces.	s, solve basic numerical	l modeling ta	isks for the
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28		
Credit points	3			
Course achievement	None			
Examination				
Examination duration and scale				
Assignment for the Following Curricula	General Engineering Science Mechanical Engineering, Focus General Engineering Science Biomedical Engineering: Computengineering Science: Specialisa General Engineering Science Biomedical Engineering: Computengineerial Engineering: Computengineerial Engineering: Science Mechanical Engineering: Special Engineering: Special Engineering: Special Elective Compulsory Biomedical Engineering: Special Engineering:	Biomechanics: Compulsor (German program, 7 ulsory ation Biomedical Engineering (English program, 7 ulsory (English program, 7 Biomechanics: Compulsor alisation Biomechanics: Compulsor alisation Artificial Organs a cialisation Implants and ialisation Medical Techno	y semester): S ng: Compulsor semester): S semester): S y mpulsory nd Regenerati Endoprosthes logy and Con	pecialisation y pecialisation pecialisation ve Medicine: es: Elective trol Theory:

Orientierungsstudium: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0376: Imp	lants and Fracture Healing			
Тур	Lecture			
Hrs/wk	2			
СР				
	Independent Study Time 62, Study Time in Lecture 28			
	Prof. Michael Morlock			
Language Cycle				
Cycle	Topics to be covered include:			
	Introduction (history, definitions, background importance)			
	2. Bone (anatomy, properties, biology, adaptations in femur, tibia, humerus, radius)			
	3. Spine (anatomy, biomechanics, function, vertebral bodies, intervertebral disc, ligaments)			
	3.1 The spine in its entirety			
	3.2 Cervical spine			
	3.3 Thoracic spine			
	3.4 Lumbar spine			
	3.5 Injuries and diseases			
Content	4. Pelvis (anatomy, biomechanics, fracture treatment)			
Content	5 Fracture Healing			
	5.1 Basics and biology of fracture repair			
	5.2 Clinical principals and terminology of fracture treatment			
	5.3 Biomechanics of fracture treatment			
	5.3.1 Screws			
	5.3.2 Plates			
	5.3.3 Nails			
	5.3.4 External fixation devices			
	5.3.5 Spine implants			
	6.0 New Implants			
	Cook way M.D. Outhou and discha Biannachaudh			
	Cochran V.B.: Orthopädische Biomechanik			
	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics			
Literature	White A.A., Panjabi M.M.: Clinical biomechanics of the spine			
	Nigg, B.: Biomechanics of the musculo-skeletal system			
	Schiebler T.H., Schmidt W.: Anatomie			
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat			

Module M1334	4: BIO II: Biomaterials		
Courses			
Title Biomaterials (L0593)	TypHrs/wkCPLecture23		
Module Responsible	Prof. Michael Morlock		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge of orthopedic and surgical techniques is recommended.		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional			
Competence Knowledge	The students can describe the materials of the human body and the materials being used in medical engineering, and their fields of use.		
Skills	The students can explain the advantages and disadvantages of different kinds of biomaterials.		
Personal Competence			
Social Competence	The students are able to discuss issues related to materials being present or being used for replacements with student mates and the teachers.		
Autonomy	The students are able to acquire information on their own. They can also judge the information with respect to its credibility.		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points	3		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory		

Course L0593: Biomaterials	
Тур	Lecture
Hrs/wk	2

	3 Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Michael Morlock		
Language			
Cycle	WiSe Topics to be covered include:		
	Introduction (Importance, nomenclature, relations) Biological materials		
	2.1 Basics (components, testing methods)		
	2.2 Bone (composition, development, properties, influencing factors)		
	2.3 Cartilage (composition, development, structure, properties, influencing factors)2.4 Fluids (blood, synovial fluid)		
	3 Biological structures 3.1 Menisci of the knee joint		
	3.2 Intervertebral discs		
	3.3 Teeth		
	3.4 Ligaments 3.5 Tendons		
Content			
	3.7 Nervs		
	3.8 Muscles		
	4. Replacement materials		
	4.1 Basics (history, requirements, norms)		
	4.2 Steel (alloys, properties, reaction of the body)		
	4.3 Titan (alloys, properties, reaction of the body)		
	4.4 Ceramics and glas (properties, reaction of the body)		
	4.5 Plastics (properties of PMMA, HDPE, PET, reaction of the body)		
	4.6 Natural replacement materials		
	Knowledge of composition, structure, properties, function and changes/adaptation of biological and technical materials (which are used for replacements in-vivo Acquisition of basics for theses work in the area of biomechanics.		
	Hastings G and Ducheyne P.: Natural and living biomaterials. Boca Raton: CRO Press, 1984.		
	Williams D.: Definitions in biomaterials. Oxford: Elsevier, 1987.		
	Hastings G.: Mechanical properties of biomaterials: proceedings held at Kee University, September 1978. New York: Wiley, 1998.		
Literature	Black J.: Orthopaedic biomaterials in research and practice. New York: Church Livingstone, 1988.		
	Park J. Biomaterials: an introduction. New York: Plenum Press, 1980.		
	ı		

Wintermantel, E. und Ha, SW: Biokompatible Werkstoffe und Bauweisen. Berlin, Springer, 1996.

Module M0808	3: Finite Element	ts Methods			
Courses					
Title Finite Element Method Finite Element Method			Typ Lecture Recitation	Hrs/wk 2 Section 2	CP 3
Time Element Method	3 (10004)		(large)		
Module Responsible	Prof. Otto von Estorii				
Admission Requirements	none				
Recommended Previous Knowledge	Kinematics, Dynamics)				
Educational Objectives	After taking part succes	ssfully, students h	ave reached th	ne following learn	ing results
Professional Competence					
Knowledge	The students possess a element method and ar basis of the method.				
Skills	The students are capal finite elements, assem resulting system of equ	bling the corresp			
Personal Competence Social Competence	Students can work in sr	mall groups on spe	ecific problems	to arrive at joint	solutions.
Autonomy	The students are able and develop own finite are critically scrutinized	element routines.			
Workload in Hours	Independent Study Time	e 124. Study Time	e in Lecture 56		
Credit points	<u>. </u>	, 2-223, 12110			
-	CompulsorBonus	Form Midterm	De	escription	
Examination	Written exam				
Examination duration and scale					
	Civil Engineering: Core Energy Systems: Core of Aircraft Systems Engine Aircraft Systems Engin	qualification: Elect eering: Specialisat	ive Compulsor ion Aircraft Sy	stems: Elective C	

Assignment for the Following Curricula	Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Product Development, Materials and Production: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Compulsory
--	--

Course L0291: Finite Element Methods		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Otto von Estorff	
Language	EN	
Cycle	WiSe	
Content	 General overview on modern engineering Displacement method Hybrid formulation Isoparametric elements Numerical integration Solving systems of equations (statics, dynamics) Eigenvalue problems Non-linear systems Applications Programming of elements (Matlab, hands-on sessions) Applications 	
Literature	Bathe, KJ. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin	

Course L0804: Finite Element Methods		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Otto von Estorff	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1342	2: Polymers				
Courses					
Title		Тур	Hrs/wk	СР	
	es of Polymers (L0389) with polymers (L1892)	Lecture Lecture	2 2	3 3	
Module					
Responsible	Dr. Hans Witticn				
Admission Requirements	None				
Recommended Previous Knowledge	Basics: chemistry / physics / ma	aterial science			
Educational Objectives	After taking part successfully, s	tudents have reached the	following learn	ing results	
Professional Competence					
Competence	Students can use the knowled analysis.	ge of plastics and define	the necessary	testing and	
Knowledge	They can explain the complex r	elationships structure-pro	perty relationsh	nip and	
	the interactions of chemical structure of the polymers, including to explain neighboring contexts (e.g. sustainability, environmental protection).				
	Students are capable of				
Skills	- using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials.				
	- selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.				
Personal					
Competence	Students can				
	- arrive at funded work results in heterogenius groups and document them.				
Social Competence	- provide appropriate feedback and handle feedback on their own performance constructively.				
	Students are able to				
	- assess their own strengths and weaknesses.				
Autonomy	- assess their own state of learning in specific terms and to define further work steps on this basis.				
	- assess possible consequences of their professional activity.				
Workload in Hours	Independent Study Time 124, S	Study Time in Lecture 56			
Credit points	I				
Course achievement	None				
Examination	Written exam				
Examination duration and					

scale	
Assignment for the Following Curricula	Materials Science: Specialisation Engineering Materials: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L0389: Stru	cture and Properties of Polymers			
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Dr. Hans Wittich			
Language	DE			
Cycle	WiSe			
	- Structure and properties of polymers			
	- Structure of macromolecules			
Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular w distribution				
	- Morphology			
	amorph, crystalline, blends			
Content - Properties				
	Elasticity, plasticity, viscoelacity			
	- Thermal properties			
	- Electrical properties			
	- Theoretical modelling			
	- Applications			
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag			

Course L1892: Prod	cessing and design with polymers
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Dr. Hans Wittich
Language	DE/EN
Cycle	WiSe
Content	Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining Designing with Polymers: Materials Selection; Structural Design; Dimensioning
Literature	Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag Crawford: Plastics engineering, Pergamon Press Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag Konstruieren mit Kunststoffen, Gunter Erhard, Hanser Verlag

Module M0632	2: Regenerative	Medicine			
Courses					
Title Regenerative Medicine (L0347) Lecture Tissue Engineering - Regenerative Medicine (L1664)			Typ Seminar Seminar	Hrs/wk 2 2	CP 3 3
Module Responsible	Prof. Ralf Pörtner				
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part succe	essfully, students h	nave reached the	following learn	ing results
Professional Competence					
Knowledge	After successful completion of the module students will be able to describe the basic methods of regenerative medicine and to explain the use of the tissue cells for different methods of tissue engineering. They are able to give a basic overview of methods for the cultivation of animal and human cells. The students can outline the actual concepts of Tissue Engineering and regenerative medicine and can explain the basic udnerlying principles of the discussed topics.				
Skills	 able to use medical databases for acquirierung and presentation of relevant up-to-date data independently able to present their work results in the form of presentations able to carry out basic cell culture methods and the corresponding analysis independently able to analyse and evaluate current research topics for Tissue Engineering and regenerative medicine. 				
Personal Competence Social Competence	Students are able to wand discuss their resulustudents are able to reteachers.	Its in the plenary a	nd to defend ther	n.	
Autonomy	After completion of t problem in teams of a the results.	ipprox. 2-4 person	s independently i		
	Independent Study Tin	ne 124, Study Tim	e in Lecture 56		
Credit points					
Course achievement	Yes 20 %	Form Written elaborat	ion Ausai	ription rbeitung zu Rir ocol for lecture	
Examination	Presentation		-		

Examination duration and scale	Oral presentation + discussion (30 min)
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory

Course L0347: Regenerative Medicine			
Тур	Seminar		
Hrs/wk			
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Ralf Pörtner, Dr. Frank Feyerabend		
Language	DE		
Cycle	WiSe		
Content	The course deals with the application of biotechnological engineering principles for re-generation of human tissues. The main topics are "tissue engineering" for the generation of "artificial organs" such as cartilage, liver, blood vessel etc., and their applications: • Introduction (historical development, examples for medical and technical applications, commercial aspets) • Cell specific fundamentals (cell physiology, biochemistry, metabolism, special requirements for cell cultivation "in vitro") • Process specific fundamentals (requirements for culture systems, examples for reactor design, mathematical modelling, process and control strategies) • Examples for applications for clinical applications, drug testing and material testing The fundamentals will be presented by the lecturers. The "state of the art" of specific applications will be exploited by the students based on selected papers and presented during the course.		
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Academic Pr Inc; ISBN-10: 0123693713, ISBN-13: 978-0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-3540777540		

Course L1664: Lecture Tissue Engineering - Regenerative Medicine			
Тур	Seminar		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Ralf Pörtner, Prof. Michael Morlock		
Language	DE		
Cycle	WiSe		
Content	Discussion of current research topics for tissue engineering and regenerative medicine by invited experts		
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Academic Pr Inc; ISBN-10: 0123693713 , ISBN-13: 978-0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-3540777540		

Module M0630: Robotics and Navigation in Medicine					
Carrie					
Courses			T	11 /1-	<u> </u>
Title Robotics and Navigation	on in Medicine (L0335)		Typ Lecture	Hrs/wk 2	CP 3
Robotics and Navigation			Project Seminar	2	2
Robotics and Navigation	on in Medicine (L0336)		Recitation Section (small)	on 1	1
Module Responsible	IPINI AIPYANNEI SCHIAF	efer			
Admission Requirements	None				
Recommended Previous Knowledge	 principles of pro 	ath (algebra, analys ogramming, e.g., in b skills			
Educational Objectives	After taking part succe	essfully, students h	ave reached the foll	owing learn	ing results
Professional					
Competence	;				
Knowledge	The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.				
Skills	The students are able to design and evaluate navigation systems and robotic systems for medical applications.				
Personal Competence					
Social Competence	The students discuss incoorporate feedback		r groups, provide he	elpful feedb	ack and car
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.				
Workload in Hours	Independent Study Tir	ne 110, Study Time	e in Lecture 70		
Credit points	6				
Course achievement	CompulsorBonus Yes 10 % Yes 10 %	Form Written elaborati Presentation	Descrip ion	otion	
Examination	Written exam				
Examination duration and scale	90 minutes				
	Computer Science: Sp Electrical Engineering: International Manager Elective Compulsory International Manager and Biotechnology: Ele Mechatronics: Special Biomedical Engineerin Elective Compulsory Biomedical Engineeri	: Specialisation Medment and Engineering ment and Enginee ective Compulsory isation Intelligent Song: Specialisation A	dical Technology: Ele ing: Specialisation II ring: Specialisation ystems and Robotic rtificial Organs and	ective Comp . Electrical l II. Process s: Elective C Regenerativ	oulsory Engineering Engineering Compulsory ve Medicine

the Following	Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory			
Curricula	Biomedical Engineering: Specialisation Management and Business Administration:			
	Elective Compulsory			
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory			
	Product Development, Materials and Production: Specialisation Production: Elective			
	Compulsory			
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory			
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective			
	Compulsory			
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology:			
	Elective Compulsory			

Course L0335: Robotics and Navigation in Medicine		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	SoSe	
Content	 kinematics calibration tracking systems navigation and image guidance motion compensation The seminar extends and complements the contents of the lecture with respect to recent research results. 	
Literature	Spong et al.: Robot Modeling and Control, 2005 Troccaz: Medical Robotics, 2012 Further literature will be given in the lecture.	

Course L0338: Robotics and Navigation in Medicine		
Тур	Project Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0336: Robotics and Navigation in Medicine		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	EN	
Cycle	Cycle SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M138 Engineering	4: Case Studies for Reger	nerative Mo	edicine and	d Tissue
Courses				
Title Case Studies for Reger (L1963)	nerative Medicine and Tissue Engineering	Typ Seminar	Hrs/wk	CP 6
Module Responsible	Prof. Ralf Pörtner			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students	have reached th	e following learn	ing results
Professional Competence <i>Knowledge</i> <i>Skills</i>				
Personal Competence Social Competence Autonomy				
	Independent Study Time 138, Study Tin	ne in Lecture 42		
Credit points				
Course achievement	None			
Examination	Presentation			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisatio Compulsory Biomedical Engineering: Specialisation Elective Compulsory Biomedical Engineering: Specialisation Elective Compulsory	n Implants and	d Endoprosthese	es: Elective

Course L1963: Case Studies for Regenerative Medicine and Tissue Engineering		
Тур	Seminar	
Hrs/wk	3	
СР	6	
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42	
Lecturer	Prof. Ralf Pörtner, Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content		
Literature		

Courses					
	cal Technology and Syster cal Technology and Syster		Typ Lecture Project Seminar	Hrs/wk 2 2	CP 3 2
Introduction into Media	cal Technology and Syster	ms (L1876)	Recitation Section (large)	ⁿ 1	1
Module Responsible		fer	-		
Admission Requirements					
Recommended Previous Knowledge	principles of stochastic	cs	culus)		
Educational Objectives	LATTER TAKING NATT SHEED	ssfully, students h	nave reached the follo	wing learn	ing results
Professional Competence					
Knowledge	The students can ex systems, computer aid to give an overview of	led surgery, and r	medical information s	ystems. Th	ney are ab
Skills	The students are able clinical applications.	to evaluate syste	ems and medical dev	vices in the	e context
Personal Competence					
Social Competence	The students describe tasks that are solved in		edical technology as	a project,	and defir
Autonomy	The students can refle They can present the r			results of	their wor
Workload in Hours	Independent Study Tim	ne 110, Study Tim	e in Lecture 70		
Credit points	6				
Course achievement	Yes 10 % Yes 10 %	Form Written elaborat Presentation	Descript ion	ion	
	Written exam				
Examination duration and scale	90 minutes				
Assignment for	General Engineering Biomedical Engineering Computer Science: Sp Computer Science: Spe Computer Science: Spe Computer Science: Spe Compulsory Data Science: Core qua Electrical Engineering: Engineering Science: S General Engineering Biomedical Engineering Computational Science Engineering Science: E	g: Compulsory pecialisation Comecialisation II. Mat alification: Elective Core qualification pecialisation Biomecialisation (Englist) g: Compulsory ce and Enginee	puter and Software hematics and Engine e Compulsory : Elective Compulsory nedical Engineering: Compulsory nedical Engineering: Compulsory nedical Engineering: Compulsory	Engineerii ering Scier Compulsory ester): Sp	ng: Electiv nce: Electiv , pecialisatio
the Following	Engineering Science: E	lective Compulsor	ТУ		

Curricula	Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory
	Computational Science and Engineering: Specialisation Engineering Sciences:
	Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
	Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
	Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0342: Introduction into Medical Technology and Systems		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	DE	
Cycle	SoSe	
Content	 imaging systems computer aided surgery medical sensor systems medical information systems regulatory affairs standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning. 	
Literature	Wird in der Veranstaltung bekannt gegeben.	

Course L0343: Introduction into Medical Technology and Systems		
Тур	Project Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Alexander Schlaefer	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1876: Introduction into Medical Technology and Systems		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Alexander Schlaefer	
Language	DE	
Cycle	SoSe	
Content	 imaging systems computer aided surgery medical sensor systems medical information systems regulatory affairs standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning. 	
Literature	Wird in der Veranstaltung bekannt gegeben.	

Module M0752	2: Nonlinear Dynamics			
Courses				
Title Nonlinear Dynamics (L	_0702)	Typ Integrated Lecture	Hrs/wk 4	CP 6
Admission Requirements	None			
Recommended Previous Knowledge	Linear Algebra			
Educational Objectives	After taking part successfully, students h	ave reached the follo	wing learni	ng results
Professional Competence				
Knowledge	to develop and research new terms and o	concepts.		
Skills _	Dynamics and to develop novel methods		cesures of	Nonlinear
Personal Competence				
Social Competence	Students can reach working results also i			
Autonomy	Students are able to approach given res follow up novel research tasks by themse		Ily and to i	dentify and
	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	2 Hours			
Assignment for the Following Curricula		ing: Specialisation II. ent: Specialisation M ign: Elective Compuls ystems and Robotics: rtificial Organs and R Implants and End Medical Technology Management and Bu Production: Core	Mechatron Mechatronic Sory Elective Cegenerativ oprosthese and Cont siness Adr qualificatio tary Cours	ompulsory e Medicine: es: Elective rol Theory: ninistration: n: Elective ee: Elective

Course L0702: Nonlinear Dynamics		
Тур	Integrated Lecture	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Norbert Hoffmann	
Language	DE/EN	
Cycle	Cycle SoSe	
Content	Fundamentals of Nonlinear Dynamics.	
Literature	S. Strogatz: Nonlinear Dynamics and Chaos. Perseus, 2013.	

Module M0761	L: Semiconductor Techn	ology						
Courses								
Title Semiconductor Technologemiconductor		Typ Lecture Practical Course	Hrs/wk 4 2	CP 4 2				
	Prof. Hoc Khiem Trieu							
Admission Requirements	None	None						
Recommended Previous Knowledge	Basics in physics, chemistry, mater	asics in physics, chemistry, material science and semiconductor devices						
Educational Objectives	After taking part successfully, stud	ents have reached the fol	lowing learn	ing results				
Professional Competence								
Knowledge	 to describe and to explain current fabrication techniques for Si and GaAs substrates, to discuss in details the relevant fabrication processes, process flows and the impact thereof on the fabrication of semiconductor devices and integrated circuits and to present integrated process flows. 							
Skills	 Students are capable to analyze the impact of proce to select and to evaluate proce to develop process flows for the 	esses and	-					
Personal Competence								
Social Competence	Students are able to prepare and well as to present and discuss the			am work as				
Autonomy	None							
	Independent Study Time 96, Study	Time in Lecture 84						
Credit points								
Course achievement								
Examination Examination								

duration and scale	
	Electrical Engineering: Specialisation Nanoelectronics and Microsystems Technology: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
	Elective Compulsory
Assignment for	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
the Following	Compulsory
Curricula	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
	Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory
	Microelectronics and Microsystems: Core qualification: Elective Compulsory

	chip, wafer level package, 3D stacking)
	S.K. Ghandi: VLSI Fabrication principles - Silicon and Gallium Arsenide, John Wiley & Sons
	S.M. Sze: Semiconductor Devices - Physics and Technology, John Wiley & Sons
	U. Hilleringmann: Silizium-Halbleitertechnologie, Teubner Verlag
Literature	H. Beneking: Halbleitertechnologie - Eine Einführung in die Prozeßtechnik von Silizium und III-V-Verbindungen, Teubner Verlag
	K. Schade: Mikroelektroniktechnologie, Verlag Technik Berlin
	S. Campbell: The Science and Engineering of Microelectronic Fabrication, Oxford University Press
	P. van Zant: Microchip Fabrication - A Practical Guide to Semiconductor Processing, McGraw-Hill

Course L0723: Sem	Course L0723: Semiconductor Technology			
Тур	Practical Course			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Hoc Khiem Trieu			
Language	DE/EN			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Module M083	5: Hu	ımano	id Robo	otics				
Courses								
Title Humanoid Robotics (LC	0663)				Typ Seminar		Hrs/wk 2	CP 2
Module Responsible	Patricl	k Göttsch	l					
Admission Requirements	None							
Recommended Previous Knowledge	•		tion to con theory and		ms			
Educational Objectives	After t	taking pa	rt successf	fully, stud	ents have reache	d the follo	wing learn	ing results
Professional Competence								
Knowledge			s learn to a		noid robots. c control concept	s for differ	ent tasks i	n humanoid
Skills	•	based or Students	n specified s generaliz	literature e develop	e about selected e ped results and pr e and give a prese	esent then		
Personal Competence								
Social Competence		present They ar	them	provide	veloping solution appropriate feed			
Autonomy		presenta Students	ation for sp s familiariz ow present	ecific tasl e themse	tages and draw ks and select the lves with a scient other students, s	best soluti ific field, a	on ire able of	introduce it
Workload in Hours	!	endent St	udy Time	32, Study	Time in Lecture 2	28		
Credit points								
Course achievement	<u> </u>	ntation						
Examination Examination duration and scale	30 mii							
	Mecha Biome Electiv Biome	atronics: S edical Eng ve Compu	Specialisat gineering: S ulsory	ion Syste Specialisa	gent Systems and m Design: Electivation Artificial Org sation Implants	e Compuls ans and Re	ory egenerativ	ve Medicine:

Assignment for	Biomedical Engineering: Specialisation Medical Technology and Control Theory:
the Following	Elective Compulsory
Curricula	Biomedical Engineering: Specialisation Management and Business Administration:
	Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective
	Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science:
	Elective Compulsory

Course L0663: Hun	nanoid Robotics
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Patrick Göttsch
Language	DE
Cycle	SoSe
Content	 Grundlagen der Regelungstechnik Control systems theory and design
Literature	- B. Siciliano, O. Khatib. "Handbook of Robotics. Part A: Robotics Foundations", Springer (2008).

	8: Linear and Nonlinea								
Courses									
Title Linear and Nonlinear S	System Identification (L0660)	Typ Lecture	Hrs/wk 2	CP 3					
Module Responsible	Prof. Herbert Werner								
Admission Requirements	None								
Recommended Previous Knowledge	 Classical control (frequence) State space methods Discrete-time systems Linear algebra, singular volume 								
Educational Objectives	I After taking nart cliccectillia ct	udents have reached the	e following learr	ing results					
Professional Competence									
Knowledge	 Students can explain the general framework of the prediction error method and its application to a variety of linear and nonlinear model structures They can explain how multilayer perceptron networks are used to model nonlinear dynamics They can explain how an approximate predictive control scheme can be based on neural network models They can explain the idea of subspace identification and its relation to Kalmar realisation theory 								
Skills	 Students are capable of applying the predicition error method to th experimental identification of linear and nonlinear models for dynami systems They are capable of implementing a nonlinear predictive control schem based on a neural network model They are capable of applying subspace algorithms to the experimental identification of linear models for dynamic systems They can do the above using standard software tools (including the Matla System Identification Toolbox) 								
Personal Competence									
Social Competence	Students can work in mixed grou	ups on specific problems	to arrive at join	t solutions.					
Autonomy	Students are able to find requing literature, software documentati			cture notes					
Workload in Hours	I Independent Study Time 62, Stu	dy Time in Lecture 28							
Credit points									
Course achievement	LNODE								
Examination	Oral exam								
Examination duration and scale	30 min								
	Electrical Engineering: Special Elective Compulsory Mechatronics: Specialisation Inte		-						

	Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:							
	ective Compulsory							
Assignment for	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective							
the Following	Compulsory							
Curricula	Biomedical Engineering: Specialisation Medical Technology and Control Theory:							
	Compulsory							
	Biomedical Engineering: Specialisation Management and Business Administration:							
	Elective Compulsory							
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective							
	Compulsory							
	Theoretical Mechanical Engineering: Core qualification: Elective Compulsory							

Course L0660: Linear and Nonlinear System Identification				
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Herbert Werner			
Language	EN			
Cycle	SoSe			
Content	 Prediction error method Linear and nonlinear model structures Nonlinear model structure based on multilayer perceptron network Approximate predictive control based on multilayer perceptron network model Subspace identification 			
Literature	 Lennart Ljung, System Identification - Theory for the User, Prentice Hall 1999 M. Norgaard, O. Ravn, N.K. Poulsen and L.K. Hansen, Neural Networks for Modeling and Control of Dynamic Systems, Springer Verlag, London 2003 T. Kailath, A.H. Sayed and B. Hassibi, Linear Estimation, Prentice Hall 2000 			

Courses								
Title Optimal and Robust Co Optimal and Robust Co					Typ Lecture Recitation	Secti	Hrs/wk 2 ^{on} 2	CP 3
Module		lerbert We	rner		(small)			
Responsible Admission Requirements	None							
Recommended Previous Knowledge	•	State space	e methods	5	oonse, root l			
Educational Objectives	After t	aking part	successful	ly, students	s have reach	ed the fol	lowing learn	ning results
Professional Competence								
Knowledge	 Students can explain the significance of the matrix Riccati equation for the solution of LQ problems. They can explain the duality between optimal state feedback and optimal state estimation. They can explain how the H2 and H-infinity norms are used to represent stability and performance constraints. They can explain how an LQG design problem can be formulated as special case of an H2 design problem. They can explain how model uncertainty can be represented in a way that lends itself to robust controller design They can explain how - based on the small gain theorem - a robust controller can guarantee stability and performance for an uncertain plant. They understand how analysis and synthesis conditions on feedback loops can be represented as linear matrix inequalities. 							
Skills	•	multivaria They are form of a it. They are c control loc carrying o They are c system, ar They are matrix ine	ble plant in capable of generalize capable of out a mixed capable of desigoapable of qualities (L carry out	represent of plant, and translating constraints constructir ning a mixed formulatin LMI), and of all of the al	esigning and and of using standard from closed-lodesign. Ing an LFT uned-objective ganalysis ausing standabove using	H-infinity andard so equency doop sensing certainty robust conditions and synthem and LMI-so	design prooftware tool omain spectivity functi model for antroller. esis condition	oblem in the second for solving ifications of one, and one one one as line lying them
Personal Competence								
Social Competence	Studer	nts are abl	e to find r	required inf	specific prob formation in Id use it to so	sources	orovided (le	

Course L0658: Opti	mal and Robust Control
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	 Optimal regulator problem with finite time horizon, Riccati differential equation Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system Kalman's identity, phase margin of LQR controllers, spectral factorization Optimal state estimation, Kalman filter, LQG control Generalized plant, review of LQG control Signal and system norms, computing H2 and H∞ norms Singular value plots, input and output directions Mixed sensitivity design, H∞ loop shaping, choice of weighting filters Case study: design example flight control Linear matrix inequalities, design specifications as LMI constraints (H2, H∞ and pole region) Controller synthesis by solving LMI problems, multi-objective design Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty
Literature	 Werner, H., Lecture Notes: "Optimale und Robuste Regelung" Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 Skogestad, S. and I. Postlewhaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998

Course L0659: Optimal and Robust Control		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

ns (L2009)	Typ Lecture	Hrs/wk	CP 4
ations (L0862)	Project-/problem- based Learning	1	2
Prof. Christian Lüthje			
None			
 Basic understanding of bus decision theory, project ma Bachelor-level Marketing I Competitor Strategies, Basi Unerstanding the difference Understanding of the impomarkets 	iness administration princi nagement, international be Knowledge (Marketing Ins cs of Buying Behavior) es beweetn B2B and B2C n rtance of managing innova	usiness) struments, narketing	Market ar
After taking part successfully, stud	dents have reached the fol	lowing learn	ing results
 Specific characteristics in the Approaches for analyzing the development The gathering of information Concepts and approaches product and service develon Approaches and tools for each of new products and innovation Marketing mix elements requirements and challenged Pricing methods for new products of complete 	ne marketing of innovative the current market situation in about future customer in the control of the current market situation in about future customer in the consum of the customer orientative services in that take into consum of the customer or consum of the customer or customer	n and the fureeds and restand their sion in the dideration to the selling	ture mark quirements needs in evelopmer he specif
 Design and to evaluate strategies Analyze markets by applyin Conduct forecasts and deviplanning Translate customer needs and successfully apply adviservice development Use adequate methods to f services Choose suitable pricing innovations 	decisions regarding managements and technology pelop compelling scenarios into concepts, prototypes anced methods for custom oster efficient diffusion of strategies and communications.	portfolios as a basis and marke ner-oriented innovative p	for strateg table offer product ar roducts ar ctivities fo
	Prof. Christian Lüthje Mone Module International Busine Basic understanding of bus decision theory, project ma Bachelor-level Marketing I Competitor Strategies, Basi Unerstanding the difference Understanding of the impo markets Good English proficiency; p After taking part successfully, stude Students will have gained a deep Specific characteristics in the Approaches for analyzing the development The gathering of information Concepts and approaches product and service development The gathering of information Concepts and tools for each of new products and innovation marketing mix elements requirements and challenged Pricing methods for new prometic in the organization of comples and tools for each of new products and innovation concepts and the acquired knowledge Design and to evaluate strategies Analyze markets by applying Conduct forecasts and development Use adequate methods to for services Choose suitable pricing innovations Make strategic sales decisions	After taking part successfully, students have reached the fold surface for analyzing the current market situation development The gathering of information about future customer new products and approaches to integrate lead users product and services Approaches and tools for ensuring customer-orientat of new products and instruments for new products and instruments for new products and instruments for new products and instruments for new products and services Analyze markets by applying market and technology Computed to Students will be able to: Design and to evaluate decisions regarding mainstrategies Analyze markets by applying market and technology Conduct forecasts and develop compelling scenarios planning Translate customer needs into concepts, prototypes and successfully apply advanced methods for customs services Analyze markets by applying market and technology Conduct forecasts and develop compelling scenarios planning Translate customer needs into concepts, prototypes and successfully apply advanced methods for customs service development Use adequate methods to foster efficient diffusion of services Analyze markets by applying strategies and communinovations Make strategics sales decisions for products and services Choose suitable pricing strategies and communinovations Make strategic sales decisions for products and services	ations (L0862) Prof. Christian Lüthje None Module International Business Basic understanding of business administration principles (strategics ion theory, project management, international business) Bachelor-level Marketing Knowledge (Marketing Instruments, Competitor Strategies, Basics of Buying Behavior) Understanding the differences beweeth BZB and BZC marketing Understanding of the importance of managing innovation in glob markets Good English proficiency; presentation skills After taking part successfully, students have reached the following learn Students will have gained a deep understanding of Specific characteristics in the marketing of innovative poroducts a Approaches for analyzing the current market situation and the fudevelopment The gathering of information about future customer needs and ree. Concepts and approaches to integrate lead users and their product and service development processes Approaches and tools for ensuring customer-orientation in the dof new products and innovative services Marketing mix elements that take into consideration to requirements and challenges of innovative products and services Pricing methods for new products and services Pricing methods for new products and services The organization of complex sales forces and personal selling Communication concepts and instruments for new products and services The organization of complex sales forces and personal selling Communication concepts and instruments for new products and services The organization of complex sales forces and personal selling Communication concepts and instruments for new products and services The organization of complex sales forces and personal selling Communication concepts and instruments for new products and services The organization of complex sales forces and personal selling Communication concepts and instruments for new products and services The organization of complex sales forces and personal selling Communication concepts and instruments for new products and services Challengers and servi

Competence					
	The students will be able to				
Social Competence	 have fruitful discussions and exchange arguments develop original results in a group present results in a clear and concise way carry out respectful team work 				
	The students will be able to				
Autonomy	 Acquire knowledge independently in the specific context and to map this knowledge on other new complex problem fields. Consider proposed business actions in the field of marketing and reflect on them. 				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points					
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and scale	Written elaboration, excercises, presentation, oral participation				
Assignment for the Following Curricula	Global Technology and Innovation Management & Entrepreneurship: Core qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory				

Course L2009: Mar	keting of Innovations
Тур	Lecture
Hrs/wk	4
СР	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	SoSe
	I. Introduction
	 Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing)
	II. Methods and approaches of strategic marketing planning
	 patterns of industrial development, patent and technology portfolios
	III. Strategic foresight and scenario analysis
	 objectives and challenges of strategic foresight, scenario analysis, Delphi method
	IV. User innovations
Content	 Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis
	V. Customer-oriented Product and Service Engineering
	 Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting
	VII. Pricing
	Basics of Pricing, Value-based pricing, Pricing models
	VIII. Sales Management
	 Basics of Sales Management, Assessing Customer Value, Planning Customer Visits
	IX. Communications
	 Diffusion of Innovations, Communication Objectives, Communication Instruments
	Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technology products and innovations, third edition, Pearson education. ISBN-10: 1292040335. Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (352-365), Chapter 12 (419-426).
	Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition, McGrw Hill, Boston et al., 2008
	Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?,pp. 3-24.
	Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4 th edition, Boston et al., McGraw Hill
	Tidd; J. & Hull, Frank M. (Editors) (2007) Service Innovation, London
	Von Hippel, E.(2005). Democratizing Innovation, Cambridge: MIT Press

Course L0862: PBL	Marketing of Innovations
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	SoSe
Content	This PBL course is seggregated into two afternoon sessions. This cours aims at enhancing the students' practical skills in (1) forecasting the future development of markets and (2) making appropriate market-related decisions (particularly segmentation, managing the marketing mix). The students will be prompted to use the knowledge gathered in the lecture of this module and will be invited to (1) Conduct a scenario analysis for an innovative product category and (2) Engage in decision making wtihin a market simulation game.
Literature	

Module M1143	3: Applied Design Metho	odology in Mecha	atronics	
Courses				
	dology in Mechatronics (L1523) dology in Mechatronics (L1524)	Typ Lecture Project-/problem-	Hrs/wk 2 3	CP 2
		based Learning		•
	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of mechanical design, elect	rical design or computer	-sciences	
Educational Objectives	After taking part successfully, stuc	lents have reached the f	ollowing learn	ing results
Professional Competence	Science-based working on interc	lisciplinary product des	ian consideri	ng targete
Knowledge	application of specific product des	ign techniques		
Skills	Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.			
Personal Competence				
Social Competence	Students will solve and execute technical-scientific tasks from an industrial contex in small design-teams with application of common, creative methodologies.			
Autonomy	Students are enabled to optimize the design and development process according to the target and topic of the design			
	Independent Study Time 110, Stud	ly Time in Lecture 70		
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical w	ork		
Examination duration and scale	30 min Presentation for a group de	esign-work		
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective			

Compulsory

Course L1523: App	lied Design Methodology in Mechatronics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thorsten Kern
Language	EN
Cycle	SoSe
Content	 Systematic analysis and planning of the design process for products combining a multitude of disciplines Structure of the engineering process with focus on engineering steps (task-definition, functional decomposition, physical principles, elements for solution, combination to systems and products, execution of design, component-tests, system-tests, product-testing and qualification/validation) Creative methods (Basics, methods like lead-user-method, 6-3-5, BrainStorming, Intergalactic Thinking, Applications in examples all around mechatronics topics) Several design-supporting methods and tools (functional strcutures, GALFMOS, AEIOU-method, GAMPFT, simulation and its application, TRIZ, design for SixSigma, continous integration and testing,) Evaluation and final selection of solution (technical and business-considerations, preference-matrix, pair-comparision), dealing with uncertainties, decision-making Value-analysis Derivation of architectures and architectural management Project-tracking and -guidance (project-lead, guiding of employees, organization of multidisciplinary R&D departments, idea-identification, responsibilities and communication) Presentation-skills Questions of aesthetic product design and design for subjective requirements (industrial design, color, haptic/optic/acoustic interfaces) Evaluation of selected methods at practical examples in small teams
Literature	 Definition folgt Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, KH.: Konstruktionslehre: Grundlage erfolgreicher Produktentwicklung, Methoden und Anwendung, 7. Auflage, Springer Verlag, Berlin 2007 VDI-Richtlinien: 2206; 2221ff

Course L1524: Applied Design Methodology in Mechatronics			
Тур	Typ Project-/problem-based Learning		
Hrs/wk	Hrs/wk 3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Thorsten Kern		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M093	8: Bioprocess Engineering -	Fundamentals		
Courses				
Title	g - Fundamentals (L0841)	Typ Lecture	Hrs/wk	CP 3
	g- Fundamentals (L0842)	Recitation Section	1 2	1
Bioprocess Engineerin	g - Fundamental Practical Course (L0843)	(large) Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements				
Recommended Previous Knowledge	none, module "organic chemistry", mod	ule "fundamentals for	process er	ngineering"
Educational Objectives	After taking part successfully, students	have reached the follo	wing learn	ing results
Professional Competence				
Knowledge	Students are able to describe the basic concepts of bioprocess engineering. They are able to classify different types of kinetics for enzymes and microorganisms, as well as to differentiate different types of inhibition. The parameters of stoichiometry and rheology can be named and mass transport processes in bioreactors can be explained. The students are capable to explain fundamental bioprocess management, sterilization technology and downstream processing in detail.			
Skills	 After successful completion of this module, students should be able to describe different kinetic approaches for growth and substrate-uptake and to calculate the corresponding parameters predict qualitatively the influence of energy generation, regeneration of redox equivalents and growth inhibition on the fermentation process analyze bioprocesses on basis of stoichiometry and to set up / solve metabolic flux equations distinguish between scale-up criteria for different bioreactors and bioprocesses (anaerobic, aerobic as well as microaerobic) to compare them as well as to apply them to current biotechnical problem propose solutions to complicated biotechnological problems and to deduce the corresponding models to explore new knowledge resources and to apply the newly gained contents identify scientific problems with concrete industrial use and to formulate solutions. to document and discuss their procedures as well as results in a scientific manner 			
Personal Competence Social Competence	After completion of this module participants should be able to debate technical questions in small teams to enhance the ability to take position to their own			
Autonomy	After completion of this module part problem in a team independently by orgonical results in a plenum.			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		

Credit points	6		
Course	Compulsor ₽ onus	Form Subject theoretical	Description
achievement	Yes 5 %	practical work	unu
Examination	Written exam		
Examination duration and scale			
the Following	Engineering: Compulsor General Engineering Bioprocess Engineering Bioprocess Engineering General Engineering Bioprocess Engineering General Engineering General Engineering Compulsory Biomedical Engineering Compulsory Biomedical Engineering Elective Compulsory Biomedical Engineering Elective Compulsory Technomathematics: Sp	Science (German prog : Compulsory : Core qualification: Com Science (English prog : Compulsory :ience (English program, ry : Specialisation Artificial g: Specialisation Impla g: Specialisation Medica	ram, 7 semester): Specialisation 7 semester): Specialisation Process Organs and Regenerative Medicine: ants and Endoprostheses: Elective al Technology and Control Theory: ement and Business Administration: ring Science: Elective Compulsory

Course L0841: Bio	process Engineering - Fundamentals		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng		
Language	DE		
Cycle	SoSe		
Content	 Introduction: state-of-the-art and development trends in the biotechnology, introduction to the lecture Enzyme kinetics: Michaelis-Menten, differnt types of enzyme inhibition, linearization, conversion, yield, selectivity (Prof. Liese) Stoichiometry: coefficient of respiration, electron balance, degree of reduction, coefficient of yield, theoretical oxygen demand (Prof. Liese) Microbial growth kinetic: batch- and chemostat culture (Prof. Zeng) Kinetic of subtrate consumption and product formation (Prof. Zeng) Rheology: non-newtonian fluids, viscosity, agitators, energy input (Prof. Liese) Transport process in a bioreactor (Prof. Zeng) Technology of sterilization (Prof. Zeng) Fundamentals of bioprocess management: bioreactors and calculation of batch, fed-batch and continuouse bioprocesses (Prof. Zeng/Prof. Liese) Downstream technology in biotechnology: cell breakdown, zentrifugation, filtration, aqueous two phase systems (Prof. Liese) 		
Literature	 K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012 H. Chmiel: Bioprozeßtechnik, Elsevier, 2006 R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010 H.W. Blanch, D. Clark: Biochemical Engineering, Taylor & Francis, 1997 P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013 		

Course L0842: Bioprocess Engineering- Fundamentals				
Тур	Typ Recitation Section (large)			
Hrs/wk	2			
СР	1			
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28			
	Prof. Andreas Liese, Prof. An-Ping Zeng			
Language				
Cycle				
	1. Introduction (Prof. Liese, Prof. Zeng)			
	2. Enzymatic kinetics (Prof. Liese)			
	3. Stoichiometry I + II (Prof. Liese)			
	4. Microbial Kinetics I+II (Prof. Zeng)			
Content	5. Rheology (Prof. Liese)			
Content	6. Mass transfer in bioprocess (Prof. Zeng)			
	7. Continuous culture (Chemostat) (Prof. Zeng)			
	8. Sterilisation (Prof. Zeng)			
	9. Downstream processing (Prof. Liese)			
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)			
Literature siehe Vorlesung				

Course L0843: Bioprocess Engineering - Fundamental Practical Course				
Тур	Practical Course			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Andreas Liese, Prof. An-Ping Zeng			
Language	DE			
Cycle SoSe				
Content	In this course fermentation and downstream technologies on the example of the production of an enzyme by means of a recombinant microorganism is learned. Detailed characterization and simulation of enzyme kinetics as well as application of the enzyme in a bioreactor is carried out. The students document their experiments and results in a protocol.			
Literature	Skript			

Courses					
Title Introduction to Anatom	Typ Hrs/wk CP ny (L0384) Lecture 2 3				
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	The students can describe basal structures and functions of internal organs and the musculoskeletal system. The students can describe the basic macroscopy and microscopy of those systems.				
Skills	The students can recognize the relationship between given anatomical facts and the development of some common diseases; they can explain the relevance of structures and their functions in the context of widespread diseases.				
Personal Competence					
Social Competence	The students can participate in current discussions in biomedical research and medicine on a professional level.				
Autonomy	The students are able to access anatomical knowledge by themselves, cal participate in conversations on the topic and acquire the relevant knowledge themselves.				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28				
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and scale	90 minutes				
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Engineering Science: Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory				
Assignment for the Following Curricula Curr					

Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0384: Intr	oduction to Anato	omy				
Тур	Lecture					
Hrs/wk	2					
СР	3					
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28					
	Prof. Tobias Lange					
Language						
Cycle						
	General Anatomy 1 st week:	The Eucaryote Cell				
	2 nd week: 3 rd week:	The Tissues Cell Cycle, Basics in Development				
	4 th week: 5 th week:	Musculoskeletal System Cardiovascular System				
	6 th week: 7 th week:	Respiratory System Genito-urinary System				
Content	8 th week:	Immune system				
	9 th week: 10 th week:	Digestive System II				
	11 th week:	Endocrine System				
	12 th week:	Nervous System				
	13 th week:	Exam				
Literature	Adolf Faller/Michae Stuttgart, 2016	l Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag				

Courses					
Гitle	Typ Hrs/wk CP				
	pgy and Radiation Therapy (L0383) Lecture 2 3				
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Therapy The students can distinguish different types of currently used equipment respect to its use in radiation therapy. The students can explain treatment plans used in radiation therapy interdisciplinary contexts (e.g. surgery, internal medicine). The students can describe the patients' passage from their in					
	admittance through to follow-up care. Diagnostics				
Knowledge	The students can illustrate the technical base concepts of projection radiography including angiography and mammography, as well as sectional imaging techniques (CT, MRT, US).				
	The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for those techniques.				
	The students can choose the right treatment method depending on the patien clinical history and needs.				
	The student can explain the influence of technical errors on the imaging technique				
	The student can draw the right conclusions based on the images' diagnos findings or the error protocol.				
	Therapy The students can distinguish curative and palliative situations and motivate w they came to that conclusion.				
	The students can develop adequate therapy concepts and relate it to the radiation biological aspects.				
	The students can use the therapeutic principle (effects vs adverse effects)				
	The students can distinguish different kinds of radiation, can choose the best one depending on the situation (location of the tumor) and choose the energy needed in that situation (irradiation planning).				
The student can assess what an individual psychosocial service should look li (e.g. follow-up treatment, sports, social help groups, self-help groups, social services, psycho-oncology).					

	The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.						
	The students can classify results of imaging techniques according to different proups of diseases based on their knowledge of anatomy, pathology and pathophysiology.						
Personal Competence							
	The students can assess the special social situation of tumor patients and interact with them in a professional way. The students are aware of the special, often fear-dominated behavior of sick people caused by diagnostic and therapeutic measures and can meet them appropriately.						
	The students can apply their new knowledge and skills to a concrete therapy case. The students can introduce younger students to the clinical daily routine.						
Autonomy	The students are able to access anatomical knowledge by themselves, can participate competently in conversations on the topic and acquire the relevant knowledge themselves.						
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28						
Credit points	3						
Course achievement							
Examination	Written exam						
Examination							
	duration and 90 minutes						
scale							
the Following	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Engineering Science: Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering: Compulsory General Engineering: Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology Administration:						

Course L0383: Introduction to Radiology and Radiation Therapy					
Тур	Typ Lecture				
Hrs/wk	Hrs/wk 2				
СР	3				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28				
Lecturer Prof. Ulrich Carl, Prof. Thomas Vestring					
Language	Language DE				

Cycle					
Content	The students will be given an understanding of the technological possibilities in the field of medical imaging, interventional radiology and radiation therapy/radiation oncology. It is assumed, that students in the beginning of the course have heard the word "X-ray" at best. It will be distinguished between the two arms of diagnostic (Prof. Dr. med. Thomas Vestring) and therapeutic (Prof. Dr. med. Ulrich Carl) use of X-rays. Both arms depend on special big units, which determine a predefined sequence in their respective departments				
	• "Technik der medizinischen Radiologie" von T. + J. Laubenberg –				
	7. Auflage – Deutscher Ärzteverlag – erschienen 1999				
	 "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr - 				
	4. Auflage - Verlag Urban & Fischer - erschienen 02.03.2006				
	ISBN: 978-3-437-23960-1				
	"Strahlentherapie und Onkologie für MTA-R" von R. Sauer –				
	5. Auflage 2003 - Verlag Urban & Schwarzenberg - erschienen 08.12.2009				
	ISBN: 978-3-437-47501-6				
Literature	 "Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus- 				
	8. Auflage – Georg Thieme Verlag - erschienen 19.09.2012				
	ISBN: 978-3-13-567708-8				
	• "Der Körper des Menschen " von A. Faller u. M. Schünke -				
	16. Auflage 2004 - Georg Thieme Verlag - erschienen 18.07.2012				
	ISBN: 978-3-13-329716-5				
	"Praxismanual Strahlentherapie" von Stöver / Feyer -				
	1. Auflage - Springer-Verlag GmbH - erschienen 02.06.2000				

Module M1280	D: MED II: Introduction	on to Physiology		
Courses				
Title Introduction to Physiol	ogy (L0385)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Dr. Roger Zimmermann			
Admission Requirements				
Recommended Previous Knowledge	None			
Educational Objectives		students have reached the	e following lear	ning results
Professional Competence				
Knowledge	 The students can describe the basics of t describe physiological neuro- and sensory phy 	relations in selected fields	of muscle, hea	rt/circulation,
Skills	The students can describe transmission and processing functions) and relate them to	g of information, develop		
Personal Competence				
Social Competence	The students can conduct disc The students can find solu analytical and metrological.			
Autonomy	The students can derive an physiological areas, using tech			se and other
Workload in Hours	Independent Study Time 62, S	Study Time in Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and scale				
the Following	General Engineering Science Biomedical Engineering: Complemental Engineering Science Mechanical Engineering, Focus Data Science: Specialisation Melectrical Engineering: Special Engineering Science: Specialis General Engineering Science Mechanical Engineering, Focus General Engineering Science Biomedical Engineering: Complemental Engineering: Complemental Engineering: Special Engineeri	culsory the (German program, 7 as Biomechanics: Compulso Medicine: Compulsory Ilisation Medical Technology Station Biomedical Engineer the (English program, 7 as Biomechanics: Compulso the (English program, 7 action of the compulsory the (English program, 7 action of the compulsory the Compulsory the Compulsory the Compulsory the Compulsory the Compulsory	semester): ! y: Elective Com ing: Elective Ci semester): ! ry semester): ! semester): !	Specialisation npulsory ompulsory Specialisation Specialisation

Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Elective Compulsory
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective
Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0385: Introduction to Physiology				
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Lecturer Dr. Gerhard Engler, Dr. Gerhard Engler			
Language DE				
Cycle SoSe				
Content				
Literature	Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier			

Module M1332	2: BIO I: Experimen	tal Methods in	n Biomecha	anics	
Courses					
Title Experimental Methods	in Biomechanics (L0377)	Typ Lecture		Hrs/wk	CP 3
Module Responsible	Prof. Michael Morlock				
Admission Requirements	None				
	It is recommended to p attending "Experimentelle I		antate und Fra	akturheilu	ng" before
Educational Objectives	After taking part successful	ly, students have rea	ached the follow	ing learni	ng results
Professional Competence					
Knowledge	The students can describe the different ways how bones heal, and the requirements for their existence. The students can name different treatments for the spine and hollow bones under given fracture morphologies. The students can describe different measurement techniques for forces and				
Skills	movements, and choose the adequate technique for a given task. The students can describe the basic handling of several experimental techniques used in biomechanics.				
Personal Competence					
Social Competence	The students can, in groups	s, solve basic experin	nental tasks.		
Autonomy	The students can, in groups	s, solve basic experin	nental tasks.		
	Independent Study Time 62	2, Study Time in Lect	ure 28		
Credit points					
Course achievement					
Examination Examination duration and scale					
the Following	General Engineering Scie Mechanical Engineering, Fo General Engineering Scie Biomedical Engineering: Co Engineering Science: Specia General Engineering Scie Mechanical Engineering, Fo General Engineering: Co General Engineering: Co General Engineering: Scie Biomedical Engineering: Sp Biomedical Engineering: Sp Biomedical Engineering: Sp Biomedical Engineering: Sp Elective Compulsory Biomedical Engineering: Scompulsory Biomedical Engineering: Sp Compulsory Biomedical Engineering: Sp	cus Biomechanics: Cence (German programpulsory alisation Biomedical lence (English programpulsory ence (English programpulsory ence (English programpulsory ective Compulsory eccialisation Biomechanics (English programpulsory eccialisation Artificial Specialisation Impla	ompulsory gram, 7 seme Engineering: Ele ram, 7 seme ompulsory ram, 7 seme ram, 7 seme ram, 7 seme anics: Compuls Organs and Re	ster): Spective Corster): Spective Spective Spective Spective Spective Spective Spective Spective Specification Sp	pecialisation inpulsory pecialisation pecialisation pecialisation e Medicine es: Elective

Elective Compulsory
Biomedical Engineering: Specialisation Management and Business Administration:
Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0377: Exp	Course L0377: Experimental Methods in Biomechanics	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content		
Literature	Wird in der Veranstaltung bekannt gegeben	

Module M1335	5: BIO II: Artificial Joint	Replacement		
Courses				
Title Artificial Joint Replacer	ment (L1306)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of orthopedic an	d surgical techniques is ı	recommended	
Educational Objectives	After taking part successfully, stu	dents have reached the t	following learn	ing results
Professional Competence		ent kinds of artificial limb	ns	
	The students can explain the ad endoprotheses.			ent kinds of
Personal Competence				
Social Competence	The students are able to discuss i and the teachers.	ssues related to endopro	othese with stu	ıdent mates
Autonomy	The students are able to acquire information with respect to its cre		n. They can als	so judge the
Workload in Hours	Independent Study Time 62, Stud	y Time in Lecture 28		
Credit points	3			
Course achievement	None			
	Written exam			
Examination duration and scale	90 min			
the Following	International Management and E and Biotechnology: Elective Comp Materials Science: Specialisation I Biomedical Engineering: Specialis Elective Compulsory Biomedical Engineering: Specialis Biomedical Engineering: Specialis Elective Compulsory Biomedical Engineering: Specialis Elective Compulsory Biomedical Engineering: Specialis Elective Compulsory Orientierungsstudium: Core qualif Theoretical Mechanical Engineer Compulsory Theoretical Mechanical Engineer Elective Compulsory	vulsory Nano and Hybrid Materia ation Artificial Organs ar ation Implants and Endo sation Medical Technolo sation Management and fication: Elective Compuls ring: Technical Compler	ls: Elective Cond Regeneration prostheses: Conductory and Content Business Address sory mentary Cours	mpulsory ve Medicine: ompulsory crol Theory: ministration: se: Elective

Course L1306: Arti	ficial Joint Replacement
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE
Cycle	
Content	 Inhalt (deutsch) EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenker-satzes) FUNKTIONSANALYSE (Der menschliche Gang, die menschliche Arbeit, die sportliche Aktivität) DAS HÜFTGELENK (Anatomie, Biomechanik, Gelenkersatz Schaftseite und Pfannenseite, Evolution der Implantate) DAS KNIEGELENK (Anatomie, Biomechanik, Bandersatz, Gelenkersatz femorale, tibiale und patelläre Komponenten) DER FUß (Anatomie, Biomechanik, Gelen-kersatz, orthopädische Verfahren) DIE SCHULTER (Anatomie, Biomechanik, Gelenkersatz) DER ELLBOGEN (Anatomie, Biomechanik, Gelenkersatz) DIE HAND (Anatomie, Biomechanik, Ge-lenkersatz) TRIBOLOGIE NATÜRLICHER UND KÜNST-LICHER GELENKE (Korrosion, Reibung, Verschleiß)
Literature	Literatur: Kapandji, I: Funktionelle Anatomie der Gelenke (Band 1-4), Enke Verlag, Stuttgart, 1984. Nigg, B., Herzog, W.: Biomechanics of the musculo-skeletal system, John Wiley&Sons, New York 1994 Nordin, M., Frankel, V.: Basic Biomechanics of the Musculoskeletal System, Lea&Febiger, Philadelphia, 1989. Czichos, H.: Tribologiehandbuch, Vieweg, Wiesbaden, 2003. Sobotta und Netter für Anatomie der Gelenke

Module M0845	5: Feedback Control in	Medical Technol	ogy	
Courses				
Title Feedback Control in Me	edical Technology (L0664)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Basics in Control, Basics in Physio	logy		
Educational Objectives		dents have reached the	following learn	ing results
Professional Competence				
	The lecture will introduce into the engineering point of view. Fund introduced like knowledge in cont	amentals in human ph		
Knowledge	Internal control loops of the huma design of external closed loop sys			
	The handling of PID controllers a fuzzy controller or neural netwo equivalent circuits will be discusse	orks will be illustrated.		
Skills	Application of modeling, identific technology.	cation, control technolo	gy in the field	l of medical
Personal Competence				
Social Competence	Students can develop solutions their results	to specific problems in	small groups	and present
Autonomy	Students are able to find necessary literature and to set it into the context of the lecture. They are able to continuously evaluate their knowledge and to take control of their learning process. They can combine knowledge from different courses to form a consistent whole.			
Workload in Hours	Independent Study Time 62, Stud	y Time in Lecture 28		
Credit points				
Course achievement				
Examination	Oral exam			
Examination duration and scale	20 min			
Assignment for the Following Curricula	Biomedical Engineering: Specialis	ation Control and Povilisation Implants and ation Artificial Organs a	wer Systems in Endoprostheson in Regenerative	Engineering: es: Elective ve Medicine:

Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory

Course L0664: Fee	dback Control in Medical Technology
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	 Always viewed from the engineer's point of view, the lecture is structured as follows: Introduction to the topic Fundamentals of physiological modelling Introduction to Breathing and Ventilation Physiology and Pathology in Cardiology Introduction to the Regulation of Blood Glucose kidney function and renal replacement therapy Representation of the control technology on the concrete ventilator Excursion to a medical technology company Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.
Literature	 Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Module M0635	5: Medical Techr	nology Lab			
Courses					
Title			Тур	Hrs/wk	СР
Medical Technology La	b (L1096)		Project-/problem- based Learning	6	6
1100 p 0 1101010	Prof. Alexander Schlae	fer			
Admission Requirements	None				
Recommended	sound programming sk skills in R/Matlab knowledge of image pr principles of math (algo principles of stochastic	ocessing ebra, analysis/calc	ulus)		
Educational Objectives	After taking part succe	ssfully, students h	ave reached the follo	owing learn	ing results
Professional					
Competence Knowledge	The students recogniz which methods are app			logy and o	can explain,
Skills	The students are able t	co analyze and sol	ve problems in medio	cal technolo	ogy.
Personal Competence					
Social Competence	The students can defir work. They can present				ect as team
Autonomy	The students take resp with other group mem acquire additional know	bers. They delive	er their work on tim	e. They in	
Workload in Hours	Independent Study Tim	ne 96, Study Time	in Lecture 84		
Credit points					
Course achievement	CompulsorBonus Yes None	Form Group discussion	Descrip	tion	
-	Written elaboration				
Examination duration and scale	approx. 8 pages, time t	frame: over the co	urse of the semester	-	
the Following	Electrical Engineering: Biomedical Engineerin Elective Compulsory Biomedical Engineerin Elective Compulsory	g: Specialisation	Medical Technology	and Cont	rol Theory:

Course L1096: Med	Course L1096: Medical Technology Lab	
Тур	Project-/problem-based Learning	
Hrs/wk	6	
СР	6	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	
Lecturer	Prof. Alexander Schlaefer	
Language	DE/EN	
Cycle		
Content	The actual project topic will be defined as part of the project.	
Literature	Wird in der Veranstaltung bekannt gegeben.	

Courses				
Fitle Advanced Topics in Co	ontrol (I 0661)	Typ Lecture	Hrs/wk 2	CP 3
Advanced Topics in Co		Recitation	Section 2	3
•		(small)		
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	H-infinity optimal control, mixed-se	ensitivity design, line	ar matrix inequal	ities
Educational Objectives	After taking part successfully, stud	ents have reached t	he following learr	ing results
Professional Competence				
Knowledge	communication topology of They can explain the corprotocols They can explain analysis as involving either LTI or LPV a Students can explain the distributed systems that are they can explain (in outling such distributed systems)	entation of nonlinear conditions ing techniques can be systems opic and LFT represe techniques associate raph theoretic conce multiagent systems evergence properties and synthesis condition gent models state space represe te discretized accordir e) the extension of	r systems in the free conditions for I be used to solve a centations of LPV sted with each of the pts are used to resolve for formation of spatial and to an actuator, the bounded resolves in the sounded resolves and the sounded resolves are used to an actuator, the bounded resolves are solves and the sounded resolves are solves are used to an actuator, the bounded resolves are solves are solves are used to an actuator, the solves are solves are solves are used to an actuator, the solves are solves are solves are solves are used to an actuator, the solves are solves	orm of quasion of quas
Skills	 Students are capable of controllers Students are capable of controllers Students are capable of controllers They are amixed-sensitivity do this using polytopic, LFT They are able to use stands for these tasks Students are able to design agents with either LTI or LPN 	ey design of gain-scl or general LPV mode ard software tools (N n distributed format	neduled controlle els fatlab robust con cion controllers fo	rs; they ca trol toolbox or groups o

	 Students are able to design distributed controllers for spatially interconnected systems, using the Matlab MD-toolbox
Personal Competence	
<u>-</u>	Students can work in small groups and arrive at joint results.
, , , , , , , , , , , , , , , , , , , ,	Students are able to find required information in sources provided (lecture notes,
Autonomy	literature, software documentation) and use it to solve given problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Course L0661: Adv	anced Topics in Control
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	
Cycle	WiSe
Content	 Linear Parameter-Varying (LPV) Gain Scheduling Linearizing gain scheduling, hidden coupling Jacobian linearization vs. quasi-LPV models Stability and induced L2 norm of LPV systems Synthesis of LPV controllers based on the two-sided projection lemma Simplifications: controller synthesis for polytopic and LFT models Experimental identification of LPV models Controller synthesis based on input/output models Applications: LPV torque vectoring for electric vehicles, LPV control of a robotic manipulator Control of Multi-Agent Systems Communication graphs Spectral properties of the graph Laplacian First and second order consensus protocols Formation control, stability and performance LPV models for agents subject to nonholonomic constraints Application: formation control for a team of quadrotor helicopters Control of Spatially Interconnected Systems Multidimensional signals, I2 and L2 signal norm Multidimensional systems in Roesser state space form Extension of real-bounded lemma to spatially interconnected systems LMI-based synthesis of distributed controllers Spatial LPV control of spatially varying systems Applications: control of temperature profiles, vibration damping for an actuated beam
Literature	 Werner, H., Lecture Notes "Advanced Topics in Control" Selection of relevant research papers made available as pdf documents via StudIP

Course L0662: Adv	Course L0662: Advanced Topics in Control	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0548: Bioelectromagnetics: Principles and Applications				
Courses				
_	Principles and Applications (L0371) Principles and Applications (L0373)	Typ Lecture Recitation (small)	Hrs/wk 3 Section 2	CP 5
Module Responsible	Prof. Christian Schuster	(5.1.4.1)		
Admission Requirements				
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, stude	nts have reached th	ne following learn	ing results
Professional Competence				
Knowledge	Students can explain the basic bioelectromagnetics, i.e. the quantitin biological tissue. They can defin phenomena and order them correfields. They can give an overview of characterization of electromagnetic examples for therapeutic and diamedical technology.	fication and applica ne and exemplify to sponding to wavel ver measurement a fields in practical	tion of electroma the most importa ength and frequ and numerical ted applications . Th	gnetic fields ant physical ency of the chniques for ey can give
Skills	Students know how to apply varielectromagnetic fields in biological to make use of the elementary solut assess the most important effects they can order the effects corespectively, and they can analyzed develop validation strategies for the effects of electromagnetic fields formake an appropriate choice.	cissue. In order to dions of Maxwell's that these models rresponding to we them in a quantitheir predictions. The	do this they can r Equations. They predict for biolo vavelength and tative way. They ley are able to e	elate to and are able to gical tissue, frequency, are able to evaluate the
Personal Competence Social Competence				
Autonomy	Students are capable to gather in publications and relate that information make a connection between the content of other lectures (e.g. the electrical engineering / physics). The field of bioelectromagnetics in English	ition to the context eir knowledge obta ory of electromagr ey can communicat	of the lecture. The ined in this lectunetic fields, fund	ney are able ure with the amentals of
Workload in Hours	Independent Study Time 110, Study	Time in Lecture 70		

Credit points	6			
Course achievement	Compulsor B onus Yes 10 %	Form Presentation	Description	
Examination	Oral exam			
Examination duration and scale	45 min			
the Following			lsory Igineering: Medicine: Inistration: In Theory: Elective Echnology:	

Course L0371: Bioe	electromagnetics: Principles and Applications
Тур	Lecture
Hrs/wk	3
СР	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
	Prof. Christian Schuster
Language	
Cycle	
	- Fundamental properties of electromagnetic fields (phenomena)
	- Mathematical description of electromagnetic fields (Maxwell's Equations)
	- Electromagnetic properties of biological tissue
	- Principles of energy absorption in biological tissue, dosimetry
	- Numerical methods for the computation of electromagnetic fields (especially FDTD)
	- Measurement techniques for characterization of electromagnetic fields
Content	- Behavior of electromagnetic fields of low frequency in biological tissue
Content	- Behavior of electromagnetic fields of medium frequency in biological tissue
	- Behavior of electromagnetic fields of high frequency in biological tissue
	- Behavior of electromagnetic fields of very high frequency in biological tissue
	- Diagnostic applications of electromagnetic fields in medical technology
	- Therapeutic applications of electromagnetic fields in medical technology
	- The human body as a generator of electromagnetic fields
	- C. Furse, D. Christensen, C. Durney, "Basic Introduction to Bioelectromagnetics", CRC (2009)
Literature	- A. Vorst, A. Rosen, Y. Kotsuka, "RF/Microwave Interaction with Biological Tissues", Wiley (2006)
	- S. Grimnes, O. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008)
	- F. Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnetic Fields", CRC (2006)

Course L0373: Bioelectromagnetics: Principles and Applications	
Тур	Recitation Section (small)
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Thesis

Courses	
Title	Typ Hrs/wk CP
Module Responsible	Professoren der TUHH
Admission Requirements	 According to General Regulations §21 (1): At least 60 credit points have to be achieved in study programme. The examinations board decides on exceptions.
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	 The students can use specialized knowledge (facts, theories, and methods) or their subject competently on specialized issues. The students can explain in depth the relevant approaches and terminologies in one or more areas of their subject, describing current developments and taking up a critical position on them. The students can place a research task in their subject area in its context and describe and critically assess the state of research.
Skills	 The students are able: To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in question. To apply knowledge they have acquired and methods they have learnt in the course of their studies to complex and/or incompletely defined problems in a solution-oriented way. To develop new scientific findings in their subject area and subject them to a critical assessment.
Personal Competence	
Social Competence	 Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structured way. Deal with issues competently in an expert discussion and answer them in a manner that is appropriate to the addressees while upholding their own assessments and viewpoints convincingly.
	Students are able:
Autonomy	 To structure a project of their own in work packages and to work them off accordingly. To work their way in depth into a largely unknown subject and to access the information required for them to do so.

	 To apply the techniques of scientific work comprehensively in research of their own.
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0
Credit points	30
Course achievement	None
Examination	Thesis
Examination duration and scale	According to General Regulations
Assignment for the Following Curricula	Materials Science: Thesis: Compulsory