

Module Manual

Master of Science

Biomedical Engineering

Cohort: Winter Term 2018

Updated: 28th September 2018

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Module Manual

Master

Biomedical Engineering

Cohort: Winter Term 2018

Updated: 28th September 2018

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



Core qualification

Module M0523: B	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: Nontechnical Elective Complementary Courses for Master

Module Responsible	Dagmar Richter
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	
Professional	

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.

Fields of Teaching

Knowledge

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,

Skills

- 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

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 gender-sensitive 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 real-life fields of



Autonomy	 application 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: A	pplied Statistics			
Courses				
Title Applied Statistics (L1584)		Typ Lecture	Hrs/wk 2	CP 3
Applied Statistics (L1586)		Project-/problem-based Learning	2	2
Applied Statistics (L1585)		Recitation Section (small)	1	1
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of statistical n	nethods		
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge		ical methods and the conditions of the		
Skills	Students are able to use the stadepict the results	atistics program to solve statistics prob	lems and t	o interpret an
Personal Competence				
Social Competence	Team Work, joined presentation	n of results		
Autonomy	To understand and interpret the	e question and solve		
Workload in Hours	Independent Study Time 110, S	Study Time in Lecture 70		
Credit points	6			
Studienleistung	Yes None Writ	m Description ten elaboration	on	
Examination	Written exam			
Examination duration and scale	90 minutes, 28 questions			
	Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Core qualification: Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory			



Course L1584: Applied	l Statistics		
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/EN		
Cycle	WiSe		
Content	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 One way analysis of variance 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: 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	



Module M0811: N	ledical Imaging Systems	
Courses		
Title Medical Imaging Systems	Typ Hrs/wk CP (L0819) Lecture 4 6	
Module Responsible	Dr. Michael Grass	
Admission Requirements	None	
Recommended Previous Knowledge	none	
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	 Describe the system configuration and components of the main clinical imaging systems; Explain how the system components and the overall system of the imaging systems function; Explain and apply the physical processes that make imaging possible and use with the fundamental physical equations; Name and describe the physical effects required to generate image contrasts; Explain how spatial and temporal resolution can be influenced and how to characterize the images generated; Explain which image reconstruction methods are used to generate images; Describe and explain the main clinical uses of the different systems. 	
Skills	 Explain the physical processes of images and assign to the systems the bas mathematical or physical equations required; Calculate the parameters of imaging systems using the mathematical or physical equations; Determine the influence of different system components on the spatial and temporal resolution of imaging systems; Explain the importance of different imaging systems for a number of clinical applications; Select a suitable imaging system for an application.	
Personal		
Competence		
Social Competence	none	
Autonomy	 Students can: Understand which physical effects are used in medical imaging; Decide independently for which clinical issue a measuring system can be used. 	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Credit points	6	
Studienleistung	None	
Examination	Written exam	
Examination duration		



and scale	
Assignment for the Following Curricula	I 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: N	ledical Basics and Patho	ology		
Courses				
Title		Тур	Hrs/wk	СР
Medical Basics and Patho	logy I (L1599)	Lecture	2	2
Medical Basics and Patho	logy II (L1600)	Lecture	2	2
Medical Basics and Patho	logy III (L1602)	Lecture	2	2
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, stuc	lents have reached the follow	ving learning resu	lts
Professional Competence				
Knowledge				
Skills				
Personal				
Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Stud	y Time in Lecture 84		
Credit points	6			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	120 minutes			
Assignment for the Following Curricula	Biomedical Engineering: Core qu	alification: Compulsory		



Course L1599: Medica	I 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: Medica	I 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: Medica	I 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
	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
Content	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						
Fitle Practical Course Product	t Developme	nt, Materials and Prod	duction (L1566)	Typ Practical Course	Hrs/wk 6	CP 6
Module Responsible	Prof. Wolf	gang Hintze				
Admission Requirements	INANA					
Recommended Previous Knowledge	• Le • Le Materials • Le Ini • Le Co Productio • Le • Le	ectures: Structural production to Material sctures: Structure omposites, Manufactor: Production E	Product Develop Metallic Materia als Testing and Properties sturing of Polyme	ment I incl. CAD practals, Metallic Materials of Polymers, Streets and Composites	ls for Aircraft ructure and	Properties o
Educational Objectives	I ATTER TAKIN	g part successfully	, students have r	eached the following	learning resu	Its
Professional Competence		can				
Knowledge	• de	•		ferent fields of study. measurement instru	umentations	and machine
	Students	are capable of				
Skills	• ap	oplying provided ex udy.	perimental methation	actical applications. nods for examining of al results by using pro- mentations.		
Personal Competence		can				
Social Competence		rry out and docume		work in groups. ults in mixed teams o	of different field	ls of study.



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
Studienleistung	None
Examination	Written elaboration
Examination duration and scale	
_	Biomedical Engineering: Core qualification: Compulsory Product Development, Materials and Production: Core qualification: Compulsory

Тур	Practical Course
Hrs/wk	
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
Literature	 Evaluation of stock removal processes Analysis of basic laws in production logistics Analysis of positioning behaviour and trajectory accuracy of industrial robots Nach Themenstellung / depending on topic



Module M1180: C	ase Studie and Clinical Int	ternship		
Courses				
Title		Тур	Hrs/wk	СР
Casestudies Surgery and		Seminar	5	5
Clinical Internship (L1587)		Practical Course	1	1
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	The lectures addressing medical iss respective BSc Programs.	sues from the concentration B	iomedical Eng	ineering in the
Educational Objectives	After taking part successfully, studer	nts have reached the following	g learning resu	Its
Professional Competence				
Knowledge	The students learn the process of clinical practice regarding medical history, diagnosis an treatment decision with representative surgical and medical diseases in the variou departments, and get an insight into the daily patient care through case studies in a hospital.			n the various
Skills	Interpreting and explaining the med Dealing with patients.	ical history and medical recor	ds of a patient.	
Personal				
Competence				
Social Competence	Dealing with patients.			
Autonomy				
Workload in Hours	Independent Study Time 96, Study 7	Time in Lecture 84		
Credit points	6			
Studienleistung	None			
Examination	Written elaboration			
Examination duration and scale	5 Pages (10 Case studies)			
Assignment for the Following Curricula	Biomedical Engineering: Core quali	fication: Compulsory		



Course L1603: Casesto	udies 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	DE		
Cycle	WiSe/SoSe		
	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 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: S	Study work
Courses	
Title	Typ Hrs/wk CP
Module Responsible	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous Knowledge	Subjects of the Master program and the specialisations.
Educational Objectives	After taking part successfully, students have reached the following learning results
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 find new 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
Studienleistung	
Examination	
Examination duration and scale	according to FSPO
Assignment for the Following Curricula	Biomedical Engineering: Core qualification: Compulsory



Specialization Implants and Endoprostheses

Module M0623: Ir	ntelligent Systems i	in Medicine			
Courses					
Intelligent Systems in Med			Typ Lecture Project Seminar Recitation Section (small)	Hrs/wk 2 2 1	CP 3 2 1
Module Responsible	Prof. Alexander Schlaefer				
Admission Requirements	None				
Recommended Previous Knowledge	 principles of stoch 	amming, Java/C++ a	·		
Educational Objectives	I Attar takına nart ellecaceti	ully, students have re	ached the following lea	rning resul	lts
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 discuss the incoorporate feedback into		groups, provide help	oful feedb	ack and can
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 Time	110, Study Time in L	ecture 70		
Credit points	!				
Studienleistung	Yes 10 % Yes 10 %	Form Written elaboration Presentation	Descriptio	on	
Examination	Written exam				
Examination duration and scale	190 minutes				
	Computer Science: Speci Electrical Engineering: Sp Computational Science a Elective Compulsory	ecialisation Medical	Technology: Elective C	ompulsory	,



Assignment for the Following Curricula	I Riomodical Engineering: Specialization Implants and Endopreethocos: Elective Compulsory 1
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Course L0331: Intelligent 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: Intellige	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	



Courses				
= =	ents and Cognitive Robotics (L0341) ents and Cognitive Robotics (L0512)	Typ Lecture Recitation Section (small)	Hrs/wk	CP 4 2
Module Responsible	. ,	necitation Section (Smail)	2	2
Admission Requirements				
Recommended Previous Knowledge	Vectors, matrices, Calculus			
Educational Objectives	After taking part successfully, students h	ave reached the following lea	rning resul	lts
Professional Competence				
	Students can explain the agent abstract and give details about agent design (genain features of environments. The notion in terms of decision problems and algorithms and algorithms are decision problems and algorithms. The notion in terms of decision problems and algorithms are decision problems and algorithms are described in a sequential settings, with and with composition of the context, students can describe technique problems, and they can recall technique identify techniques for simultaneous located techniques for achieving desired state decision making in a multi-agent setting functions, voting protocol, and mechanisms. Students can select an appropriate scenarios. For simplified agent application optimization techniques. For those networks/dynamic Bayesian networks Students can also name and apply scenarios. For simple and complex decisions.	coals, utilities, environments) on of adversarial agent cooper or the state of lents can summarize how Bation and reasoning formalist efine decision making proceed to be state of lents access to the state of lents for solving (partially obsets for measuring the value of intermination and mapping, and is. Students can explain cooper in term of different types of measuring the value of intermination and mapping and lents can explain cooper in term of different types of measured the students can derive decision applications they can and apply bayesian reason different sampling techniques in making students can co	They can blems. For example, the environment of the	n describe the be discussed redealing with tworks can be and dynaming an and dynaming redealing the second application of application appl
	policies for concrete settings. In multi- finding different equilibria states,e.g., students will apply different voting protoc	agent situations students w Nash equilibria. For multi-	ill apply t agent dec	echniques fo cision makin
Personal				
Competence Social Competence	Students are able to discuss their solu English	tions to problems with other	s. They co	mmunicate i
Autonomy	Students are able of checking their undo concrete problems	erstanding of complex concep	ots by solv	ing varaints o
Workload in Hours	Independent Study Time 124, Study Tim	e in Lecture 56		
Credit points	6			
Studienleistung	None			
Examination	Written exam			



and scale	
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: Elective Compulsory International Production Management: Specialisation Production Technology: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Technical Complementary Course: 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 Numerics and Computer Science: Elective Compulsory



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, Minin algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environme probabilities, conditional probabilities, product rule, Bayes rule, full joint probab distribution, marginalization, summing out, answering queries, compley independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference enumeration), typical-case complexity, pragmatics: reasoning from effect (that can 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, dynai Bayesian networks, Markov assumption, transition model, sensor model, inferer problems: filtering, prediction, smoothing, most-likely explanation, special cashidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decis networks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteratif MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MD 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, Gibba Satterthwaite Impossibility Theorem, Direct mechanisms, expe
Literature	 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Norward 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, Youngard



Course L0512: Intellige	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		

Compulsory



Module M1230: S	Selected Topics of Biomedical Eng	gineering - Optior	n A (6 LI	P)
Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Mat	erials (I 1663)	Seminar	2	3
	des, Antennas, and Electromagnetic Compatibility		3	4
Introduction to Waveguie (L1877)	des, Antennas, and Electromagnetic Compatibility	Recitation Section (small)	2	2
Development and Regulat	tory Approval of Implants (L1588)	Lecture	2	3
Experimental Methods for	the Characterization of Materials (L1580)	Lecture	2	3
Numerical Methods in Bio	mechanics (L1583)	Seminar	2	3
Seminar Biomedical Engin	neering (L1890)	Seminar	2	3
Six Sigma (L1130)		Lecture	2	3
Fluid Mechanics II (L0001)	Lecture	2	4
Ceramics Technology (LC	0379)	Lecture	2	3
Admission Requirements Recommended Previous Knowledge Educational Objectives	After taking part successfully, students have re	eached the following lea	rning resu	Its
Professional Competence <i>Knowledge</i>				
Skills	! !			
Personal] 			
Competence				
Social Competence	! !			
Autonomy	! !			
	Depends on choice of courses			
Credit points				
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Impla Biomedical Engineering: Specialisation Med Compulsory Biomedical Engineering: Specialisation Mana Compulsory	lical Technology and (Control Th	eory: Electiv
	Biomedical Engineering: Specialisation Artific	ial Organs and Regene	rative Med	licine: Flectiv

Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective



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: Introdu	ction 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
	Mündliche Prüfung
Examination duration and scale	30 min
	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) for graduate engineering students that do not have a formal background in electrical engineering. 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 - 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	
	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	WiSe	
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		
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-iminternet.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		
Examination duration and scale	90 min	
Lecturer	Prof. Patrick Huber	
Language	DE/EN	
Cycle	SoSe	
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		
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	I SCHTITUCHE AUSARDEIUNG UNG 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		
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			
Тур	D Lecture		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Examination Form	Klausur		
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 L0379: Ceram	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			
Examination duration and scale	90 Minuten		
Lecturer	Dr. Rolf Janßen		
Language			
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. In:	troduction	
	Inhalt: 2. Ra	w materials	
Content	3. Pov	wder fabrication	
	4. Pov	wder processing	
	5. Sha	ape-forming processes	
	6. Dei	nsification, sintering	
	7. Gla	ss and Cement technology	
	8. Ce	ramic-metal joining techniques	
	W.D. Kingery, "Introduction to Cera	amics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Handl	oook Vol.4 "Ceramics and Glasses", 1991	
Literature	D.W. Richerson, "Modern Ceramic	Engineering", Marcel Decker, New York, 1992	
	Skript zur Vorlesung		

Compulsory



Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) **Courses** Title Hrs/wk CP Typ Seminar Nature's Hierarchical Materials (L1663) 3 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Lecture 3 4 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Recitation Section (small) 2 2 (L1877)Development and Regulatory Approval of Implants (L1588) 2 Lecture 3 Experimental Methods for the Characterization of Materials (L1580) Lecture 2 3 2 Numerical Methods in Biomechanics (L1583) Seminar 3 Seminar Biomedical Engineering (L1890) Seminar 2 3 Six Sigma (L1130) Lecture 2 3 2 Fluid Mechanics II (L0001) Lecture 4 Ceramics Technology (L0379) Lecture 2 3 Module Responsible Prof. Michael Morlock Admission None Requirements Recommended **Previous Knowledge** Educational After taking part successfully, students have reached the following learning results **Objectives Professional** Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses

Credit points 12

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



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: Introdu	ction 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
	Mündliche Prüfung
Examination duration and scale	30 min
	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) for graduate engineering students that do not have a formal background in electrical engineering. 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	
	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	WiSe	
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-iminternet.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	
Examination duration and scale	90 min
Lecturer	Prof. Patrick Huber
Language	DE/EN
Cycle	SoSe
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: Numer	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			
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	I schriftliche ausarheitung 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			
Тур	D Lecture		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Examination Form	Klausur		
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 L0379: Ceram	ics Technology		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study	Time in Lecture 28	
Examination Form			
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		
	Content: 1. In:	troduction	
	Inhalt: 2. Ra	w materials	
Content	3. Pov	wder fabrication	
	4. Pov	wder processing	
	5. Sha	ape-forming processes	
	6. Dei	nsification, sintering	
	7. Gla	ss and Cement technology	
	8. Ce	ramic-metal joining techniques	
	W.D. Kingery, "Introduction to Cera	amics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Handl	oook Vol.4 "Ceramics and Glasses", 1991	
Literature	D.W. Richerson, "Modern Ceramic	Engineering", Marcel Decker, New York, 1992	
	Skript zur Vorlesung		



Module M0746: N	/licrosystem Engi	ineering				
Courses						
Title			Typ	Hrs/wk	СР	
Microsystem Engineering	(1.0680)		Typ Lecture	115/WK 2	4	
Microsystem Engineering	Project_/problem-hased					
Module Responsible	Prof. Manfred Kasper	<u> </u>				
Admission Requirements	None					
Recommended Previous Knowledge	I Racic college in phyci	ics, mathematics and ele	ectric engineering			
Educational Objectives	After taking part succes	essfully, students have re	eached the following lea	ırning resul	ts	
Professional						
Competence Knowledge	! !	oout the most important ensors and actuators.	technologies and mate	rials of ME	MS as well as	
Skills		tudents are able to analyze and describe the functional behaviour of MEMS components and bevaluate the potential of microsystems.				
Personal Competence						
Social Competence	Students are able to s accordingly.	solve specific problems	alone or in a group a	nd to prese	ent the result	
Autonomy	Students are able to acquire particular knowledge using specialized literature and to integrate and associate this knowledge with other fields.					
Workload in Hours	Independent Study Tin	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6					
Studienleistung	Compulsory Bonus No 10 %	Form Presentation	Description	on		
Examination	Written exam					
Examination duration and scale	2h					
Assignment for the Following Curricula	Computational Science Elective Compulsory International Managen Compulsory International Manage Compulsory Mechanical Engineerin Mechatronics: Speciali Biomedical Engineerin Compulsory Biomedical Engineerin Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory	ce and Engineering: Special En	ecialisation Systems Er Specialisation II. Electric ng: Specialisation II. pecialisation Mechatron Elective Compulsory sial Organs and Regene nts and Endoprosthese dical Technology and a agement and Business	cal Engined Mechatron sics: Elective erative Med s: Elective (Control The	ering: Elective nics: Elective e Compulsory icine: Elective Compulsory eory: Elective	
	I	[40]				



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

Typ Lecture Hrs/wk 2 CP 4 Workload in Hours Independent Study Time 92, Study Time in Lecture 28 Lecturer Prof. Manfred Kasper Language EN Cycle WiSe Object and goal of MEMS Scaling Rules Lithography	
CP 4 Workload in Hours Independent Study Time 92, Study Time in Lecture 28 Lecturer Prof. Manfred Kasper Language EN Cycle WiSe Object and goal of MEMS Scaling Rules	
Workload in Hours Independent Study Time 92, Study Time in Lecture 28 Lecturer Prof. Manfred Kasper Language EN Cycle WiSe Object and goal of MEMS Scaling Rules	
Lecturer Prof. Manfred Kasper Language EN Cycle WiSe Object and goal of MEMS Scaling Rules	
Language EN Cycle WiSe Object and goal of MEMS Scaling Rules	
Cycle WiSe Object and goal of MEMS Scaling Rules	
Object and goal of MEMS Scaling Rules	
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: Micros	ystem 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	N	
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: V	/ibration Theory			
Courses				
Title Vibration Theory (L0701)		Typ Integrated Lecture	Hrs/wk 4	CP 6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	INone			
Recommended Previous Knowledge	T ● Linear Algebra			
Educational Objectives	Latter taking part circesetully etudente have	e reached the following I	earning resu	its
Professional Competence				
Knowledge	Students are able to denote terms and con-	cepts of Vibration Theor	y and develo	o them further
	Students are able to denote methods of Vib	oration Theory and deve	lop them furth	er.
Personal Competence				
Social Competence	Students can reach working results also in	groups.		
	Students are able to approach individually		on Theory.	
	Independent Study Time 124, Study Time in	n Lecture 56		
Credit points				
Studienleistung	1			
	Written exam			
Examination duration and scale	12 Hours			
_	Energy Systems: Core qualification: Elective Computational Science and Engineering Compulsory International Management and Engine Compulsory Biomedical Engineering: Specialisation Art Compulsory Biomedical Engineering: Specialisation Implicational Engineering: Specialisation Implication Implic	g: Specialisation Scie ering: Specialisation tificial Organs and Rege plants and Endoprosther Medical Technology and anagement and Busine action: Core qualification : Core qualification: Elective Co	II. Mechatron nerative Med ses: Elective d Control Th ess Administr : Compulsory ctive Compulsory	nics: Elective licine: Elective Compulsory eory: Elective ation: Elective



Course L0701: Vibration	on 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.
	K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen. Springer Verlag, 2013.



Module M0768: N	licrosystems Tecl	nnology in Theo	ry and Practice			
Courses						
Title			Тур	Hrs/wk	СР	
Microsystems Technology	y (L0724)		Lecture	2	4	
Microsystems Technology	y (L0725)		Project-/problem-based Learning	2	2	
Module Responsible	Prof. Hoc Khiem Trieu					
Admission Requirements	None					
Recommended Previous Knowledge	Basics in physics, chemi	Basics in physics, chemistry, mechanics and semiconductor technology				
Educational Objectives	After taking part success	sfully, students have re	ached the following lea	arning resu	ts	
Professional						
Competence						
Marie I. d.	Students are able to present and to explain current fabrication techniques for microstructures and especial methods for the fabrication of microsensors and microactuators, as well as the integration thereof in more complex systems				•	
Knowledge	• to explain in details operation principles of microsensors and microactuators and					
	to discuss the potential and limitation of microsystems in application.					
Students are capable						
	• to analyze the feasib					
	to develop process flows for the fabrication of microstructures and					
Skills	to apply them.					
Personal Competence						
Social Competence	Students are able to present and discuss the			team work	as well as t	
Autonomy	None					
Workload in Hours	Independent Study Time	e 124, Study Time in Le	ecture 56			
Credit points	6					
	Compulsory Bonus	Form	Descriptio Studierend Kleingrup	den fi	ühren iı aborpraktikun	
	Į	[54]				



Studienleistung	Yes None	Subject theor practical work	etical and durch. Jede Gruppe präsentiert und diskutiert die Theorie sowie die Ergebniise ihrer Labortätigkeit. vor dem gesamten Kurs.
Examination			
Examination duration and scale	30 min		
Assignment for the Following Curricula	Elective Compulsory Electrical Engineering: Computational Science Elective Compulsory International Manage Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory	: Specialisation Medicate and Engineering: Specialisation Artification Specialisation Implang: Specialisation Medication	an Technology: Elective Compulsory pecialisation Systems Engineering and Robotics: ring: Specialisation II. Mechatronics: Elective cial Organs and Regenerative Medicine: Elective ants and Endoprostheses: Elective Compulsory edical Technology and Control Theory: Elective magement and Business Administration: Elective alification: Elective Compulsory

Typ Lecture
Typ Lecture Hrs/wk 2 CP 4 Workload in Hours Independent Study Time 92, Study Time in Lecture 28 Lecturer Prof. Hoc Khiem Trieu Language EN Cycle WiSe • Introduction (historical view, scientific and economic relevance, scaling laws) • Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography improving resolution, next-generation lithography, nano-imprinting, molecula 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, corne undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryoprocess, XeF2 etching) • Surface Micromachining and alternative Techniques (sacrificial etching, film stress)
Hrs/wk 2 CP 4 Workload in Hours Independent Study Time 92, Study Time in Lecture 28 Lecturer Prof. Hoc Khiem Trieu Language EN Cycle WiSe Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography improving resolution, next-generation lithography, nano-imprinting, molecula 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, corne undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryoprocess, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress)
Workload in Hours Independent Study Time 92, Study Time in Lecture 28
Norkload in Hours Independent Study Time 92, Study Time in Lecture 28
Lecturer Language EN Cycle WiSe Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography improving resolution, next-generation lithography, nano-imprinting, molecula 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, corne undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryoprocess, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress)
Language EN Cycle WiSe Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography improving resolution, next-generation lithography, nano-imprinting, molecula 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, corne undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryoprocess, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress)
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 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography improving resolution, next-generation lithography, nano-imprinting, molecula 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, corne undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryoprocess, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress)
 Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography improving resolution, next-generation lithography, nano-imprinting, molecula 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, corne undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryoprocess, XeF2 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress)
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: magneto resistance, AMR and GMR



- 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, topdown 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-onboard, 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

Literature

N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009

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

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

Course L0725: Micros	ystems 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	
Finite Element Methods (L	·		Lecture	2	3	
Finite Element Methods (L	_0804)		Recitation Section (large)	2	3	
Module Responsible	!					
Admission Requirements	None					
Recommended Previous Knowledge	Dynamics)	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics Dynamics) Mathematics I, II, III (in particular differential equations)				
Educational Objectives	LATTER TAKING NART SUCCESS	fully, students have re	ached the following lea	rning result	S	
Professional						
Competence Knowledge	The students possess an in-depth knowledge regarding the derivation of the finite element method and are able to give an overview of the theoretical and methodical basis of the method.					
Skills	The students are capal elements, assembling th equations.	-		-		
Personal Competence	Ctudonto con work in am	all groups on specific	problems to arrive at ioi	int solutions	3 .	
Social Competence Autonomy	The students are able develop own finite elemscrutinized.	to independently so	olve challenging comp	utational p	roblems ar	
Workload in Hours	Independent Study Time	124, Study Time in Le	ecture 56			
Credit points	6					
Studienleistung	No 20 %	Form Midterm	Descriptio	on		
Examination	Written exam					
Examination duration and scale	I 120 min					
Examination duration	120 min	ualification: Elective C ering: Specialisation A	Compulsory Aircraft Systems: Elective			



	Computational Science and Engineering: Specialisation Scientific Computing: Elective					
	Compulsory					
	International Management and Engineering: Specialisation II. Mechatronics: Elective					
	Compulsory					
	International Management and Engineering: Specialisation II. Product Development and					
	Production: Elective Compulsory					
Assignment for the	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					
	Technomathematics: Core qualification: Elective Compulsory					
	Theoretical Mechanical Engineering: Core qualification: Compulsory					
	modification Modification Lingmodiffig. Core qualification. Computatory					

Course L0291: Finite E	Element Methods					
Тур	cture					
Hrs/wk						
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 E	ourse L0804: Finite Element Methods				
Тур	ecitation 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
Technology Management	(L0849)	Project-/problem-based Learning	3	3
Technology Management	Seminar (L0850)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	INone			
Recommended Previous Knowledge	Bachelor knowledge in business mana	agement		
Educational Objectives	After taking part successfully, students	have reached the following lea	arning resu	lts
Professional Competence				
Knowledge	Students will gain deep insights into: • 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 The course aims to:			
Skills	 Develop an understanding of the importance of Technology Management - on national as well as international level Equip students with an understanding of important elements of Technolog Management (strategic, operational, organizational and process-related aspects) Foster a strategic orientation to problem-solving within the innovation process as we as Technology Management and its importance for corporate strategy Clarify activities of Technology Management (e.g. technology sourcing, maintenanc and exploitation) Strengthen essential communication skills and a basic understanding of manageria organizational and financial issues concerning Technology-, Innovation- and R&E management. Further topics to be discussed include: Basic concepts, models and tools, relevant to the management of technology, R&I and innovation Innovation as a process (steps, activities and results) 			
Personal Competence				
Social Competence	 Interact within a team Raise awareness for globabl issues 			
	Gain access to knowledge soul	rces		



	Develop presentation skills				
Workload in Hours	ndependent Study Time 110, Study Time in Lecture 70				
Credit points	3				
Studienleistung	None				
	Written exam				
Examination duration and scale	90 minutes				
Assignment for the Following Curricula	Global Innovation Management: Core qualification: Compulsory 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 Glomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Glomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Glomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Glomedical Engineering: Specialisation Management and Business Administration: Compulsory				

Course L0849: Techno	ology 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 Incovation Management, Elgar Research Collection, Northhampton (MA) 2011

Course L0850: Technology 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	Aspects of and Cases in combination with the content of the lecture.	
Literature	see lecture Technology Management.	



Courses						
Title				Тур	Hrs/wk	СР
Control Systems Theory a Control Systems Theory a	_			Lecture Recitation Section (small	2	4 2
Module Responsible	•			Treestation Contain (cimain		
Admission	1	IDOIT WOMEN				
Requirements	<u> </u>					
Recommended Previous Knowledge		tion to Control Syst	ems			
Educational Objectives	Ι Δποι τοκ	ing part successful	ly, students have re	eached the following lea	arning resul	lts
Professional Competence						
Knowledge	ti • 1 • 1 • 1 • 1 • 1 • 1 • 1	 Students can explain how linear dynamic systems are represented as state space models; they can interpret the system response to initial states or external excitation as trajectories in state space They can explain the system properties controllability and observability, and their relationship to state feedback and state estimation, respectively They can explain the significance of a minimal realisation They can explain observer-based state feedback and how it can be used to achieve tracking and disturbance rejection They can extend all of the above to multi-input multi-output systems They can explain the z-transform and its relationship with the Laplace Transform They can explain state space models and transfer function models of discrete-time systems They can explain the experimental identification of ARX models of dynamic systems, and how the identification problem can be solved by solving a normal equation They can explain how a state space model can be constructed from a discrete-time impulse response 				
Skills	 Students can transform transfer function models into state space models and vice versa They can assess controllability and observability and construct minimal realisations They can design LQG controllers for multivariable plants They can carry out a controller design both in continuous-time and discrete-time domain, and decide which is appropriate for a given sampling rate They can identify transfer function models and state space models of dynamic system from experimental data They can carry out all these tasks using standard software tools (Matlab Controlloox, System Identification Toolbox, Simulink) 					
Personal Competence						
Social Competence	Students	s can work in small	groups on specific	problems to arrive at jo	oint solution	s.
		Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it when solving given problems.				
Autonomy			wledge in weekly	on-line tests and there	eby control	their learnin
	progress	S.				





Course L0656: Contro	l Systems Theory and Design				
Тур	Lecture				
Hrs/wk	2				
СР	4				
Workload in Hours	dependent Study Time 92, Study Time in Lecture 28				
Lecturer	rof. Herbert Werner				
Language	1				
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: 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				



Module M0867: P	Production Planning & Control ar	nd Digital Enterpris	se	
Courses				
Title The Digital Enterprise (L0) Production Planning and C Production Planning and C Exercise: The Digital Enter	Control (L0929) Control (L0930)	Typ Lecture Lecture Recitation Section (small) Recitation Section (small)		CP 2 2 1
	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous Knowledge	Leundamentals of Production and Ouglity Mar	nagement		
Educational Objectives	Latter taking nart circecctully childente have i	reached the following lea	rning resul	ts
Skills Personal Competence	Students can explain the contents of the mod Students are capable of choosing and applindustrial problems.	olying models and meth	ods from th	
Autonomy	-	•	Tio others.	
Credit points	Independent Study Time 96, Study Time in L	ecture 84		
Studienleistung	1			
	Written exam			
Examination duration and scale	180 Minuten			
Assignment for the Following Curricula	I BIOMEGICAL ENGINEERING. SPECIALISATION MANAGEMENT AND BUSINESS AGMINISTRATION I			



Course L0932: The Dig	gital 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: Produc	tion 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: Produc	ourse 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	WiSe	
Content	See interlocking course	
Literature	Siehe korrespondierende Vorlesung See interlocking course	



Courses				
Title		Тур	Hrs/wk	СР
Electronic Circuits for Med		Lecture	2	3
Electronic Circuits for Med Electronic Circuits for Med		Recitation Section (small) Practical Course	1	2 1
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Fundamentals of electrical engineering	ı		
Educational Objectives	After taking part successfully, students	have reached the following lea	rning resu	lts
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 its propagation along an axon Students can exemplify the communication between neurons and electronic 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 implants and artificial eyes 			
Skills	 Students can calculate the time dependent voltage behavior of an action potential Students can give scenarios for further improvement of low-noise and low-power signal acquisition. Students can develop the block diagrams of prosthetic systems Students can define the building blocks of electronic systems for an articifial eye. 			
Personal Competence				
Social Competence	 Students are trained to solve problems in the field of medical electronics in team together with experts with different professional background. Students are able to recognize their specific limitations, so that they can ask for assistance to the right time. 			
Autonomy	 Students are able to realistica actions for improvements when Students can break down their work in a realistic way. Students can handle the comp needing support. 	necessary. work in appropriate work pack	ages and	schedule the



	Students are all experimental wo		a responsible	manner in a	all cases and situations of
Workload in Hours	Independent Study Time	e 124, Study T	ime in Lecture	56	
Credit points	6				
	Compulsory Bonus	Form		Descri	ption
Studienleistung	No None	Subject practical w	theoretical ork	and	
	No 20 %	Excercises			
Examination	Oral exam				
Examination duration and scale	140 min				
Assignment for the Following Curricula	Compulsory Biomedical Engineering Biomedical Engineering Biomedical Engineering Compulsory Microelectronics and M Compulsory Theoretical Mechanical Compulsory	g: Specialisations: Specialisations: Specialisations: Specialisations: Specialisations: Specialisations: Engineering:	on Artificial Orgon Implants and Medical Tecon Managements Specialisation Specialisation	gans and Regord Endoprosthe chnology and (ent and Busing Microelectron Bio- and Mo	re Compulsory enerative Medicine: Elective eses: Elective Compulsory Control Theory: Compulsory ess Administration: Elective nics Complements: Elective edical Technology: Elective



Course L0696: Electro	nic 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: Electro	nic 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/



Courses				
Courses		T	Hara tada	
Title Continuum Mechanics (L1	533)	Typ Lecture	Hrs/wk 2	CP 3
Continuum Mechanics Ex		Recitation Section (small)	_	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of linear continuum mechanics as moments, stress, linear strain, free-body energy).			
Educational Objectives	After taking part successfully, students hav	e reached the following lea	rning resul	ts
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 and apply basics of deformation theory to specific aspects, both in applied contexts as in research contexts.			
Personal				
Competence	The students are able to develop solutions	to present them to special	iete in writte	n form and t
Social Competence	The students are able to develop solutions, to present them to specialists in written form and to develop ideas further.			
Autonomy	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.			
Workload in Hours	Independent Study Time 124, Study Time i	n Lecture 56		
Credit points	6			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Computational Science and Engineerin Compulsory Materials Science: Specialisation Modeling Mechanical Engineering and Managemen Mechatronics: Technical Complementary Compulsory Biomedical Engineering: Specialisation Imbiomedical Engineering:	g: Elective Compulsory g: Specialisation Materials: Course: Elective Compulsor tificial Organs and Regene plants and Endoprostheses Medical Technology and O	Elective Co ry rative Medi s: Elective C Control The	mpulsory cine: Electiv Compulsory eory: Electiv



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

Course L1533: Continu	uum 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/EN
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: Continuum 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/EN
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



Madula Mades. B	Antonial BAndalinon			
Module M1151: N	nateriai Modeling			
Courses				
Title		Тур	Hrs/wk	СР
Material Modeling (L1535)		Lecture	2	3
Material Modeling (L1536)		Recitation Section (small)	2	3
	Prof. Christian Cyron			
Admission Requirements	None			
	Basics of linear and nonlinear continuum Mechanics II and Continuum Mechanics (for strain, free-body principle, linear and nonlinear	ces and moments, stre	ss, linear a	
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional				
Competence		multidimensional consit	tutivo motor	ial lawa
-	The students can explain the fundamentals of multidimensional consitutive material laws The students can implement their own material laws in finite element codes. In particular, the students can apply their knowledge to various problems of material science and evaluate the			
D	corresponding material models.			
Personal Competence				
,	The students are able to develop solutions,	to present them to spe	ecialists an	d to develop
Social Competence	ideas further.			
Autonomy	The students are able to assess their independently and on their own identify and s and acquire the knowledge required to this en	solve problems in the are		•
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56		
Credit points	6			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Impla Biomedical Engineering: Specialisation Med Compulsory Biomedical Engineering: Specialisation Man	elective Compulsory pecialisation Materials: loial Organs and Regene nts and Endoprostheses dical Technology and (Elective Corative Medins: Elective Control The	mpulsory cine: Elective compulsory cory: Elective
	1			



Course L1535: Materia	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/EN		
Cycle	WiSe		
Content	 fundamentals of finite element methods fundamentals of material modeling introduction to numerical implementation of material laws overview of modelling of different classes of materials combination of macroscopic quantities to material microstructure 		
Literature	 D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge G. Gottstein., Physical Foundations of Materials Science, Springer 		

Course L1536: Materia	al 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/EN
Cycle	WiSe
Content	 fundamentals of finite element methods fundamentals of material modeling introduction to numerical implementation of material laws overview of modelling of different classes of materials combination of macroscopic quantities to material microstructure
Literature	D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge G. Gottstein., Physical Foundations of Materials Science, Springer



Module M1199: A	Advanced Functional Mat	erials		
Courses				
Title Advanced Functional Mat	erials (L1625)	Typ Lecture	Hrs/wk 2	CP 6
Module Responsible	Prof. Patrick Huber			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in Materials Scie	ence, e.g. Materials Science I/II		
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The students will be able to expapplications in technology, in particomposite materials (biomaterials	rticular metallic, ceramic, polym		
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 microto 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 s	solutions to specialists and to de	velop ideas fur	ther.
Autonomy	The students are able to assess their own strengths gather new necessary exp			
Workload in Hours	Independent Study Time 152, Stu	dy Time in Lecture 28		
Credit points	6			
Studienleistung	None			
	Presentation			
Examination duration and scale	30 min			
Assignment for the Following Curricula	Materials Science: Core qualificat Mechanical Engineering and Man Biomedical Engineering: Speciali Compulsory Biomedical Engineering: Speciali Biomedical Engineering: Special Compulsory Biomedical Engineering: Special Compulsory Theoretical Mechanical Engineeri Theoretical Mechanical Engineeri	sagement: Specialisation Materi sation Artificial Organs and Reg sation Implants and Endoprosth lisation Medical Technology a isation Management and Busin ing: Technical Complementary (generative Med eses: Elective nd Control Th ness Administra Course: Elective	icine: Elective Compulsory eory: Elective ation: Elective Compulsory



Course L1625: Advanced Functional Materials	
Тур	Lecture
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/EN
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	Wird in der Veranstaltung bekannt gegeben



Courses	
Fitle ntroduction to Biochemis	Typ Hrs/wk CP try and Molecular Biology (L0386) Lecture 2 3
Module Responsible	Prof. Hans-Jürgen Kreienkamp
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	LATTER TAKING NAIT SUCCESSIUM STUGENTS NAVE REACHED THE TOUCHWING JEARNING RESULTS
Professional Competence	
Knowledge	 The students can 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 discussions in research and medicine on a technical level.
Autonomy	
	The students can develop understanding of topics from the course, using technical literatur
	The students can develop understanding of topics from the course, using technical literature by themselves. Independent Study Time 62, Study Time in Lecture 28
Workload in Hours	The students can develop understanding of topics from the course, using technical literatur by themselves. Independent Study Time 62, Study Time in Lecture 28
Workload in Hours Credit points Studienleistung Examination	The students can develop understanding of topics from the course, using technical literature by themselves. Independent Study Time 62, Study Time in Lecture 28 None Written exam
Workload in Hours Credit points Studienleistung	The students can develop understanding of topics from the course, using technical literature by themselves. Independent Study Time 62, Study Time in Lecture 28 None Written exam



Engineering: Compulsory
Mechanical Engineering: Specialisation Biomechanics: 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: Core qualification: 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: E	BIO I: Implants and Fracture Healing		
Courses			
Title Implants and Fracture He	Typ Hrs/wk CP Lecture 2 3		
Module Responsible	Prof. Michael Morlock		
Admission Requirements	None		
Recommended Previous Knowledge	Fracture Healing"		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	The students can describe the different ways how bones heal, and the requirements for the existence. The students can name different treatments for the spine and hollow bones under give fracture morphologies.		
Skills	The students can determine the forces acting within the human body under quasi-stati situations under specific assumptions.		
Personal Competence			
Social Competence	The students can, in groups, solve basic numerical modeling tasks for the calculation c internal forces.		
Autonomy	The students can, in groups, solve basic numerical modeling tasks for the calculation c internal forces.		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points	3		
Studienleistung	None		
Examination	Written exam		
Examination duration and scale	I 90 min		
	General Engineering Science (German program): Specialisation Mechanical Engineering Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering Compulsory		
Assignment for the Following Curricula	General Engineering Science (English program): Specialisation Mechanical Engineering Focus Biomechanics: 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 Mechanical Engineering: Specialisation Biomechanics: 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



ourse L0376: Implan	ts and Fracture Healing	
Тур	Lecture	
Hrs/wk		
CP		
	Independent Study Time 62, Study Time in Lecture 28 Prof. Michael Morlock	
Language		
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	
	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	
Literature	Nigg, B.: Biomechanics of the musculo-skeletal system	
	Schiebler T.H., Schmidt W.: Anatomie	
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat	



Module M1334: B	BIO II: Biomaterials			
Courses				
Title		Тур	Hrs/wk	СР
Biomaterials (L0593)		Lecture	2	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	After taking part successfully, students have reached the following learning results		
Professional Competence				
-	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 ad	vantages and disadvantages of o	different kinds o	f biomaterials.
Personal Competence				
Social Competence	The students are able to discus replacements with student mates		ing present or t	peing used for
Autonomy	The students are able to acquire with respect to its credibility.	information on their own. They o	can also judge t	he information
Workload in Hours	Independent Study Time 62, Stu	dy Time in Lecture 28		
Credit points	3			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	International Management and Biotechnology: Elective Compuls Materials Science: Specialisation Biomedical Engineering: Special Compulsory Biomedical Engineering: Special Biomedical Engineering: Special Compulsory Biomedical Engineering: Special Compulsory Biomedical Engineering: Special Compulsory Theoretical Mechanical Engineer Theoretical Mechanical Engineer Compulsory	sory n Nano and Hybrid Materials: Electric list in Nano and Hybrid Materials: Electric list in Nano and Relistation Implants and Endoprost alisation Medical Technology and alisation Management and Busing: Technical Complementary	ective Compulse generative Med heses: Compuls and Control Th iness Administr	ory licine: Elective sory eory: Elective ation: Elective e Compulsory

Course L0593: Biomaterials	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
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materials. Oxford: Elsevier, 1987.
operties of biomaterials: proceedings held at Keele University Wiley, 1998.
erials in research and practice. New York: Churchill Livingstone
duction. New York: Plenum Press, 1980.
[60]



Wintermantel, E. und Ha, S.-W: Biokompatible Werkstoffe und Bauweisen. Berlin, Springer, 1996.



Module M1342: P	Polymers				
Courses					
Courses Title		Typ	Hrs/wk	СР	
Structure and Properties	of Polymers (L0389)	Typ Lecture	2	3	
Processing and design wi		Lecture	2	3	
Module Responsible	Dr. Hans Wittich				
Admission Requirements	None				
Recommended Previous Knowledge	Basics: chemistry / physics / material sci	ence			
Educational Objectives	After taking part successfully, students h	ave reached the followi	ng learning resul	ts	
Professional Competence					
Competence	Students can use the knowledge of plas	tics and define the nece	essary testing and	l analysis.	
	They can explain the complex relationsh	nips structure-property r	elationship and		
Knowledge	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 hand	dle feedback on their o	wn performance o	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, Study Tim	e in Lecture 56			
Credit points					
Studienleistung					
	Written exam				
Examination duration and scale	180 min				
	Materials Science: Specialisation Engine Biomedical Engineering: Specialisation	_		ory	



	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
Assignment for the	
Following Curricula	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	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	
Content	- Structure and properties of polymers - Structure of macromolecules Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution - Morphology amorph, crystalline, blends - 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: R	Regenerative Medi	cine			
Courses					
Fitle Fitle			Тур	Hrs/wk	СР
Regenerative Medicine (L	•	(1.4004)	Seminar	2	3
-	ng - Regenerative Medicine	(L1664)	Seminar	2	3
Module Responsible					
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part success	sfully, students have re	eached the followin	g learning resu	Its
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	 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 w discuss their results in the Students are able to reflect to reflect to the students are able to reflect to the students are able to reflect to the students are able to reflect the students are able to the students are able to the students are able to washingtonessed to the students are able to washingtonessed the students are able to washingtonessed the students are able to washingtonessed the students are able to reflect the students	ne plenary and to defe	nd them.		
Autonomy	After completion of this module, participants will be able to solve a technical problem in team of approx. 2-4 persons independently including a presentation of the results.				
Workload in Hours	Independent Study Time	e 124, Study Time in L	ecture 56		
Credit points	6				
Studienleistung	Compulsory Bonus Yes 20 %	Form Written elaboration	Ausar	ription beitung zu Rin col for lecture se	
Examination	Presentation		-		
Examination duration and scale	Oral presentation + disc	ussion (30 min)			



	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Assignment for the	Compulsory
	Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective
	Compulsory

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/EN	
Cycle	WiSe	
	The course deals with the application of biotechnological engineering principles for regeneration 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	
Content	for cell cultivation "in vitro")	
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	e 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		



Courses					
-	ciples and Applications (L0371 ciples and Applications (L0373		Typ Lecture Recitation Section (small)	Hrs/wk 3 2	CP 5 1
	Prof. Christian Schuster				
Admission Requirements	None				
Recommended Previous Knowledge	Basic principles of physics	3			
Educational Objectives	After taking part successfu	lly, students have re	eached the following lea	rning resul	ts
Professional Competence					
Knowledge	Students can explain the bile. the quantification and define and exemplify the root to wavelength and frequenumerical techniques for They can give examples for medical technology.	application of elect most important physics of the fields. The characterization of	tromagnetic fields in bio sical phenomena and or ey can give an overview electromagnetic fields in	ological tiss der them of over mea n practical	sue. They ca correspondir surement ar applications
Skills	Students know how to app fields in biological tissue. solutions of Maxwell's Equ models predict for biologi and frequency, respectivel develop validation strateg electromagnetic fields for choice.	In order to do this the pations. They are all call tissue, they can anally, and they can anally for their predictions.	ney can relate to and ma ole to assess the most im n order the effects corre alyze them in a quantitati ctions. They are able to	ke use of the portant efforts of the sponding to the way. The sevaluate	ne elementa ects that the to waveleng ey are able the effects
Personal Competence	Students are able to work	together on subject	rt related tasks in small o	aroups. Th	ev are able
Social Competence	present their results effecti				o, a.o as.o
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 1	10, Study Time in L	ecture 70		
Credit points	6				
Studienleistung	Compulsory Bonus	Form	Descriptio	n	



Examination	
Examination duration and scale	45 min
Assignment for the Following Curricula	I Riomadical Endinaaring, Spacialisation implants and Endoprostuases, Flactiva Compilison, Fl



Course L0371: Bioelec	ctromagnetics: 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		
Contont	- 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)		
	- 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: Bioelec	ctromagnetics: 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	rof. 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)		
	- 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)		



Module M0630: F	Robotics an	ıd Navig	ation in Medic	ine		
Courses						
Title				Тур	Hrs/wk	СР
Robotics and Navigation in	· ·	-		Lecture	2	3
Robotics and Navigation in Robotics and Navigation in	•	*		Project Seminar Recitation Section (small)	2	2 1
	•	•		necitation Section (Smail)	1	ı
Module Responsible		er Schlaefei	r			
Admission Requirements	None					
Recommended Previous Knowledge	princip		(algebra, analysis/c ramming, e.g., in Jav skills			
Educational Objectives	After taking pa	rt successf	ully, students have re	eached the following lea	ırning resu	Its
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 S	Study Time	110, Study Time in L	ecture 70		
Credit points	6					
Studienleistung		Bonus 10 % 10 %	Form Written elaboration Presentation	Descriptic	on	
Examination	Written exam					
Examination duration and scale	90 minutes					
	Electrical Engi Computationa Elective Comp International N Compulsory Mechatronics: Biomedical Er Compulsory	Ineering: Spansering: Spansory Management Specialisa	pecialisation Medica and Engineering: Sp nt and Engineering: tion Intelligent Syste Specialisation Artific	e Engineering: Elective (al Technology: Elective (pecialisation Systems Er Specialisation II. Electric ms and Robotics: Elective cial Organs and Regenerants and Endoprostheses	compulsory ngineering cal Engine ve Compul rative Med	and Robotics ering: Elective sory licine: Elective



Assignment for the	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective
Following Curricula	Compulsory
i ollowing our reala	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: Robotic	cs 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 M0634: li	ntroduction into M	edical Technol	ogy and Systems		
Courses					
Title			Тур	Hrs/wk	СР
	Technology and Systems (L	0342)	Lecture	2	3
	Technology and Systems (L	•	Project Seminar	2	2
Introduction into Medical	Technology and Systems (L	1876)	Recitation Section (large)	1	1
Module Responsible	Prof. Alexander Schlaef	er			
Admission Requirements	INANA				
	principles of math (algeb)		
	principles of stochastics principles of programmin				
Trevious Knowleage	principles of programmin	ig, n/ivialiab			
Educational Objectives	LATTER TAKING DART SUCCESS	sfully, students have r	eached the following lea	rning resul	ts
Professional Competence					
Knowledge	The students can explain principles of medical technology, including imaging systems,				
	The students are able to evaluate systems and medical devices in the context of clinical applications.				
Personal					
Competence	;	problem in modical t	echnology as a project,	and dofino	tacke that are
Social Competence	solved in a joint effort.	problem in inedicar i	comology as a project,		ומטווט ווימו מוכ
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 Time	e 110, Study Time in L	ecture 70		
Credit points	6				
	Compulsory Bonus	Form	Description	n	
Studienleistung		Written elaboration	า		
	Yes 10 %	Presentation			
	Written exam				
Examination duration and scale	90 minutes				
Assignment for the Following Curricula	Compulsory General Engineering S Engineering: Compulsor Computer Science: Specifications Electrical Engineering: C General Engineering S Compulsory General Engineering S Engineering: Compulsor Computational Science Compulsory	Science (German pro ry cialisation Computer Core qualification: Ele Science (English pro Science (English pro ry and Engineering:	ogram): Specialisation E ogram, 7 semester): Special Software Engineering ective Compulsory ogram): Specialisation E ogram, 7 semester): Specialisation Engineering	pecialisationg: Elective Biomedical pecialisation	n Biomedica Compulsory Engineering n Biomedica
. Januaring Juni Idula	1	5 5	· '		



Compulsory
Computational Science and Engineering: Specialisation Mathematics & Engineering Science:
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: Flective Compulsory

Course L0342: Introdu	ction 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: Introdu	ction 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: N	Ionlinear Dynamics				
Courses					
Title Nonlinear Dynamics (L07	02)	Typ Integrated Lecture	Hrs/wk	CP 6	
Module Responsible	Prof. Norbert Hoffmann				
Admission Requirements	LNODE				
Recommended Previous Knowledge	I ● Linear Algebra				
Educational Objectives	After taking part successfully, students have re	eached the following lea	rning resul	ts	
Professional Competence					
Knowledge	Students are able to reflect existing terms and concepts in Nonlinear Dynamics and 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 L	ecture 56			
Credit points					
Studienleistung					
	Written exam				
Examination duration and scale	2 Hours				
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation A Computational Science and Engineering: Compulsory International Management and Engineerin Compulsory Mechanical Engineering and Management: Specialisation System Design: Mechatronics: Specialisation System Design: Mechatronics: Specialisation Intelligent System Biomedical Engineering: Specialisation Artific Compulsory Biomedical Engineering: Specialisation Implated Biomedical Engineering: Specialisation Medical Engineering: Specialisation Management: Specialisation Management Materials and Production Theoretical Mechanical Engineering: Technical Theoretical Mechanical Engineering: Core qui	Specialisation Scienting: Specialisation II. pecialisation Mechatron Elective Compulsory ms and Robotics: Elective Sial Organs and Regenerate and Endoprostheses dical Technology and eagement and Business on: Core qualification: Eal Complementary Cour	Mechatron Mechat	ting: Elective lics: Elective e Compulsory cine: Elective Compulsory eory: Elective ation: 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.	



				<u> </u>	
Courses					
Γitle		Тур	Hrs/wk	СР	
Semiconductor Technolog		Lecture	4	4	
Semiconductor Technolog		Practical Course	2	2	
	Prof. Hoc Khiem Trieu				
Admission Requirements	None				
	Basics in physics, chemistry,	material science and semiconduc	ctor devices		
Educational Objectives	After taking part successfully,	students have reached the follow	ving learning resu	ılts	
Professional					
Competence					
	Students are able				
	to describe and to explain	current fabrication techniques fo	r Si and GaAs sub	ostrates,	
Knowledge	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 proc 	ess flows.			
	to process and granted proce				
	Students are capable				
	to analyze the impact of process parameters on the processing results,				
Skills			onig resuits,		
	to select and to evaluate processes and				
	 to develop process flows f 	or the fabrication of semiconduct	or devices.		
D					
Personal Competence					
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,					
	Students are able to propare	and perform their lab experime	onte in toom work	cae woll ac	
Social Competence	present and discuss the resul		enis in team worr	t as well as	
Autonomy					
	Independent Study Time 96, 9	Study Time in Lecture 84			
Credit points					
Studienleistung					
Examination					
Examination duration and scale	30 min				
	Floatrical Facilitation Co.	ecialisation Nanoelectronics a	ad Miayaayatama		



Assignment for the Following Curricula	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: Specialisation Microelectronics Complements: Elective
	Microelectronics and Microsystems: Specialisation Microelectronics Complements: Elective Compulsory

ourse L0722: Semiconductor Technology					
	Lecture				
Hrs/wk					
СР					
	Independent Study Time 64, Study Time in Lecture 56				
	Prof. Hoc Khiem Trieu				
Language	DE/EN				
Cycle	SoSe				
Content	 Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallograph defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralsi Bridgeman and float zone process) Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusic transport processes, doping profile, higher order effects and process technology, i implantation: theory, implantation profile, channeling, implantation damage, anneali and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, therm oxidation: reactions, kinetics, influences on growth rate, process technology a equipment, anodic oxidation, plasma oxidation, thermal oxidation of GaAs) Deposition techniques (theory: nucleation, film growth and structure zone model, fi growth process, reaction kinetics, temperature dependence and equipment; epita gas phase, liquid phase, molecular beam epitaxy; CVD techniques: APCVD, LPCV deposition of metal silicide, PECVD and LECVD; basics of plasma, equipment, PV techniques: high vacuum evaporation, sputtering) Structuring techniques (subtractive methods, photolithography: resist propertic printing techniques: contact, proximity and projection printing, resolution limit, practic issues and equipment, additive methods: liftoff technique and electroplating, improviresolution: excimer laser light source, immersion lithography and phase slithography, electron beam lithography, X-ray lithography, EUV lithography, ion beal lithography, electron beam lithography, X-ray lithography, EUV lithography and phase slithography, electron beam lithography. Storopic and anisotropic, corner undercuttir compensation masks and etch stop techniques; dry etching: plasma enhance etching, backsputtering, ion milling, chemical dry etching, RIE, sidewall passivation				



	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	



Courses					
Title			Тур	Hrs/wk	СР
Humanoid Robotics (L066	53)		Seminar	2	2
Module Responsible	Patrick	k Göttsch			
Admission Requirements	None				
Recommended Previous Knowledge	•	Introduction to control Control theory and de	-		
Educational Objectives	After ta	aking part successfully,	students have reached the follow	ving learning resu	Its
Professional Competence					
Knowledge	 Students can explain humanoid robots. Students learn to apply basic control concepts for different tasks in humanoid robotics. 				
Skills	 Students acquire knowledge about selected aspects of humanoid robotics, based or specified literature Students generalize developed results and present them to the participants Students practice to prepare and give a presentation 				
Personal Competence					
Social Competence	 Students are capable of developing solutions in interdisciplinary teams and prese them They are able to provide appropriate feedback and handle constructive criticism their own results 				
Autonomy	 Students evaluate advantages and drawbacks of different forms of presentation for specific tasks and select the best solution Students familiarize themselves with a scientific field, are able of introduce it and follow presentations of other students, such that a scientific discussion develops 				
Workload in Hours	Indepe	endent Study Time 32,	Study Time in Lecture 28		
Credit points	2				
Studienleistung	None				
Examination	Presei	ntation			
Examination duration and scale	30 mir	1			
Assignment for the Following Curricula	Mecha Mecha Biome Comp Biome	atronics: Specialisation atronics: Specialisation dical Engineering: Spe ulsory dical Engineering: Spe dical Engineering: Spe dical Engineering: Spe	alisation Control and Power System Intelligent Systems and Robotics System Design: Elective Compulcialisation Artificial Organs and Ficialisation Implants and Endoproecialisation Medical Technology	Elective Compul sory Regenerative Med estheses: Elective	sory licine: Electiv 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 L0663: Humanoid 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 Syst	tem Identification (L0660)	Typ Lecture	Hrs/wk	CP 3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	I • I)iccrata-tima evetame			
Educational Objectives	After taking part successfully,	students have reached the followi	ing learning resul	its
Professional Competence				
Knowledge	 Students can explain the general framework of the prediction error method and it 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 Kalman 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 g	roups on specific problems to arriv	ve at joint solutior	ns.
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 62, S	Study Time in Lecture 28		
Credit points				
Studienleistung				
Examination				
Examination duration and scale	30 min			
	Mechatronics: Specialisation	alisation Control and Power Syste Intelligent Systems and Robotics: System Design: Elective Compuls	Elective Compuls	



	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective
Assignment for the	Compulsory
Following Curricula	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
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
	Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L0660: Linear	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 		



Module M0840: C	Optimal and Robust Control			
Courses				
Title Optimal and Robust Conti Optimal and Robust Conti		Typ Lecture Recitation Section (small)	Hrs/wk 2 2	CP 3 3
Module Responsible	Prof. Herbert Werner			
Admission Requirements				
Recommended Previous Knowledge	 State snace methods 			
Educational Objectives	LATTOR TOKING NORT CHACACCTURIN CTURANTS	s have reached the following lea	rning resul	ts
Professional Competence				
Knowledge	 estimation. They can explain how the H2 performance constraints. They can explain how an LQC an H2 design problem. They can explain how model to robust controller design 	y between optimal state feedle and H-infinity norms are used to a design problem can be formulated uncertainty can be represented and on the small gain theorem mance for an uncertain plant.	back and to represer lated as s in a way the	optimal stant stability and pecial case that lends its controller can
Skills	 Students are capable of designing and tuning LQG controllers for multivariable models. They are capable of representing a H2 or H-infinity design problem in the foregeneralized plant, and of using standard software tools for solving it. They are capable of translating time and frequency domain specifications for cloops into constraints on closed-loop sensitivity functions, and of carrying out a resensitivity design. They are capable of constructing an LFT uncertainty model for an uncertain seand of designing a mixed-objective robust controller. They are capable of formulating analysis and synthesis conditions as linear inequalities (LMI), and of using standard LMI-solvers for solving them. They can carry out all of the above using standard software tools (Matlab robust of toolbox). 		the form of ons for cont g out a mixe ertain syste	
Personal Competence				
Social Competence	Students can work in small groups on			
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	6		
Studienleistung	None		
Examination			
Examination duration and scale	30 min		
Assignment for the Following Curricula	IRIOMEGICAL ENGINEERING. SPECIALISATION MEGICAL LECUNOLOGY AND CONTROL INFORM ELECTIVE		



Course L0658: Optima	I 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	



Courses						
Title Marketing of Innovations (L2009)			Typ Lecture		Hrs/wk	CP 4
PBL Marketing of Innovation	ons (L08	862)	Project-/problem-b Learning	ased	1	2
Module Responsible	Prof. C	hristian Lüthje				
Admission Requirements	None					
Recommended Previous Knowledge	•	Module International Busine Basic understanding of busi theory, project management Bachelor-level Marketing K Strategies, Basics of Buying Unerstanding the difference Understanding of the import Good English proficiency; pr	ness administration principl t, international business) nowledge (Marketing Instru Behavior) s beweetn B2B and B2C ma ance of managing innovatio	ments arketin	s, Market ar	nd Competito
Educational Objectives	After ta	king part successfully, stude	nts have reached the follow	ng lea	arning resul	ts
Professional Competence						
Knowledge	•	Specific characteristics in the Approaches for analyzing development. The gathering of information Concepts and approaches service development process. Approaches and tools for exproducts and innovative ser Marketing mix elements the challenges of innovative process. Pricing methods for new process. The organization of complete Communication concepts at the acquired knowledge.	e marketing of innovative por the current market situ about future customer need to integrate lead users and sees ensuring customer-orientation vices at take into consideration aducts and services ducts and services a sales forces and personal and instruments for new prod	ation ds and their on in the sp	and the following and the development of the develo	inture marked ints or product and coment of ne direments and
Skills	•	Design and to evaluate decided Analyze markets by applying Conduct forecasts and dever Translate customer needs successfully apply advance development Use adequate methods to for Choose suitable pricing stratement Make strategic sales decided apply methods of sales force.	sions regarding marketing as granket and technology por lop compelling scenarios as into concepts, prototyped ed methods for customeraster efficient diffusion of innategies and communication assions for products and see	rtfolios s a bas s and orient ovativ activiti rvices	sis for strate marketabled product e products a es for innov	egic planning e offers ar and services and services
Personal						



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	The students will be able to 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	6		
Studienleistung	None		
	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: Market	ting 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
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
Literature	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 Ma	arketing 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: N	Mechanical Design Methodo	ology		
Module Wi 143. N	nechanical Design Method	ology		
Courses				
Title		Тур	Hrs/wk	СР
Mechanical Design Metho Mechanical Design Metho		Lecture	3	4 2
		Recitation Section (small)	1	2
	Prof. Josef Schlattmann			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, studen	ts have reached the following lea	rning resul	ts
Professional				
Competence Knowledge	Science-based working on product of design techniques	design considering targeted appli	cation of sp	ecific product
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				
Autonomy Workload in Hours	Independent Study Time 124, Study	Time in Lecture 56		
Credit points		Time in Lecture 30		
Studienleistung				
Examination				
Examination duration and scale	30 min			
Assignment for the Following Curricula	International Management and En Production: Elective Compulsory Mechatronics: Specialisation System Biomedical Engineering: Specialisat Compulsory Biomedical Engineering: Specialisat Biomedical Engineering: Specialisat Compulsory Biomedical Engineering: Specialisat Compulsory Biomedical Engineering: Specialisat Compulsory Product Development, Materials at Elective Compulsory Product Development, Materials Compulsory Product Development, Materials Compulsory Product Development, Materials Compulsory Theoretical Mechanical Engineering Elective Compulsory Theoretical Mechanical Engineering Elective Compulsory Theoretical Mechanical Engineering	n Design: Elective Compulsory tion Artificial Organs and Regene tion Implants and Endoprostheses ation Medical Technology and o tion Management and Business and Production: Specialisation and Production: Specialisatio and Production: Specialisatio	rative Medi s: Elective (Control The Administra Product I n Product on Materi	icine: Elective Compulsory eory: Elective ation: Elective Development ion: Elective als: Elective



Course L1523: Mechai	nical Design Methodology
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Josef Schlattmann
Language	DE
Cycle	SoSe
Content	 Systematic reflection and analysis of the mechanical design process Process structuring in sections (task, functions, acting principles, design-elements and total construction) as well as levels (working-, controlling-, and deciding-levels) Creativity (basics, methods, practical application in mechatronics) Diverse methods applied as tools (function structure, GALFMOS, AEIOU method, GAMPFT, simulation tools, TRIZ) Evaluation and selection (technical-economical evaluation, preference matrix) Value analysis, cost-benefit analysis Low-noise design of technical products Project monitoring and leading (leading projects / employees, organisation in product development, creating ideas / responsibility and communication) Aesthetic product design (industrial design, colouring, specific examples / exercises)
Literature	 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: Mechanical Design Methodology			
Тур	Recitation Section (small)		
Hrs/wk			
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Josef Schlattmann		
Language	DE		
Cycle	SoSe		
Content	 Systematic reflection and analysis of the mechanical design process Process structuring in sections (task, functions, acting principles, design-elements and total construction) as well as levels (working-, controlling-, and deciding-levels) Creativity (basics, methods, practical application in mechatronics) Diverse methods applied as tools (function structure, GALFMOS, AEIOU method, GAMPFT, simulation tools, TRIZ) Evaluation and selection (technical-economical evaluation, preference matrix) Value analysis, cost-benefit analysis Low-noise design of technical products Project monitoring and leading (leading projects / employees, organisation in product development, creating ideas / responsibility and communication) Aesthetic product design (industrial design, colouring, specific examples / exercises) 		
Literature	 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 		



Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering -		Lecture	2	3
Bioprocess Engineering - Rioprocess Engineering -	-undamentals (L0842) Fundamental Practical Course (L0843)	Recitation Section (large) Practical Course	2	1 2
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	none, module "organic chemistry", modu	le "fundamentals for process	engineerin	ıg"
Educational Objectives	After taking part successfully, students ha	ave reached the following lea	rning resul	ts
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		



	practical work
	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Process Engineering: Compulsory General Engineering Science (German program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess 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: Bioprocess 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, fedbatch 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	
Content	 Introduction (Prof. Liese, Prof. Zeng) Enzymatic kinetics (Prof. Liese) Stoichiometry I + II (Prof. Liese) Microbial Kinetics I+II (Prof. Zeng) Rheology (Prof. Liese) Mass transfer in bioprocess (Prof. Zeng) Continuous culture (Chemostat) (Prof. Zeng) Sterilisation (Prof. Zeng) Downstream processing (Prof. Liese) 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		Tun	Hrs/wk	СР
Introduction to Physiology	(L0385)	Typ Lecture	2	3
Module Responsible	Dr. Roger Zimmermann			
Admission Requirements	None			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, students	s have reached the follow	ving learning resul	ts
Professional Competence				
	The students can			
Knowledge	 describe the basics of the energy metabolism; describe physiological relations in selected fields of muscle, heart/circulation, neuro and sensory physiology. 			
Skills	The students can describe the effect processing of information, developme technical systems.			
Personal Competence				
Social Competence	The students can conduct discussions The students can find solutions to p metrological.			
Autonomy	The students can derive answers to questions arising in the course and other physiologica areas, using technical literature, by themselves.			
Workload in Hours	Independent Study Time 62, Study Tin	ne in Lecture 28		
Credit points	3			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	60 minutes			
	General Engineering Science (Germ Focus Biomechanics: Compulsory General Engineering Science (Germ Compulsory General Engineering Science (Germ Engineering: Compulsory General Engineering Science (Germ Engineering, Focus Biomechanics: Compulsory General Engineering: Specialisation General Engineering Science (Engli Focus Biomechanics: Compulsory General Engineering Science (Engli Compulsory	nan program): Specialis nan program, 7 semes nan program, 7 semes ompulsory Medical Technology: Ele ish program): Specialis	sation Biomedical ster): Specialisation ster): Specialisation ective Compulsory sation Mechanical	Engineering n Biomedica n Mechanica , Engineering
	General Engineering Science (Engl			



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

Course L0385: Introduction to Physiology		
Lecture		
2		
3		
Independent Study Time 62, Study Time in Lecture 28		
Dr. Roger Zimmermann		
DE		
SoSe		
Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier		



Courses			
Title Introduction to Anatomy (I	Typ Hrs/wk CP Lo384) Lecture 2 3		
	Prof. Udo Schumacher		
Admission			
Requirements	None		
Recommended Previous Knowledge	LNANA		
Educational Objectives	I Affer taking hart successium, 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. The students can recognize the relationship between given anatomical facts and the		
Skills	development of some common diseases; they can explain the relevance of structures an 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 professional level.		
Autonomy	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	3		
Studienleistung	None		
	Written exam		
Examination duration and scale	90 minutes		
	General Engineering Science (German program): Specialisation Mechanical Engineering Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering Focus Biomechanics: Compulsory		
Assignment for the Following Curricula	Mannaral Engineering Science (English program / comester): Specialisation Machanie		



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 L0384: Introdu	ction to Anatom	ıy	
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent St	udy Time 62, Study Time in Lecture 28	
Lecturer	Prof. Tobias Lar	nge	
Language			
Cycle			
	General Anator	The Eucaryote Cell	
	2 nd week: 3 rd week: 4 th week:	The Tissues Cell Cycle, Basics in Development Musculoskeletal System	
	5 th week:	Cardiovascular System	
Content	6 th week: 7 th week: 8 th week:	Respiratory System Genito-urinary System Immune system	
	9 th week: 10 th week:	Digestive System II	
	11 th week:	Endocrine System	
	12 th week: 13 th week:	Nervous System Exam	
Literature	Adolf Faller/Mid Stuttgart, 2012	chael Schünke, Der Körper des Menschen, 16. Auflage, Thieme Verlag	



Courses				
Title Introduction to Radiology	and Radiation Therapy (L0383)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	LINIONA			
Educational Objectives	After taking part successfully, studen	ts have reached the follo	wing learning resu	lts
Professional Competence				
	Therapy The students can distinguish differer in radiation therapy.	nt types of currently used	equipment with res	spect to its us
	The students can explain treatme contexts (e.g. surgery, internal media	•	tion therapy in in	terdisciplinaı
	The students can describe the par follow-up care.	tients' passage from the	eir initial admittan	ce through t
	Diagnostics			
Knowledge	The students can illustrate the tech angiography and mammography, as			
	The students can explain the diagno well as the technical basis for those	•	ic use of imaging t	echniques, a
	The students can choose the right treat and needs.	eatment method dependii	ng on the patient's	clinical histor
	The student can explain the influenc	e of technical errors on th	e imaging techniq	ues.
	The student can draw the right con error protocol.	clusions based on the in	nages' diagnostic f	indings or th
	Therapy The students can distinguish curative that conclusion.	e and palliative situations	s and motivate why	they came t
	The students can develop adequate aspects.	therapy concepts and re	elate it to the radia	tion biologica
	The students can use the therapeution	c principle (effects vs adv	erse effects)	
Skills	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 incup treatment, sports, social help grou			
	Diagnostics			
	The students can suggest solutions error analyses.	for repairs of imaging in	strumentation afte	r having don



	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.
Autonomy	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. 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
Studienleistung	None
	Written exam
Examination duration and scale	I 9() minutes
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): 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 Mechanical 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



Cvcle	SoSe
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



Courses				
Title Experimental Methods in I	Biomechanics (L0377)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	It is recommended to participate "Experimentelle Methoden".	in "Implantate und Fra	akturheilung" bef	ore attendin
Educational Objectives	After taking part successfully, students	have reached the follow	ving learning resul	ts
Professional Competence				
Knowledge	The students can describe the differe existence. The students can name different tre fracture morphologies.	atments for the spine a	and hollow bones	under give
Skills	The students can describe different methods the adequate technique for a quantity that the students can describe the basic biomechanics.	given task.		
Personal Competence				
Social Competence	The students can, in groups, solve bas	sic experimental tasks.		
Autonomy	The students can, in groups, solve bas	sic experimental tasks.		
Workload in Hours	Independent Study Time 62, Study Tin	ne in Lecture 28		
Credit points	3			
Studienleistung	None			
	Written exam			
Examination duration and scale	90 min			
	General Engineering Science (Germ Focus Biomechanics: Compulsory General Engineering Science (Germ Compulsory General Engineering Science (Germ Engineering, Focus Biomechanics: Compulsory General Engineering Science (Germ Engineering: Compulsory General Engineering Science (Engl Compulsory	nan program): Specialis nan program, 7 semes ompulsory nan program, 7 semes ish program): Specialis	sation Biomedical ter): Specialisatio ter): Specialisatio sation Biomedical	Engineering n Mechanica n Biomedica Engineering
Assignment for the Following Curricula	General Engineering Science (Engl Focus Biomechanics: Compulsory General Engineering Science (Engl Engineering, Focus Biomechanics: Co General Engineering Science (Engl Engineering: Compulsory Mechanical Engineering: Specialisation	ish program, 7 semest ompulsory lish program, 7 semes	ter): Specialisatio	n Mechanic



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 L0377: Experin	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: E	BIO II: Artificial Joint Repla	cement		
Courses				
Title		Тур	Hrs/wk	СР
Artificial Joint Replacemen	nt (L1306)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of orthopedic and	d surgical techniques is recomme	ended.	
Educational Objectives	After taking part successfully, stude	ents have reached the following I	earning resu	Its
Professional Competence				
Knowledge	The students can name the differen	nt kinds of artificial limbs.		
Skills	The students can explain the endoprotheses.	advantages and disadvantag	es of differ	rent kinds of
Personal Competence				
Social Competence	The students are able to discuss teachers.	issues related to endoprothese v	with student	mates and the
Autonomy	The students are able to acquire in with respect to its credibility.	nformation on their own. They car	n also judge t	he information
Workload in Hours	Independent Study Time 62, Study	Time in Lecture 28		
Credit points	3			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	International Management and I Biotechnology: Elective Compulso Materials Science: Specialisation I Biomedical Engineering: Specialis Compulsory Biomedical Engineering: Specialis Biomedical Engineering: Specialis Compulsory Biomedical Engineering: Specialis Compulsory Theoretical Mechanical Engineering Theoretical Mechanical Engineering	ry Nano and Hybrid Materials: Elect sation Artificial Organs and Rege sation Implants and Endoprosthes sation Medical Technology and sation Management and Busine	ive Compulsonerative Med ses: Compulsonerative Med Gentrol Thess Administr	ory licine: Elective sory eory: Elective ation: Elective e Compulsory



Course L1306: Artifici	al Joint Replacement
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Michael Morlock
Language	
Cycle	
	Inhalt (deutsch)
	1. EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenkersatzes)
	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.
	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: F	eedback Control in Medical T	echnology		
module mooto. I	ccabaok control in incalcal i	comiciogy		
Courses				
Title		Тур	Hrs/wk	СР
Feedback Control in Med	ical Technology (L0664)	Lecture	2	3
Module Responsible	Johannes Kreuzer			
Admission Requirements	None			
Recommended Previous Knowledge	Basics in Control, Basics in Physiology			
Educational Objectives	LATTER TAKING DART SUCCESSIUM STUGENTS DE	ave reached the follow	ring learning resul	ts
Professional Competence				
	The lecture will introduce into the fascing point of view. Fundamentals in human prin control theory.	-		-
Knowledge	Internal control loops of the human body external closed loop system fo example			the design
	The handling of PID controllers and recontroller or neural networks will be illust be discussed.		•	
Skills	Application of modeling, identification, co	ontrol technology in the	e field of medical t	echnology.
Personal				
Competence	! !			
Social Competence	Students can develop solutions to speci (e.g. during project week)	fic problems in small (groups and presei	nt their resul
Autonomy	Students are able to find necessary liter are able to continuously evaluate the process. They can combine knowledge f	ir knowledge and to	take control of	their learnin
Workload in Hours	Independent Study Time 62, Study Time	in Lecture 28		
Credit points	3			
Studienleistung				
Examination				
Examination duration and scale	20 min			
	Electrical Engineering: Specialisation Me Electrical Engineering: Specialisation Co Biomedical Engineering: Specialisation Biomedical Engineering: Specialisation	ontrol and Power Syste Implants and Endopro Artificial Organs and F	ems: Elective Com stheses: Elective (Regenerative Med	pulsory Compulsory icine: Electiv
	Biomedical Engineering: Specialisation	Medical Technology a	nd Control Theory	: Compulso



Course L0664: Feedba	Course L0664: Feedback 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	navigation systems and robotic in medicine The lecture will use knowledge from modeling, simulation and controller design and MATLAB and SIMULINK will be used.		
Literature	Silbernagel/Depopoulos: Taschenatlas der Physiologie, Thieme Verlag Stuttgart Werner: Kooperative und autonome Systeme der Medizintechnik, Oldenburg Verlag M.C.K.Khoo: "Physiological Control System", IEEE Press, 2000		



Title Advanced Topics in Control (L0661) Lecture 2 3 Advanced Topics in Control (L0662) Recitation Section (small) 2 3 Module Responsible Prof. Herbert Werner Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Students can explain the advantages and shortcomings of the classical ge scheduling approach They can explain the representation of nonlinear systems in the form of quasi-Lisystems They can explain how stability and performance conditions for LPV systems can be used to solve analysis at synthesis problems for LPV systems They can explain how graph theoretic concepts are used to represent the communication topology of multiagent systems They can explain analysis and synthesis conditions for formation control loo involving either LTI or LPV agent models Students can explain the state space representation of spatially invariant distribute systems that are discretized according to an actuator/sensor array They can explain in the state space representation for formation control loo involving either LTI or LPV agent models Students can explain in the state space representation of spatially invariant distribute systems that are discretized according to an actuator/sensor array They can explain (in outline) the extension of the bounded real lemma to sudistributed systems that are capable of constructing LPV models of nonlinear plants and carry out mixed-sensitivity design of gain-scheduled controllers; they can do this usin polytopic, LFT or general LPV models Students are capable to use standard software tools (Matlab robust control toolbox) for the tasks Skills Skills Skills	Courses				
Module Responsible Prof. Herbert Werner Admission None					
Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Students can explain the advantages and shortcomings of the classical gescheduling approach They can explain the representation of nonlinear systems in the form of quasi-Lf systems They can explain how stability and performance conditions for LPV systems can formulated as LMI conditions They can explain how gridding techniques can be used to solve analysis as synthesis problems for LPV systems They are a familiar with polytopic and LFT representations of LPV systems and some the basic synthesis techniques associated with each of these model structures Knowledge Knowledge Students can explain how graph theoretic concepts are used to represent the communication topology of multiagent systems They can explain analysis and synthesis conditions for formation control loo involving either LTI or LPV agent models Students can explain the state space representation of spatially invariant distribute systems that are discretized according to an actuator/sensor array They can explain (in outline) the extension of the bounded real lemma to su distributed systems and the associated synthesis conditions for distributed controllers Students are capable of constructing LPV models of nonlinear plants and carry out mixed-sensitivity design of gain-scheduled controllers; they can do this usin polytopic, LFT or general LPV models They are able to use standard software tools (Matlab robust control toolbox) for the tasks Skills Students are able to design distributed formation controllers for groups of agents we standard software tools (Matlab robust control toolbox) for the tasks	· · · · · · · · · · · · · · · · · · ·				
Recommended Previous Knowledge Educational Objectives Professional Competence Students can explain the advantages and shortcomings of the classical gascheduling approach They can explain how stability and performance conditions for LPV systems can be formulated as LMI conditions They are replain with polytopic and LFT representations of LPV systems and some the basic synthesis techniques associated with each of these model structures Knowledge Knowledge Knowledge Students can explain how graph theoretic concepts are used to represent the basic synthesis techniques associated with each of these model structures Knowledge Students can explain how graph theoretic concepts are used to represent the communication topology of multiagent systems They can explain the convergence properties of first order consensus protocols They can explain the convergence properties of first order consensus protocols They can explain the state space representation of spatially invariant distribute systems that are discretized according to an actuator/sensor array They can explain in outline) the extension of the bounded real lemma to su distributed systems and the associated synthesis conditions for distributed controllers Students are capable of constructing LPV models of nonlinear plants and carry out mixed-sensitivity design of gain-scheduled controllers; they can do this usin polytopic, LFT or general LPV models They are able to use standard software tools (Matlab robust control toolbox) for the tasks Skills Skills Students are able to design distributed formation controllers for groups of agents we standard software tools (Matlab robust control toolbox) for the tasks	Module Responsible	Prof. Herbert Werner			
Educational Objectives		None			
Professional Competence Students can explain the advantages and shortcomings of the classical gas scheduling approach They can explain how stability and performance conditions for LPV systems can be formulated as LMI conditions They can explain how stability and performance conditions for LPV systems can be used to solve analysis as synthesis problems for LPV systems They are familiar with polytopic and LFT representations of LPV systems and some the basic synthesis techniques associated with each of these model structures Knowledge Students can explain how graph theoretic concepts are used to represent the communication topology of multiagent systems They can explain the convergence properties of first order consensus protocols They can explain analysis and synthesis conditions for formation control loo involving either LTI or LPV agent models Students can explain the state space representation of spatially invariant distribute systems that are discretized according to an actuator/sensor array They can explain (in outline) the extension of the bounded real lemma to su distributed systems and the associated synthesis conditions for distributed controllers Students are capable of constructing LPV models of nonlinear plants and carry out mixed-sensitivity design of gain-scheduled controllers; they can do this usin polytopic, LFT or general LPV models They are able to use standard software tools (Matlab robust control toolbox) for the tasks Skills Students are able to design distributed formation controllers for groups of agents we		H-infinity optimal control, mixed-sensitiv	rity design, linear matrix inequa	alities	
Students can explain the advantages and shortcomings of the classical gascheduling approach They can explain the representation of nonlinear systems in the form of quasi-Lifsystems They can explain how stability and performance conditions for LPV systems can be formulated as LMI conditions They can explain how gridding techniques can be used to solve analysis at synthesis problems for LPV systems They are familiar with polytopic and LFT representations of LPV systems and some the basic synthesis techniques associated with each of these model structures Knowledge Students can explain how graph theoretic concepts are used to represent the communication topology of multiagent systems They can explain the convergence properties of first order consensus protocols They can explain analysis and synthesis conditions for formation control loo involving either LTI or LPV agent models Students can explain the state space representation of spatially invariant distribute systems that are discretized according to an actuator/sensor array They can explain (in outline) the extension of the bounded real lemma to su distributed systems and the associated synthesis conditions for distributed controllers Students are capable of constructing LPV models of nonlinear plants and carry out mixed-sensitivity design of gain-scheduled controllers; they can do this usin polytopic, LFT or general LPV models They are able to use standard software tools (Matlab robust control toolbox) for the tasks Skills Students are able to design distributed formation controllers for groups of agents we	Objectives	After taking part successfully, students h	nave reached the following lea	rning resu	lts
scheduling approach They can explain the representation of nonlinear systems in the form of quasi-Lif systems They can explain how stability and performance conditions for LPV systems can be formulated as LMI conditions They can explain how gridding techniques can be used to solve analysis as synthesis problems for LPV systems They are familiar with polytopic and LFT representations of LPV systems and some the basic synthesis techniques associated with each of these model structures **Knowledge** Students can explain how graph theoretic concepts are used to represent the communication topology of multiagent systems They can explain the convergence properties of first order consensus protocols They can explain the convergence properties of first order consensus protocols They can explain the state space representation of spatially invariant distributed systems that are discretized according to an actuator/sensor array They can explain (in outline) the extension of the bounded real lemma to surplicate distributed systems and the associated synthesis conditions for distributed controllers. Students are capable of constructing LPV models of nonlinear plants and carry out mixed-sensitivity design of gain-scheduled controllers; they can do this using polytopic, LFT or general LPV models They are able to use standard software tools (Matlab robust control toolbox) for the tasks Skills Students are able to design distributed formation controllers for groups of agents we standard software tools (Matlab robust control toolbox) of agents we standard software tools (Matlab robust control toolbox) of agents we standard software tools (Matlab robust control toolbox) for the tasks					
mixed-sensitivity design of gain-scheduled controllers; they can do this usin polytopic, LFT or general LPV models They are able to use standard software tools (Matlab robust control toolbox) for the tasks Skills Students are able to design distributed formation controllers for groups of agents w	Knowledge	scheduling approach They can explain the represen systems They can explain how stability formulated as LMI conditions They can explain how griddin synthesis problems for LPV syst They are familiar with polytopic the basic synthesis techniques a Students can explain how gr communication topology of mult They can explain the convergen They can explain analysis ar involving either LTI or LPV agen Students can explain the state systems that are discretized acc. They can explain (in outline)	tation of nonlinear systems in and performance conditions and techniques can be used the embed and LFT representations of Linear and LFT representations of Linear and LFT representations of these represents are the systems concepts are the extension of the sound the extension of the bound the conditions for the extension of the bound.	to solve PV system model struct used to usensus pr formation fally invariance rray ed real le	of quasi-LP' ystems can be analysis and s and some of ctures represent the otocols control loop ant distributes
	Skills	mixed-sensitivity design of gapolytopic, LFT or general LPV m They are able to use standard stasks	ain-scheduled controllers; th odels	ey can d	do this using
 Students are able to design distributed controllers for spatially interconnected system 		either LTI or LPV dynamics, usin	g Matlab tools provided		



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	6
Studienleistung	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Avionic and Embedded Systems: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: 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: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory



Course L0661: Advan	ced 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	EN
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



Specialization Artificial Organs and Regenerative Medicine

Module M0623: Intelligent Systems in Medicine						
Courses						
Title Intelligent Systems in Medicine (L0331) Intelligent Systems in Medicine (L0334)				Typ Lecture Project Seminar	Hrs/wk 2 2	CP 3 2
Intelligent Systems in Med	dicine (L0333)			Recitation Section (small)	1	1
Module Responsible	Prof. Alexar	nder Schlaefe	er			
Admission Requirements	INANA					
Recommended Previous Knowledge	prine prine	ciples of stoc ciples of prog	h (algebra, analysis/c hastics gramming, Java/C++ a amming skills	,		
Educational Objectives	I After taking	part success	sfully, students have re	eached the following lea	rning resu	Its
Professional Competence						
Knowledge	The students are able to analyze and solve clinical treatment planning and decision suppor problems using methods for search, optimization, and planning. They are able to explain methods for classification and their respective advantages and disadvantages in clinica 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 discuss the results of other groups, provide helpful feedback and car 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	Independer	nt Study Time	e 110, Study Time in L	ecture 70		
Credit points	6					
Studienleistung	Compulsor Yes Yes	10 % 10 %	Form Written elaboration Presentation	Descriptio	on	
Examination	Written exa	m				
Examination duration and scale	190 minutes					
	Electrical E	ngineering: S nal Science	Specialisation Medica	e Engineering: Elective (I Technology: Elective C ecialisation Systems Er	compulsory	/



I Assianment for the	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 Bio- and Medical Technology: Elective
	Compulsory

Course L0331: Intellige	ent 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	



Courses				
= =	ents and Cognitive Robotics (L0341) ents and Cognitive Robotics (L0512)	Typ Lecture Recitation Section (small)	Hrs/wk	CP 4 2
Module Responsible	. ,	necitation Section (Smail)	2	
Admission Requirements				
Recommended Previous Knowledge				
Educational Objectives	I Affor taking nart cuccocciully, ctudente have reached the following learning reculte			
Professional Competence				
	Students can explain the agent abstract and give details about agent design (general main features of environments. The notion in terms of decision problems and algorithms are decision problems and algorithms are designed uncertainty in real-world scenarios, students can describe as a knowledge representate settings. In addition, students can desequential settings, with and with composition context, students can describe technique identify techniques for simultaneous leader to the decision making in a multi-agent setting functions, voting protocol, and mechanisms. Students can select an appropriate scenarios. For simplified agent application optimization techniques. For those networks/dynamic Bayesian networks. Students can also name and apply	oals, utilities, environments) on of adversarial agent cooperithms for solving these profers can summarize how Baion and reasoning formalist efine decision making proceeding the state of the est for solving (partially obsets for measuring the value of incalization and mapping, and in term of different types of medical decision and mapping and the students can explain cooperate architecture for concern students can derive decision applications they can and apply bayesian reason different sampling technique.	They can eration can oblems. For a special property of the environment	n describe the be discussed a dealing with tworks can be and dynaming an and dynaming arkov decision. Students capiain planning problems and apply basing the Bayesia and agerian plified agerian plified agerians.
Skills	scenarios. For simple and complex decipolicies for concrete settings. In multifinding different equilibria states,e.g., students will apply different voting protocol	sion making students can co agent situations students w Nash equilibria. For multi-	mpute the fill apply to agent dec	best action of echniques for cision makin
Personal Competence				
Social Competence	Students are able to discuss their solu English	tions to problems with other	s. They co	mmunicate i
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 Tim	e in Lecture 56		
Credit points	6			
Studienleistung	None			
	Written exam			
Examination duration	90 minutes			



and scale	
	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: Elective Compulsory International Production Management: Specialisation Production Technology: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective



тур	Lecture		
Hrs/wk			
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, Minin algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environme probabilities, conditional probabilities, product rule, Bayes rule, full joint probab distribution, marginalization, summing out, answering queries, complex independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference enumeration), typical-case complexity, pragmatics: reasoning from effect (that can 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, dynal Bayesian networks, Markov assumption, transition model, sensor model, inferer problems: filtering, prediction, smoothing, most-likely explanation, special cashidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decis networks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteratif MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MD 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, Gibba Satterthwaite Impossibility Theorem, Direct mechanisms, expe		
Literature	 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Nor-Prentice Hall, 2010, Chapters 2-5, 10-11, 13-17 Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005 		



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 M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) **Courses** Title Hrs/wk CP Typ Seminar Nature's Hierarchical Materials (L1663) 3 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Lecture 3 4 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Recitation Section (small) 2 2 (L1877)Development and Regulatory Approval of Implants (L1588) 2 Lecture 3 Experimental Methods for the Characterization of Materials (L1580) Lecture 2 3 2 Numerical Methods in Biomechanics (L1583) Seminar 3 Seminar Biomedical Engineering (L1890) Seminar 2 3 Six Sigma (L1130) Lecture 2 3 2 Fluid Mechanics II (L0001) Lecture 4 Ceramics Technology (L0379) Lecture 2 3 Module Responsible Prof. Michael Morlock Admission None Requirements Recommended **Previous Knowledge** Educational After taking part successfully, students have reached the following learning results **Objectives Professional** Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses **Credit points**

Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory

Assignment for the Following Curricula

Compulsory

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

Biomedical Engineering: Specialisation Management and Business Administration: 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		



Hrs/wk	Lecture		
0.0	3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
	Mündliche Prüfung		
Examination duration and scale	30 min		
Lecturer	Prof. Christian Schuster		
Language	DE/EN		
Cycle	WiSe		
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending and receiving as well as Electromagnetic Compatibility (EMC) for graduate engineering students that do not have a formal background in electrical engineering. It will be useful to 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) 		



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

Course L1588: Develo	pment and Regulatory Approval of Implants		
Тур	ecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
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-iminternet.de/mpg/BJNR196300994.html 		



Course L1580: Experimental Methods for the Characterization of Materials			
Тур	ecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
Examination duration and scale	90 min		
Lecturer	Prof. Patrick Huber		
Language	DE/EN		
Cycle	SoSe		
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: Numer	ical Methods in Biomechanics		
Тур	Seminar		
Hrs/wk			
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
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)		
СР			
Workload in Hours	ndependent 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 Sig	ma		
Тур	Lecture		
Hrs/wk			
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
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 M	echanics II		
Тур	Lecture		
Hrs/wk			
СР			
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Examination Form	Klausur		
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 L0379: Ceramics Technology				
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Examination Form				
Examination duration and scale	90 Minuten	90 Minuten		
	Dr. Rolf Janßen			
Language	DE/EN			
Cycle	WiSe			
	Introduction to ceramic processing with emphasis on advanced structural ceram course focus predominatly on powder-based processing, e.g. "powder-meta techniques and sintering (soild state and liquid phase). Also, some aspects of glacement science as well as new developments in powderless forming techniques of and ceramic composites will be addressed Examples will be discussed in ordering engineering students an understanding of technology development and specific approf 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	o Ceramics", John Wiley & Sons, New York, 1975		
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991			
Literature	D.W. Richerson, "Modern Ce	eramic Engineering", Marcel Decker, New York, 1992		
	Skript zur Vorlesung			

Following Curricula

Compulsory

Compulsory



Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) **Courses** Title Hrs/wk CP Typ Seminar Nature's Hierarchical Materials (L1663) 3 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Lecture 3 4 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Recitation Section (small) 2 2 (L1877)2 Development and Regulatory Approval of Implants (L1588) Lecture 3 Experimental Methods for the Characterization of Materials (L1580) Lecture 2 3 2 Numerical Methods in Biomechanics (L1583) Seminar 3 Seminar Biomedical Engineering (L1890) Seminar 2 3 Six Sigma (L1130) Lecture 2 3 2 Fluid Mechanics II (L0001) Lecture 4 Ceramics Technology (L0379) Lecture 2 3 Module Responsible Prof. Michael Morlock Admission None Requirements Recommended **Previous Knowledge** Educational After taking part successfully, students have reached the following learning results **Objectives Professional** Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses **Credit points** Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Assignment for the Biomedical Engineering: Specialisation Management and Business Administration: Elective

Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective



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		



Hrs/wk	Lecture		
0.0			
СР			
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Examination Form			
Examination duration and scale			
Lecturer	Prof. Christian Schuster		
Language	DE/EN		
Cycle	WiSe		
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending and receiving as well as Electromagnetic Compatibility (EMC) for graduate engineering students that do not have a formal background in electrical engineering. It will be useful to 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) 		



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	
	Mündliche Prüfung	
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1588: Develo	pment 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-iminternet.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			
Examination duration and scale	90 min		
Lecturer	Prof. Patrick Huber		
Language	DE/EN		
Cycle	SoSe		
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: Numer	ical Methods in Biomechanics		
Тур	Seminar		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
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	I SCHTITUCHE AUSARDEIUNG UNG 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			
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 M	echanics II		
Тур	Lecture		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	Prof. Michael Schlüter		
Language	DE		
Cycle			
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 L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
Examination duration and scale	90 Minuten		
	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	o Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991		
Literature	D.W. Richerson, "Modern Ce	eramic Engineering", Marcel Decker, New York, 1992	
	Skript zur Vorlesung		



Module M0746: N	/licrosystem Engi	ineering			
Courses					
Title			Typ	Hrs/wk	СР
Microsystem Engineering	(1.0680)		Typ Lecture	2	4
Microsystem Engineering			Project-/problem-based Learning	2	2
Module Responsible	Prof. Manfred Kasper	· · · · · · · · · · · · · · · · · · ·			
Admission Requirements	None				
Recommended Previous Knowledge	I Racio collicae in phycio	cs, mathematics and el	ectric engineering		
Educational Objectives	After taking part succes	ssfully, students have re	eached the following lea	ırning resul	lts
Professional					
Competence Knowledge	! !		technologies and mate	rials of ME	MS as well as
Skills	Students are able to ar to evaluate the potentia	-	e functional behaviour o	f MEMS co	mponents and
Personal Competence					
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.			
Workload in Hours	Independent Study Tim	ne 124, Study Time in L	ecture 56		
Credit points	6				
Studienleistung	Compulsory Bonus No 10 %	Form Presentation	Description	on	
Examination	Written exam				
Examination duration and scale	2h				
Assignment for the Following Curricula					
	I	[105]			



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

Course L0680: Microsystem Engineering			
Тур	Lecture		
Hrs/wk			
СР			
	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: V	/ibration Theory			
Courses				
Title Vibration Theory (L0701)		Typ Integrated Lecture	Hrs/wk 4	CP 6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	INONE			
Recommended Previous Knowledge	I ● Linear Algebra			
Educational Objectives	After taking part successfully students have	reached the following le	earning resu	Its
Professional Competence				
Knowledge	Students are able to denote terms and conce	epts of Vibration Theory	and develo	p them further.
	Students are able to denote methods of Vibr	ation Theory and develo	op them furth	ier.
Personal Competence				
<u>-</u>	l Students can reach working results also in g	rouns		
-	Students are able to approach individually re		n Theory.	
	Independent Study Time 124, Study Time in			
Credit points	6			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	12 Hours			
	Energy Systems: Core qualification: Elective Computational Science and Engineering Compulsory International Management and Enginee Compulsory Biomedical Engineering: Specialisation Artif Compulsory Biomedical Engineering: Specialisation Impl Biomedical Engineering: Specialisation Impl Biomedical Engineering: Specialisation MacCompulsory Biomedical Engineering: Specialisation MacCompulsory Biomedical Engineering: Specialisation MacCompulsory Product Development, Materials and Product Naval Architecture and Ocean Engineering: Theoretical Mechanical Engineering: Core of Theoretical Mechanical Engineering: Technical Technical Engineering: Technical Mechanical Engineering: Technical	: Specialisation Scienting: Specialisation II ricial Organs and Regereants and Endoprosthes edical Technology and magement and Busines etion: Core qualification: Elective Couplification: Elective Co	. Mechatron nerative Med es: Elective Control Th es Administr Compulsory tive Compulsory mpulsory	nics: Elective licine: Elective Compulsory eory: Elective ation: Elective



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 M0768: N	licrosystems Techi	nology in Theo	ry and Practice		
Courses					
Title			Тур	Hrs/wk	СР
Microsystems Technology	y (L0724)		Lecture	2	4
Microsystems Technology	y (L0725)		Project-/problem-based Learning	2	2
Module Responsible	Prof. Hoc Khiem Trieu				
Admission Requirements	None				
Recommended Previous Knowledge	Basics in physics, chemis	try, mechanics and se	emiconductor technolo	gy	
Educational Objectives	After taking part successfu	ully, students have re	ached the following lea	arning resu	ts
Professional					
Competence					
Knowledge	methods for the fabrication thereof in more complex s	on of microsensors	n techniques for micro and microactuators, a		•
Knowieage	to explain in details operation principles of microsensors and microactuators and				
	to discuss the potentia	ıl and limitation of mid	crosystems in application	on.	
	Students are capable				
	• to analyze the feasibili	ity of microsystems,			
	to develop process flows for the fabrication of microstructures and				
Skills	to apply them.				
Personal Competence					
Social Competence	Students are able to prepresent and discuss the re			team work	as well as t
Autonomy	None				
Workload in Hours	Independent Study Time 1	124, Study Time in Le	ecture 56		
Credit points	6				
	Compulsory Bonus	Form	Descriptio Studierend Kleingrup	den fi	ühren ir aborpraktikun
	I	[170]			



Studienleistung	Yes None	Subject theor practical work	etical and durch. Jede Gruppe präsentiert und diskutiert die Theorie sowie die Ergebniise ihrer Labortätigkeit. vor dem gesamten Kurs.
Examination			
Examination duration and scale	30 min		
Assignment for the Following Curricula	Elective Compulsory Electrical Engineering: Computational Science Elective Compulsory International Manage Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory	: Specialisation Medicate and Engineering: Specialisation Artification Specialisation Implang: Specialisation Medication	an Technology: Elective Compulsory pecialisation Systems Engineering and Robotics: ring: Specialisation II. Mechatronics: Elective cial Organs and Regenerative Medicine: Elective ants and Endoprostheses: Elective Compulsory edical Technology and Control Theory: Elective magement and Business Administration: Elective allification: Elective Compulsory

	Microelectronics and Microsystems: Core qualification: Elective Compulsory	
Course L0724: Microsystems Technology		
	Lecture	
Hrs/wk		
CP		
	Independent Study Time 92, Study Time in Lecture 28	
	Prof. Hoc Khiem Trieu	
Language		
Cycle		
Contont	 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; 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 	
Content	Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreadin resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow senso photometry, radiometry, IR sensor: thermopile and bolometer) • Mechanical Sensors (strain based and stress based principle, capacitive readou piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process accelerometer: piezoresistive, piezoelectric and capacitive; angular rate senso operating principle and fabrication process)	



- 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, topdown 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-onboard, 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

Literature

N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009

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				
Courses Title		Тур	Hrs/wk	СР
Technology Management	(L0849)	Project-/problem-based Learning	3	3
Technology Management	Seminar (L0850)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous Knowledge	Bachelor knowledge in business manag	jement		
Educational Objectives	After taking part successfully, students h	ave reached the following lea	arning resu	lts
Professional				
Competence	Students will gain deep insights into:			
Knowledge	 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 - on national as well as international level Equip students with an understanding of important elements of Technolog Management (strategic, operational, organizational and process-related aspects) Foster a strategic orientation to problem-solving within the innovation process as we 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 manageria organizational and financial issues concerning Technology-, Innovation- and R&E management. Further topics to be discussed include: Basic concepts, models and tools, relevant to the management of technology, R& and innovation Innovation as a process (steps, activities and results) 			
Personal Competence				
Social Competence	Interact within a teamRaise awareness for globabl issu	ues		
Autonomy	Gain access to knowledge sourcInterpret complicated cases	es		



	Develop presentation skills		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Studienleistung	None		
	Written exam		
Examination duration and scale	90 minutes		
Assignment for the Following Curricula	I Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Electivel		

Course L0849: Techno	ology 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 Incovation Management, Elgar Research Collection, Northhampton (MA) 2011

Course L0850: Technology 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	Aspects of and Cases in combination with the content of the lecture.	
Literature	see lecture Technology Management.	



Courses						
Title Control Systems Theory a Control Systems Theory a				Typ Lecture Recitation Section (smal	Hrs/wk 2	CP 4 2
Module Responsible				(0.110	, –	_
Admission Requirements	None					
Recommended Previous Knowledge	Introduction	Introduction to Control Systems				
Educational Objectives	After takin	g part successfully, s	students have re	ached the following le	arning resu	Its
Professional Competence						
Knowledge	motra tra Th rel Th Th tra Th Th Th Th Th Th Th Th	odels; they can interp jectories in state spaey can explain the ationship to state fee ey can explain the siey can explain obsecting and disturbance y can extend all of they can explain state stems ey can explain the ed how the identificati	oret the system race system proper edback and state gnificance of a rever-based state be rejection the above to multiple space models experimental ide fon problem can	amic systems are repessionse to initial state ties controllability and estimation, respective minimal realisation e feedback and how intringular multi-output systemationship with the stand transfer function entification of ARX model can be constructed.	s or externated observablely It can be used to see the see th	al excitation a ility, and the sed to achiev ansform f discrete-tim amic systems uation
Skills	 Students can transform transfer function models into state space models and v versa They can assess controllability and observability and construct minimal realisations They can design LQG controllers for multivariable plants They can carry out a controller design both in continuous-time and discrete-tild domain, and decide which is appropriate for a given sampling rate They can identify transfer function models and state space models of dynamic syste from experimental data They can carry out all these tasks using standard software tools (Matlab Controlbox, System Identification Toolbox, Simulink) 			ealisations discrete-tim		
Personal Competence	ļ					
Social Competence	Students	can work in small gro	oups on specific	problems to arrive at jo	oint solution	S.
		can obtain information, experiment gu		provided sources (tes, softwar



Workload in Hours
Credit points
Studienleistung
Examination
Examination duration and scale
Assignment for the Following Curricula



Course L0656: Contro	l 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
	State space methods (single-input single-output) • State space models and transfer functions, state feedback
Content	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: 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	



Module M0867: P	Production Planning & Control and	d Digital Enterpris	se	
Courses				
Title The Digital Enterprise (L0)	022)	Typ Lecture	Hrs/wk	CP 2
Production Planning and (•	Lecture	2	2
Production Planning and (Recitation Section (small)	1	1
Exercise: The Digital Ente	erprise (L0933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of Production and Quality Mana	agement		
Educational Objectives	After taking part successfully, students have re	eached the following lea	rning result	ts
Professional Competence				
•	Students can explain the contents of the modu	ule in detail and take a c	ritical nociti	on to them
Skills	Students are capable of choosing and appl			
Personal	·			
Competence				
Social Competence	Students can develop joint solutions in mixed	teams and present them	to others.	
Autonomy	-			
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Credit points	6			
Studienleistung	None			
	Written exam			
Examination duration and scale	180 Minuten			
Assignment for the Following Curricula	International Management and Engineering Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisatics, Infrastructure and Mobility: Specialisation Artification Compulsory Biomedical Engineering: Specialisation Medical Engineering: Specialisation Mobility Compulsory Product Development, Materials and Productive Compulsory Product Development, Materials and Productive Product Development, Materials and Productive Compulsory Theoretical Mechanical Engineering: Special Elective Compulsory Theoretical Mechanical Engineering: Technical Technical Mechanical Engineering: Technical	cialisation Production ial Organs and Regene ints and Endoprostheses dical Technology and O Management and Bu duction: Specialisation on: Specialisation Production: Specialisation roduction: Specialisation	and Logis rative Medi s: Elective C Control The usiness A Product I uction: Com on Materi	tics: Elective Compulsory eory: Elective dministration Development upulsory als: Elective





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	WiSe	
Content	See interlocking course	
Literature	Siehe korrespondierende Vorlesung See interlocking course	



Courses				
Title		Тур	Hrs/wk	СР
Electronic Circuits for Med		Lecture	2	3
	dical Applications (L1056) dical Applications (L1408)	Recitation Section (small) Practical Course	1	2 1
Module Responsible	Prof. Matthias Kuhl			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of electrical engineering	g		
Educational Objectives	After taking part successfully, students	have reached the following lea	rning resu	lts
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 its propagation along an axon Students can exemplify the communication between neurons and electronic 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 implants and artificial eyes 			
Skills	 Students can calculate the time dependent voltage behavior of an action potential Students can give scenarios for further improvement of low-noise and low-pow signal acquisition. Students can develop the block diagrams of prosthetic systems Students can define the building blocks of electronic systems for an articifial eye. 			
Personal Competence				
Social Competence	 Students are trained to solve together with experts with differ Students are able to recogning assistance to the right time. 	rent professional background. ze their specific limitations, so work in a clear manner and com	o that the	y can ask fo
Autonomy	 Students are able to realistica actions for improvements when Students can break down their work in a realistic way. Students can handle the compression of t	n necessary. work in appropriate work pack	ages and	schedule the



	Students are ab experimental work		oonsible manno	er in all cases and situations of
Workload in Hours	Independent Study Time	124, Study Time in	Lecture 56	
Credit points	6			
	Compulsory Bonus	Form		Description
Studienleistung	No None	Subject theorems	retical and	
	No 20 %	Excercises		
Examination	Oral exam			
Examination duration and scale	140 min			
Assignment for the Following Curricula	Compulsory Biomedical Engineering: Biomedical Engineering: Biomedical Engineering Compulsory Microelectronics and Mi Compulsory Theoretical Mechanical Compulsory	: Specialisation Artification: Specialisation Imp : Specialisation Med : Specialisation Madicrosystems: Specialisation Engineering: Specialisation Specialisation Specialisation Specialisation Specialisation Specialisation	icial Organs an lants and Endor lical Technology nagement and alisation Microe ialisation Bio- a	Elective Compulsory d Regenerative Medicine: Elective prostheses: Elective Compulsory y and Control Theory: Compulsory Business Administration: Elective electronics Complements: Elective and Medical Technology: Elective intary Course: Elective Compulsory



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 Fring (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, 8 Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springe 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: Electro	nic 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/		



Courses				
Title	1522)	Typ Lecture	Hrs/wk	CP
Continuum Mechanics (La Continuum Mechanics Ex		Recitation Section (small)	_	3 3
Module Responsible	Prof. Christian Cyron	, ,		
Admission	· · · · · · · · · · · · · · · · · · ·			
Requirements Recommended Previous Knowledge	Basics of linear continuum mechanics as moments, stress, linear strain, free-body energy).			
Educational Objectives	After taking part successfully, students hav	e reached the following lea	rning result	ts
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 and apply basics of deformation theory to specifical aspects, both in applied contexts as in research contexts.			
Personal Competence	The students are able to develop solutions	, to present them to special	ists in writte	en form and t
Social Competence	develop ideas further.			
Autonomy	The students are able to assess the independently and on their own identifumechanics and acquire the knowledge recommendation.	y and solve problems in		•
Workload in Hours	Independent Study Time 124, Study Time i	n Lecture 56		
Credit points				
Studienleistung				
	Written exam			
Examination duration and scale	145 min			
Assignment for the Following Curricula	Computational Science and Engineerin Compulsory Materials Science: Specialisation Modeling Mechanical Engineering and Managemen Mechatronics: Technical Complementary C Biomedical Engineering: Specialisation Ar Compulsory Biomedical Engineering: Specialisation Im Biomedical Engineering: Specialisation In Compulsory	g: Elective Compulsory t: Specialisation Materials: Course: Elective Compulsor tificial Organs and Regene plants and Endoprostheses	Elective Co y rative Medi s: Elective (mpulsory cine: Electiv Compulsory



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

Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L1533: Continuum Mechanics

Typ Lecture

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/EN			
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: Continuum 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/EN		
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 M1151: N	Material Modeling			
Courses				
Title		Тур	Hrs/wk	СР
Material Modeling (L1535) Material Modeling (L1536)		Lecture Recitation Section (small)	2	3 3
	Prof. Christian Cyron	· · · · · · · · · · · · · · · · · · ·		
Admission				
Requirements	INone			
	Basics of linear and nonlinear continuum Mechanics II and Continuum Mechanics (for strain, free-body principle, linear and nonlinear	ces and moments, stre	ss, linear a	
Educational Objectives	Latter taking part successfully students have re	eached the following lea	rning resul	ts
Professional Competence				
Knowledge	The students can explain the fundamentals of	multidimensional consit	tutive mate	rial laws
Skills	The students can implement their own material laws in finite element codes. In particular, the students can apply their knowledge to various problems of material science and evaluate the corresponding material models.			
Personal				
Competence	<u> </u>			
Social Competence	The students are able to develop solutions, to present them to specialists and to develop ideas further.			
Autonomy	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 materials modeling and acquire the knowledge required to this end.			
Workload in Hours	J Independent Study Time 124, Study Time in L	ecture 56		
Credit points	<u> </u>			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	145 min			
Assignment for the Following Curricula	Computational Science and Engineering: Compulsory Materials Science: Specialisation Modeling: E Mechanical Engineering and Management: S Biomedical Engineering: Specialisation Artific Compulsory Biomedical Engineering: Specialisation Impla Biomedical Engineering: Specialisation Med Compulsory Biomedical Engineering: Specialisation Man Compulsory Product Development, Materials and Producti	Elective Compulsory pecialisation Materials: lotal Organs and Regene nts and Endoprostheses dical Technology and Cagement and Business	Elective Co rative Med s: Elective (Control Th Administra	ompulsory icine: Elective Compulsory eory: Elective ation: Elective



Course L1535: Materia	al 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/EN
Cycle	WiSe
Content	 fundamentals of finite element methods fundamentals of material modeling introduction to numerical implementation of material laws overview of modelling of different classes of materials combination of macroscopic quantities to material microstructure
Literature	 D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge G. Gottstein., Physical Foundations of Materials Science, Springer

Course L1536: Materia	al 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/EN
Cycle	WiSe
Content	 fundamentals of finite element methods fundamentals of material modeling introduction to numerical implementation of material laws overview of modelling of different classes of materials combination of macroscopic quantities to material microstructure
Literature	D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge G. Gottstein., Physical Foundations of Materials Science, Springer



Module M1199: A	dvanced Functional Materials	5			
Courses					
Title Advanced Functional Mate	erials (L1625)	Typ Lecture	Hrs/wk 2	CP 6	
Module Responsible	Prof. Patrick Huber				
Admission Requirements	None				
Recommended Previous Knowledge	Basic knowledge in Materials Science, e.g. Materials Science I/II				
Educational Objectives	After taking part successfully, students ha	ave reached the following	learning resul	ts	
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 microto 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 solution	ns to specialists and to de	velop ideas fur	ther.	
Autonomy	The students are able to				
	Independent Study Time 152, Study Time	e in Lecture 28		1	
Credit points					
Studienleistung	None Presentation				
Examination duration	riesentation				
and scale	30 min				
Assignment for the Following Curricula	Materials Science: Core qualification: Compulsory Mechanical Engineering and Management: Specialisation Materials: 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 Materials Science: Elective Compulsory				



Course L1625: Advanced Functional Materials			
Тур	Lecture		
Hrs/wk	2		
СР			
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/EN		
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	Wird in der Veranstaltung bekannt gegeben		



Courses	
Fitle ntroduction to Biochemis	Typ Hrs/wk CP stry and Molecular Biology (L0386) Lecture 2 3
Module Responsible	Prof. Hans-Jürgen Kreienkamp
Admission Requirements	INone
Recommended Previous Knowledge	10000
Educational Objectives	I Affar faking nart cilccacctilliv, ctildante nava raachad tha tollowing laarning racilite
Professional	
Competence	1
	The students can
Knowledge	 describe basic biomolecules; explain how genetic information is coded in the DNA; explain the connection between DNA and proteins;
	The students can
Skills	 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	!
Autonomy	The students can develop understanding of topics from the course, using technical literary
riatoriomy	by themselves.
	Independent Study Time 62, Study Time in Lecture 28
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28 3
Workload in Hours Credit points Studienleistung Examination	Independent Study Time 62, Study Time in Lecture 28 3 None Written exam
Workload in Hours Credit points Studienleistung Examination	Independent Study Time 62, Study Time in Lecture 28 S 3 None Written exam 60 minutes
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 3 None Written exam 60 minutes General Engineering Science (German program): Specialisation Mechanical Enginee
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 3 None Written exam 60 minutes General Engineering Science (German program): Specialisation Mechanical Enginee Focus Biomechanics: Compulsory
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 3 None Written exam 60 minutes General Engineering Science (German program): Specialisation Mechanical Engineer Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineer
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 Independent Study Time 62, Study
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 3 None Written exam 60 minutes General Engineering Science (German program): Specialisation Mechanical Engineer Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineer Compulsory General Engineering Science (German program): Specialisation Biomedical Engineer Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 Independent Study Time 62, Study
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 Independent Study Time in Lecture 28
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 Independent Study Time 62, Study Time 19 Independent Study Time 19 Indepe
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 Independent Study Time in Lecture 28
Workload in Hours Credit points Studienleistung Examination Examination duration and scale	Independent Study Time 62, Study Time in Lecture 28 None Written exam General Engineering Science (German program): Specialisation Mechanical Engineer Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineer Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineer Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanic Engineering, Focus Biomechanics: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineer Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineer Compulsory
Workload in Hours Credit points Studienleistung Examination Examination	Independent Study Time 62, Study Time in Lecture 28 None Written exam General Engineering Science (German program): Specialisation Mechanical Engineer Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineer Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineer Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineer Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineer Compulsory General Engineering Science (English program): Specialisation Biomedical Engineer Compulsory General Engineering Science (English program): Specialisation Biomedical Engineer Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineer Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineer Compulsory



Engineering: Compulsory
Mechanical Engineering: Specialisation Biomechanics: 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: Core qualification: Elective Compulsory
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0386: Introduction to Biochemistry and Molecular Biology			
Тур	ecture		
Hrs/wk			
СР	3		
Workload in Hours	ndependent 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: E	BIO I: Implants and Fracture Healing		
Courses			
Title Implants and Fracture He	Typ Hrs/wk CP Lecture 2 3		
Module Responsible	Prof. Michael Morlock		
Admission Requirements	None		
Recommended Previous Knowledge	Fracture Hading"		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	The students can describe the different ways how bones heal, and the requirements for thei existence. The students can name different treatments for the spine and hollow bones under given fracture morphologies.		
Skills	The students can determine the forces acting within the human body under quasi-stations under specific assumptions.		
Personal Competence			
Social Competence	The students can, in groups, solve basic numerical modeling tasks for the calculation c internal forces.		
Autonomy	The students can, in groups, solve basic numerical modeling tasks for the calculation o internal forces.		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points	3		
Studienleistung	None		
Examination	Written exam		
Examination duration and scale	I UI) min		
	General Engineering Science (German program): Specialisation Mechanical Engineering Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering Focus Biomechanics: Compulsory		
Assignment for the Following Curricula	General Engineering Science (English program, 7 semester): Specialisation Mechanica Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedica Engineering: Compulsory Mechanical Engineering: Specialisation Biomechanics: 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
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory



Course L0376: Implan	ts and Fracture Healing		
Тур	Lecture		
Hrs/wk	2		
СР			
-	Independent Study Time 62, Study Time in Lecture 28		
	Prof. Michael Morlock		
Language 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		
	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		
Literature	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: E	BIO II: Biomaterials				
Courses					
Title Biomaterials (L0593)		Typ Lecture	Hrs/wk	CP 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			Its	
Professional Competence					
	The students can describe the materials of the human body and the materials being used in medical engineering, and their fields of use.			being used in	
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				
Studienleistung	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	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	



Lecturer Language	Prof. Michael Morlock EN		
Cycle	WiSe		
	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, S.-W: Biokompatible Werkstoffe und Bauweisen. Berlin, Springer, 1996.



Courses					
Title			Тур	Hrs/wk	СР
Finite Element Methods (L	·		Lecture	2	3
Finite Element Methods (L	_0804)		Recitation Section (large)	2	3
Module Responsible	!				
Admission Requirements	INOne				
Recommended Previous Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics Dynamics) Mathematics I, II, III (in particular differential equations)				
Educational Objectives	LATTER TAKING DART SUCCESS	fully, students have re	eached the following lea	rning result	S
Professional					
Competence Knowledge	The students possess a method and are able to method.				
Skills	The students are capal elements, assembling the equations.			-	
Personal Competence Social Competence	Ctudonto con work in om	all groups on specific	problems to arrive at join	int solutions	3.
Autonomy	The students are able to independently solve challenging computational problems an develop own finite element routines. Problems can be identified and the results are criticall scrutinized.				
Workload in Hours	Independent Study Time	124, Study Time in L	ecture 56		
Credit points	6				
Studienleistung	Compulsory Bonus No 20 %	Form Midterm	Descriptio	on	
Examination	Written exam				
Examination duration and scale	I 120 min				
and scale	Civil Engineering: Core of Energy Systems: Core of Aircraft Systems Engineer Aircraft Systems Engineer	ualification: Elective Cering: Specialisation A	Compulsory Aircraft Systems: Elective		



	Computational Science and Engineering: Specialisation Scientific Computing: Elective
	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
Following Curricula	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
	·
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: 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 E	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



Modulo M1242: D	lohimoro				
Module M1342: P	rolymers				
Courses					
Title		Тур	Hrs/wk	СР	
Structure and Properties or Processing and design wi		Lecture Lecture	2 2	3 3	
		Lecture	2	ა	
Module Responsible Admission					
Requirements	None				
Recommended Previous Knowledge	Basics: chemistry / physics / material sc	ence			
Educational Objectives	After taking part successfully, students h	nave reached the follow	ing learning resu	Its	
Professional					
Competence	Students can use the knowledge of plas	stics and define the nece	essarv testing and	d analvsis.	
			,		
Knowledge	They can explain the complex relations		•		
	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 met (modulus, strength) to calculate and eva 	_		cal propertie	
	- selecting appropriate solutions for stiffness, corrosion resistance.	mechanical recycling	problems and si	izing examp	
Personal Competence					
Competence	Students can				
	- arrive at funded work results in heterog	nenius arouns and docu	iment them		
Social Competence					
,	- provide appropriate feedback and han	idle feedback on their o	wn performance	constructively	
	Students are able to				
	- assess their own strengths and weakn	esses.			
Autonomy	- assess their own state of learning in basis.	specific terms and to de	efine further work	steps on th	
	- assess possible consequences of thei	r professional activity.			
Workload in Hours	Independent Study Time 124, Study Tin	ne in Lecture 56			
Credit points	6				
Studienleistung	None				
Examination	Written exam				
Examination duration and scale	180 min				
	Materials Science: Specialisation Engin Biomedical Engineering: Specialisation	_		sory	



	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
Assignment for the	Compulsory
Following Curricula	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: Structu	re 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
Content	- Structure and properties of polymers - Structure of macromolecules Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution - Morphology amorph, crystalline, blends - Properties Elasticity, plasticity, viscoelacity - Thermal properties - Electrical properties - Theoretical modelling - Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag



Course L1892: Proces	sing 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



violutie iviousz. n	Regenerative Medi	cine			
Courses					
Title			Тур	Hrs/wk	СР
Regenerative Medicine (L	•		Seminar	2	3
Lecture Tissue Engineerin	ng - Regenerative Medicine	(L1664)	Seminar	2	3
Module Responsible	Prof. Ralf Pörtner				
Admission Requirements	INone				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part success	sfully, students have r	eached the followi	ng learning resu	lts
Professional Competence					
	After successful comple of regenerative medicir tissue engineering. The animal and human cells	ne and to explain the ey are able to give a s.	e use of the tissue basic overview of	cells for differe methods for the	nt methods of cultivation of
	The students can outl medicine and can expla After successful comple	in the basic udnerlyin	g principles of the	-	-
Skills	data independer able to present the able to carry independently	heir work results in the out basic cell cultu	e form of presentat re methods and	ions the correspon	ding analys
Personal					
Competence					
	Students are able to w discuss their results in the	•		ents to solve giv	ven tasks ar
Social Competence	Students are able to refl	ect their work orally a	nd discuss it with o	other students an	d teachers.
Autonomy	After completion of this of approx. 2-4 persons in			•	blem in team
	Independent Study Time	e 124, Study Time in L	ecture 56		
Credit points	I				
Studienleistung	Compulsory Bonus Yes 20 %	Form Written elaboration	Ausa	cription arbeitung zu Rin ocol for lecture se	-
Examination	Presentation		·		
Examination duration	1	ussion (30 min)			



	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Assignment for the	Compulsory
Following Curricula	Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
Following Curricula	Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective
	Compulsory

Course L0347: Regen	erative 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/EN
Cycle	WiSe
	The course deals with the application of biotechnological engineering principles for regeneration 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")
Content	 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	e 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 M0548: E	Bioelectromagnetic	cs: Principles ar	nd Applications		
Courses					
Title Bioelectromagnetics: Prince	ciples and Applications (L037 ciples and Applications (L037	•	Typ Lecture Recitation Section (small)	Hrs/wk	CP 5
	Prof. Christian Schuster	7.0)	Trochation Gootion (ornali)		
Admission Requirements	1				
Recommended Previous Knowledge	Basic principles of physic	CS			
Educational Objectives	After taking part success	fully, students have re	ached the following lea	rning resu	Its
Professional Competence					
Knowledge	Students can explain the i.e. the quantification an define and exemplify the to wavelength and frequ numerical techniques fo They can give examples medical technology. Students know how to a	nd application of elect e most important physicency of the fields. The or characterization of e s for therapeutic and o	romagnetic fields in bio ical phenomena and or ey can give an overview electromagnetic fields in diagnostic utilization of	ological tiss rder them o over mea n practical electromag	sue. They can corresponding surement and applications gnetic fields in
Skills	fields in biological tissue solutions of Maxwell's Edmodels predict for biological frequency, respectively develop validation strate electromagnetic fields for choice.	e. In order to do this th quations. They are ab gical tissue, they can yely, and they can ana egies for their predic	ey can relate to and ma le to assess the most im order the effects corre lyze them in a quantitati tions. They are able to	ke use of t portant eff sponding ive way. The evaluate	he elementary ects that these to wavelength ney are able to the effects o
Personal Competence					ey are able to
Social Competence		, , ,		,	
Autonomy	Students are capable to relate that information to between their knowledge of electromagnetic field communicate problems a	to the context of the e obtained in this lect ds, fundamentals of	lecture. They are able ure with the content of o electrical engineering	e to make other lectur g / physic	a connection es (e.g. theory s). They can
Workload in Hours	IIndependent Study Time	e 110, Study Time in Le	ecture 70		
Credit points	6				
Studienleistung	Compulsory Bonus Yes 10 %	Form Presentation	Descriptio	 on	



Examination	Oral exam
Examination duration and scale	145 min
Assignment for the Following Curricula	I Riomedical Engineering, Specialication implants and Engoprostnesse, Flective Compilisory - I



cendent Study Time 108, Study Time in Lecture 42 Christian Schuster N damental properties of electromagnetic fields (phenomena) hematical description of electromagnetic fields (Maxwell's Equations)
Christian Schuster N damental properties of electromagnetic fields (phenomena) hematical description of electromagnetic fields (Maxwell's Equations)
Christian Schuster N damental properties of electromagnetic fields (phenomena) hematical description of electromagnetic fields (Maxwell's Equations)
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N damental properties of electromagnetic fields (phenomena) hematical description of electromagnetic fields (Maxwell's Equations)
damental properties of electromagnetic fields (phenomena) hematical description of electromagnetic fields (Maxwell's Equations)
damental properties of electromagnetic fields (phenomena) hematical description of electromagnetic fields (Maxwell's Equations)
hematical description of electromagnetic fields (Maxwell's Equations)
stromo anotic preparties of high significant
ctromagnetic properties of biological tissue
ciples of energy absorption in biological tissue, dosimetry
nerical methods for the computation of electromagnetic fields (especially FDTD)
surement techniques for characterization of electromagnetic fields
avior of electromagnetic fields of low frequency in biological tissue
avior of electromagnetic fields of medium frequency in biological tissue
avior of electromagnetic fields of high frequency in biological tissue
avior of electromagnetic fields of very high frequency in biological tissue
gnostic applications of electromagnetic fields in medical technology
rapeutic applications of electromagnetic fields in medical technology
human body as a generator of electromagnetic fields
Furse, D. Christensen, C. Durney, "Basic Introduction to Bioelectromagnetics", CF
Vorst, A. Rosen, Y. Kotsuka, "RF/Microwave Interaction with Biological Tissues", Wil
rimnes, O. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008)
Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnes", CRC (2006)
- F



Course L0373: Bioeled	ctromagnetics: 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				
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			
	- 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)			
	- 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)			



Module M1384: C	Case Studies for Regenerative Mo	edicine	and Tis	sue Engine	ering
Courses					
Title		Тур		Hrs/wk	СР
Case Studies for Regener	rative Medicine and Tissue Engineering (L1963)	Semina	r	3	6
Module Responsible	Prof. Ralf Pörtner				
Admission Requirements	None				
Recommended Previous Knowledge					
Educational Objectives	After taking part successfully, students have	reached	the following	ı learning resul	ts
Professional Competence					
Knowledge					
Skills					
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 138, Study Time in	Lecture 4	12		
Credit points	6				
Studienleistung	None				
Examination	Presentation				
Examination duration and scale	45 min				
Assignment for the Following Curricula	Biomedical Engineering: Specialisation Compulsory	Artificial	Organs an	d Regenerati	ve Medicine

Course L1963: Case S	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							
Title					Тур	Hrs/wk	СР
Robotics and Navigation in Medicine (L0335)					Lecture	2	3
Robotics and Navigation i Robotics and Navigation i					Project Seminar	2	2
	•				Recitation Section (small)	· I	1
Module Responsible	1	xander Schl	aeter				
Admission Requirements	INANA						
Recommended Previous Knowledge	• p	•	orogra	algebra, analysis/ca mming, e.g., in Java ills			
Educational Objectives	I Δtter taki	ing part succ	essfull	y, students have re	eached the following lea	arning resu	Its
Professional Competence							
·	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 designand limitations.						
Skills	The students are able to design and evaluate navigation systems and robotic systems fo medical applications.						
Personal Competence							
Social Competence	The students discuss the results of other groups, provide helpful feedback and caincoorporate feedback into their work.						
Autonomy	The students can reflect their knowledge and document the results of their work. They capresent the results in an appropriate manner.						
Workload in Hours	Indepen	dent Study T	ime 11	10, Study Time in L	ecture 70		
Credit points	6						
Studienleistung		10 % 10 %	,	Form Written elaboration Presentation	Descriptio	on	
Examination	Written e	exam					
Examination duration and scale	190 minii	tes					
	Electrica Computa Elective	ıl Engineerin ational Scier Compulsory	ig: Spe	cialisation Medical d Engineering: Sp	e Engineering: Elective (Technology: Elective C ecialisation Systems Er Specialisation II. Electric	Compulsory ngineering	and Robotic

Compulsory



	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective
Following Curricula	Compulsory
1 Ollowing Out ricula	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

Course L0335: Robotic	cs 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	dependent Study Time 32, Study Time in Lecture 28			
Lecturer	of. 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 M0634: Ir	ntroduction	into Me	dical Techn	ology and Syste	ms	
Courses						
Title				Тур	Hrs/wk	СР
Introduction into Medical 7	echnology and Sy	stems (L03	42)	Lecture	2	3
Introduction into Medical 7		-	•	Project Seminar	2	2
Introduction into Medical 1	echnology and Sy	stems (L18	76)	Recitation Section (la	arge) 1	1
Module Responsible	Prof. Alexander	Schlaefer				
Admission Requirements	None					
Recommended Previous Knowledge	principles of ma principles of sto principles of pro	chastics		lus)		
Educational Objectives	After taking part	successfu	lly, students hav	e reached the following	g learning resu	Its
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 as applications.	The students are able to evaluate systems and medical devices in the context of clinica applications.				
Personal						
Competence	 <u>-</u>					
Social Competence			roblem in medic	al technology as a pro	ject, and define	e tasks that ar
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 Stu	udy Time 1	10, Study Time	n Lecture 70		
Credit points	6					
Studienleistung		onus) %) %	Form Written elabora Presentation		ription	
Examination	Written exam					
Examination duration and scale	90 minutes					
Assignment for the	Compulsory General Engine Engineering: Co Computer Scien Electrical Engine General Engine Compulsory General Engine Engineering: Co	eering Sci ompulsory ace: Special eering: Col eering Sci eering Sc ompulsory	ence (German alisation Compu re qualification: ence (English ience (English	program): Specialisation program, 7 semester er and Software Engine Elective Compulsory program): Specialisation program, 7 semester g: Specialisation Eng	eering: Elective on Biomedica Specialisation	on Biomedica e Compulsory I Engineering on Biomedica
Following Curricula		Science	and Engineer	ng: Specialisation C	Computer Scie	ence: Electiv
J			[215]			



Compulsory
Computational Science and Engineering: Specialisation Mathematics & Engineering Science: 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: Introdu	ction 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				
СР	2			
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28			
Lecturer	rof. Alexander Schlaefer			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			



Course L1876: Introdu	ction 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: N	onlinear Dynamics
Courses	
Title Nonlinear Dynamics (L07	Typ Hrs/wk CP Integrated Lecture 4 6
Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	 Calculus Linear Algebra Engineering Mechanics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to reflect existing terms and concepts in Nonlinear Dynamics and 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	
Studienleistung	
	Written exam
Examination duration and scale	2 Hours
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Computational Science and Engineering: Specialisation Scientific Computing: 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.	



Courses						
Title				Тур	Hrs/wk	СР
Semiconductor Technolog				Lecture	4	4
Semiconductor Technolog	y (L0723)			Practical Course	2	2
Module Responsible	Prof. Hoc l	Khiem Trieu				
Admission Requirements	None					
Recommended Previous Knowledge	Basics in p	physics, chemist	ry, material sci	ence and semiconduct	tor devices	
Educational Objectives	After taking	g part successfu	illy, students ha	ave reached the followi	ng learning resu	Its
Professional Competence						
	Students a		lain current foh	rication techniques for	Si and GaAs sub	netratee
 to describe and to explain current fabrication techniques for Si and GaAs substration. Knowledge to discuss in details the relevant fabrication processes, process flows and thereof on the fabrication of semiconductor devices and integrated circuits and 						
	to pres	ent integrated p	rocess flows.			
	Students a	are capable				
	to analyze the impact of process parameters on the processing results,					
Skills	to select and to evaluate processes and					
	• to deve	elop process flov	ws for the fabri	cation of semiconducto	r devices.	
Personal Competence						
Social Competence				rm their lab experime faudience.	nts in team work	as well as
Autonomy	None					
Workload in Hours		ent Study Time 9	96, Study Time	in Lecture 84		
Credit points	6					
Studienleistung	None					
Evamination	Oral exam					
Examination						
Examination duration and scale	30 min					



Following Curricula	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: Specialisation Microelectronics Complements: Elective
	· · · ·

Тур	Lecture
Hrs/wk	4
СР	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Hoc Khiem Trieu
Language	DE/EN
Cycle	SoSe
Content	 Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallograp defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochrals Bridgeman and float zone process) Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusit transport processes, doping profile, higher order effects and process technology, implantation: theory, implantation profile, channeling, implantation damage, anneali and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, therroxidation: reactions, kinetics, influences on growth rate, process technology a equipment, anodic oxidation, plasma oxidation, thermal oxidation of GaAs) Deposition techniques (theory: nucleation, film growth and structure zone model, f growth process, reaction kinetics, temperature dependence and equipment; epita gas phase, liquid phase, molecular beam epitaxy; CVD techniques: APCVD, LPCV deposition of metal silicide, PECVD and LECVD; basics of plasma, equipment, Pi techniques: high vacuum evaporation, sputtering) Structuring techniques (subtractive methods, photolithography: resist properti printing techniques: contact, proximity and projection printing, resolution limit, practicissues and equipment, additive methods: liftoff technique and electroplating, improvi resolution: excimer laser light source, immersion lithography and phase s lithography, electron beam lithography, X-ray lithography, EUV lithography, ion bei lithography, wet chemical etching: isotropic and anisotropic, corner undercuttic compensation masks and etch stop techniques; dry etching: plasma enhance etching, backsputtering, ion milling, chemical dry etching, RIE, sidewall passivation) Process integration (CMOS process, bipolar process) Assembly and packaging te



	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
	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	



Courses					
Courses Title			Тур	Hrs/wk	СР
Humanoid Robotics (L066	3)		Seminar	2	2
Module Responsible	Patricl	k Göttsch			
Admission Requirements	None				
Recommended Previous Knowledge	•	Introduction to control system Control theory and design	ns		
Educational Objectives	After to	aking part successfully, studer	nts have reached the follow	ing learning resu	Its
Professional Competence					
Knowledge	•	Students can explain human Students learn to apply basic		ent tasks in huma	noid robotics
Skills	 Students acquire knowledge about selected aspects of humanoid robotics, based or specified literature Students generalize developed results and present them to the participants Students practice to prepare and give a presentation 				
Personal Competence					
Social Competence	•	Students are capable of de them They are able to provide a their own results			
Autonomy	•	Students evaluate advantage specific tasks and select the Students familiarize themsel presentations of other students.	best solution ves with a scientific field, a	re able of introduc	ce it and follo
Workload in Hours	Indepe	endent Study Time 32, Study	Fime in Lecture 28		
Credit points	2				
Studienleistung					
Examination		ntation			
Examination duration and scale	30 mir	١			
Assignment for the	Mecha Mecha Biome Comp Biome Biome	ical Engineering: Specialisation atronics: Specialisation Intelligatronics: Specialisation Systemedical Engineering: Specialisations ulsory edical Engineering: Specialisational Engineering: Specialisatical Engineering: Specialisatical Engineering: Specialisatical Engineering: Specialisations	ent Systems and Robotics: n Design: Elective Compulstion Artificial Organs and F	Elective Compul sory Regenerative Med stheses: Elective	sory licine: Electiv 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 L0663: Human	oid 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 Syst	tem Identification (L0660)	Typ Lecture	Hrs/wk	CP 3
Module Responsible	Prof. Herbert Werner			
Admission Requirements				
Recommended Previous Knowledge	 State space methods 	•		
Educational Objectives	After taking part successfully,	students have reached the following	ng learning resul	ts
Professional Competence				
Knowledge	 application to a variety They can explain how dynamics They can explain how neural network models 	the general framework of the properties of linear and nonlinear model structure with multilayer perceptron networks with an approximate predictive contests of the properties	uctures are used to mo trol scheme can	del nonlinea
Skills	identification of linear a They are capable of in neural network model They are capable of al linear models for dyna	of applying the predicition erro and nonlinear models for dynamic applementing a nonlinear predictive applying subspace algorithms to the mic systems we using standard software tools	e systems we control schem e experimental ic	e based on a
Personal Competence				
Social Competence	Students can work in mixed g	roups on specific problems to arriv	e at joint solutior	ıs.
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 62, S	Study Time in Lecture 28		
Credit points				
Studienleistung	None			
Examination				
Examination duration and scale	30 min			
	Mechatronics: Specialisation	alisation Control and Power System Intelligent Systems and Robotics: System Design: Elective Compulso	Elective Compul	



	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective
Assignment for the	Compulsory
Following Curricula	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
	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				Тур		Hrs/wk	СР
Optimal and Robust Contr Optimal and Robust Contr		·		Lec Rec	ture itation Section (small)	2	3 3
Module Responsible	Prof. H	lerbert Werner	r				
Admission Requirements	None						
Recommended Previous Knowledge	•	State space r	ntrol (frequency re methods ra, singular value	•	ŕ		
Educational Objectives	After ta	aking part succ	cessfully, students	s have reach	ed the following lea	rning resul	lts
Professional Competence							
Knowledge	 Students can explain the significance of the matrix Riccati equation for the solution 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 are performance constraints. They can explain how an LQG design problem can be formulated as special case 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	 Students are capable of designing and tuning LQG controllers for multivariable models. They are capable of representing a H2 or H-infinity design problem in the for generalized plant, and of using standard software tools for solving it. They are capable of translating time and frequency domain specifications for loops into constraints on closed-loop sensitivity functions, and of carrying out a sensitivity design. They are capable of constructing an LFT uncertainty model for an uncertain s and of designing a mixed-objective robust controller. They are capable of formulating analysis and synthesis conditions as linear inequalities (LMI), and of using standard LMI-solvers for solving them. They can carry out all of the above using standard software tools (Matlab robust toolbox). 		the form of ons for contr g out a mixed ertain system s linear matr				
Personal Competence							
_	Studer	nts can work ir	n small groups on	specific prob	olems to arrive at jo	int solution (lecture no	
,							



Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Studienleistung	None		
Examination			
Examination duration and scale	30 min		
Assignment for the Following Curricula	IRIOMEGICAL ENGINEERING. SPECIALISATION MEGICAL LECUNOLOGY AND CONTROL LIBERTY ELECTIVEL		



Course L0658: Optima	l 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	



Courses					
Title Marketing of Innovations	(L2009)		Typ Lecture	Hrs/wk 4	CP 4
PBL Marketing of Innovati	ons (L0	862)	Project-/problem-based Learning	1	2
Module Responsible		Christian Lüthje			
Admission Requirements	None				
Recommended Previous Knowledge	•	Module International Business Basic understanding of business theory, project management, into Bachelor-level Marketing Know Strategies, Basics of Buying Beh Unerstanding the differences be Understanding of the importance Good English proficiency; prese	rnational business) edge (Marketing Instrumen avior) weetn B2B and B2C marketi of managing innovation in	ts, Market a	nd Competit
Educational Objectives	After ta	aking part successfully, students h	ave reached the following le	earning resul	its
Professional Competence					
Knowledge	•	Specific characteristics in the material Approaches for analyzing the development The gathering of information about Concepts and approaches to inservice development processes Approaches and tools for ensure products and innovative services Marketing mix elements that tachallenges of innovative product Pricing methods for new product The organization of complex sale Communication concepts and in	rketing of innovative poroduct current market situation ut future customer needs and tegrate lead users and the ring customer-orientation in ke into consideration the seand services and services and services es forces and personal selling struments for new products a	and the drequirement in needs into the developeration required the developeration of the	future mark ents o product a pment of ne uirements a
Skills	•	Design and to evaluate decision Analyze markets by applying ma Conduct forecasts and develop of Translate customer needs into successfully apply advanced of development Use adequate methods to foster Choose suitable pricing strategic Make strategic sales decisions channels) Apply methods of sales force materials	s regarding marketing and in rket and technology portfolio compelling scenarios as a base o concepts, prototypes an nethods for customer-orier efficient diffusion of innovation as and communication activity of for products and service	asis for strated marketabuted products ties for innoversities.	egic planning le offers and t and services and services vations ction of sale
Personal Competence					



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	6		
Studienleistung	None		
	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: Market	ing 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) III. Methods and approaches of strategic marketing planning patterns of industrial development, patent and technology portfolios IIII. 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		
Literature	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 Ma	arketing 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	



Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering -		Lecture	2	3
Bioprocess Engineering - Rioprocess Engineering -	-undamentals (L0842) Fundamental Practical Course (L0843)	Recitation Section (large) Practical Course	2	1 2
Module Responsible			_	
Admission Requirements				
Recommended Previous Knowledge	none, module "organic chemistry", modu	le "fundamentals for process	engineerin	ıg"
Educational Objectives	After taking part successfully, students ha	ave reached the following lea	rning resul	ts
Professional Competence				
	Students are able to describe the basic classify different types of kinetics for enzing different types of inhibition. The parameter mass transport processes in bioreacto explain fundamental bioprocess manaprocessing in detail.	eymes and microorganisms, a ers of stoichiometry and rhed rs can be explained. The s	as well as to plogy can b students a	to differentiate be named and re capable to
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	After a maletice of this module monticine		to took wise	l avections in
Social Competence	After completion of this module participants should be able to debate technical questions i small teams to enhance the ability to take position to their own opinions and increase the 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		



	practical work
	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Process Engineering: Compulsory General Engineering Science (German program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess 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: Biopro	cess 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, fedbatch 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					
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				
Content	 Introduction (Prof. Liese, Prof. Zeng) Enzymatic kinetics (Prof. Liese) Stoichiometry I + II (Prof. Liese) Microbial Kinetics I+II (Prof. Zeng) Rheology (Prof. Liese) Mass transfer in bioprocess (Prof. Zeng) Continuous culture (Chemostat) (Prof. Zeng) Sterilisation (Prof. Zeng) Downstream processing (Prof. Liese) Repetition (Reserve) (Prof. Liese, Prof. Zeng) 				
Literature	siehe Vorlesung				
Literature	siene vonesung				

Course L0843: Bioprod	cess Engineering - Fundamental Practical Course			
Тур	ractical 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			



lechanical Design Methodology			
	Тур	Hrs/wk	СР
dology (L1523)	Lecture	3	4
dology (L1524)	Recitation Section (small)	1	2
Prof. Josef Schlattmann			
None			
After taking part successfully, students have re	eached the following lea	rning resul	ts
Science-based working on product design considering targeted application of specific product design techniques			
Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.			
Independent Study Time 124, Study Time in L	ecture 56		
6			
None			
Oral exam			
30 min			
International Management and Engineering: Specialisation II. Product Development and Production: 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: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory			
	dology (L1523) dology (L1524) Prof. Josef Schlattmann None After taking part successfully, students have respectively. Science-based working on product design condesign techniques Creative handling of processes used for some product design problems / Application of theoretical aspects. Independent Study Time 124, Study Time in Left of the production: Elective Compulsory Mechatronics: Specialisation System Design: Biomedical Engineering: Specialisation Artific Compulsory Biomedical Engineering: Specialisation Implated Biomedical Engineering: Specialisation Mechatronics: Specialisation Mechatronics: Specialisation Mechatronics Independent Specialisation Mechatronical Engineering: Specialisation Mechatronical Engineering: Specialisation Mechanical Engineering: Specialisation Mechanical Engineering: Specialisation Management, Materials and Product Development, Materials and P	dology (L1523)	dology (L1523) dology (L1524) Recitation Section (small) 1 Prof. Josef Schlattmann None After taking part successfully, students have reached the following learning resulted sign techniques Creative handling of processes used for scientific preparation and formulation product design problems / Application of various product design techniques Creative handling of processes used for scientific preparation and formulation product design problems / Application of various product design techniquitheoretical aspects. Independent Study Time 124, Study Time in Lecture 56 None Oral exam 30 min International Management and Engineering: Specialisation III. Product Deveroduction: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Med Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control The Compulsory Biomedical Engineering: Specialisation Management and Business Administration Compulsory Product Development, Materials and Production: Specialisation Product Elective Compulsory Product Development, Materials and Production: Specialisation Materials of Product Development, Materials and Production: Specialisation Materials of Product Development, Materials and Production: Specialisation Materials of Product Development, Materials and Production: Specialisation Materials Mechanical Engineering: Specialisation Product Development, Materials and Production: Specialisation Materials Mechanical Engineering: Specialisation Product Development and Product Devel



Course L1523: Mechanical Design Methodology			
Тур	Lecture		
Hrs/wk	3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Josef Schlattmann		
Language	DE		
Cycle	SoSe		
Systematic reflection and analysis of the mechanical design process Process structuring in sections (task, functions, acting principles, design-elements total construction) as well as levels (working-, controlling-, and deciding-levels) Creativity (basics, methods, practical application in mechatronics) Diverse methods applied as tools (function structure, GALFMOS, AEIOU met GAMPFT, simulation tools, TRIZ) Evaluation and selection (technical-economical evaluation, preference matrix) Value analysis, cost-benefit analysis Low-noise design of technical products Project monitoring and leading (leading projects / employees, organisation in prodevelopment, creating ideas / responsibility and communication) Aesthetic product design (industrial design, colouring, specific examples / exercise)			
Literature	 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: Mechanical Design Methodology			
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Josef Schlattmann		
Language	DE		
Cycle	SoSe		
Content	Systematic reflection and analysis of the mechanical design process Process structuring in sections (task, functions, acting principles, design-elements total construction) as well as levels (working-, controlling-, and deciding-levels) Creativity (basics, methods, practical application in mechatronics) Diverse methods applied as tools (function structure, GALFMOS, AEIOU me GAMPFT, simulation tools, TRIZ) Evaluation and selection (technical-economical evaluation, preference matrix) Value analysis, cost-benefit analysis Low-noise design of technical products Project monitoring and leading (leading projects / employees, organisation in prodevelopment, creating ideas / responsibility and communication) Aesthetic product design (industrial design, colouring, specific examples / exercise)		
Literature	 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 		



Courses				
Title Introduction to Anatomy (I	Typ Hrs/wk CP L0384) Lecture 2 3			
Module Responsible	Prof. Udo Schumacher			
Admission Requirements				
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, 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	3			
Studienleistung	None			
	Written exam			
Examination duration and scale	90 minutes			
	General Engineering Science (German program): Specialisation Mechanical Engineering Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory			
Assignment for the Following Curricula	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering Focus Biomechanics: Compulsory General Engineering Science (English program): 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 Mechanical 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

Typ	Lecture			
Hrs/wk				
СР				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Tobias Lange			
Language	DE			
Cycle	SoSe			
Content	General Anatomy 1st week: The Eucaryote Cell 2nd week: The Tissues 3rd week: Cell Cycle, Basics in Development 4th week: Musculoskeletal System 5th week: Cardiovascular System 6th week: Respiratory System 7th week: Genito-urinary System 8th week: Immune system 9th week: Digestive System I 10th week: Digestive System II 11th week: Endocrine System 12th week: Nervous System 13th week: Exam			
Literature	Adolf Faller/Michael Schünke, Der Körper des Menschen, 16. Auflage, Thieme Verla Stuttgart, 2012			



Courses					
Title Introduction to Radiology	and Radiation Therapy (L0383)	Typ Lecture	Hrs/wk 2	CP 3	
Module Responsible					
Admission Requirements					
Recommended Previous Knowledge	LINIONA				
Educational Objectives	After taking part successfully, studen	ts have reached the follo	wing learning resu	lts	
Professional Competence					
	Therapy The students can distinguish differer in radiation therapy.	nt types of currently used	equipment with res	spect to its us	
	The students can explain treatme contexts (e.g. surgery, internal media	•	tion therapy in in	terdisciplinaı	
	The students can describe the patients' passage from their initial admittance through to follow-up care.				
	Diagnostics				
Knowledge	The students can illustrate the tech angiography and mammography, as				
	The students can explain the diagno well as the technical basis for those	•	ic use of imaging t	echniques, a	
	The students can choose the right treat and needs.	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 that conclusion.	e and palliative situations	s and motivate why	they came t	
	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)				
Skills	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 like (e.g. for up treatment, sports, social help groups, self-help groups, social services, psycho-oncolo				
	Diagnostics				
	The students can suggest solutions error analyses.	for repairs of imaging in	strumentation afte	r having don	



	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 i a professional way. The students are aware of the special, often fear-dominated behavior of sick people cause by diagnostic and therapeutic measures and can meet them appropriately.				
Autonomy	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. 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				
Studienleistung	None				
	Written exam				
Examination duration and scale	I 90 minutes				
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): 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 Mechanical 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		
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	



Cvcie	SoSe
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



Courses				
Title Introduction to Physiology	(L0385)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Dr. Roger Zimmermann			
Admission Requirements	None			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, students ha	ave reached the follow	ing learning resul	ts
Professional				
Competence	The students can			
Knowledge	 describe the basics of the energy metabolism; describe physiological relations in selected fields of muscle, heart/circulation, neuro and sensory physiology. 			
Skills	The students can describe the effects of processing of information, development technical systems.	•	•	
Personal				
Competence	The skill out on a suduet discussion in			1
Social Competence	The students can conduct discussions in research and medicine on a technical level. The students can find solutions to problems in the field of physiology, both analytical and metrological.			
Autonomy	The students can derive answers to quareas, using technical literature, by them		course and other	physiologica
Workload in Hours	Independent Study Time 62, Study Time	in Lecture 28		
Credit points	3			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	60 minutes			
	General Engineering Science (German Focus Biomechanics: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Engineering: Compulsory General Engineering Science (German Engineering, Focus Biomechanics: Compulsory General Engineering Science (English Focus Biomechanics: Compulsory General Engineering Science (English Compulsory	n program): Specialisa n program, 7 semest n program, 7 semest oulsory edical Technology: Ele program): Specialisa	ation Biomedical er): Specialisatio er): Specialisatio ctive Compulsory ation Mechanical	Engineering n Biomedica n Mechanica Engineering
	General Engineering Science (English Engineering, Focus Biomechanics: Com General Engineering Science (English	oulsory		



Engineering: Compulsory
Mechanical 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: Core qualification: 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. Roger Zimmermann	
Language	DE	
Cycle	SoSe	
Content		
Literature	Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme	
Literature	Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier	



Courses				
Title Experimental Methods in I	Biomechanics (L0377)	Typ Lecture	Hrs/wk	CP 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	It is recommended to participate in "Experimentelle Methoden".	"Implantate und Fr	akturheilung" bef	ore attendir
Educational Objectives	After taking part successfully, students ha	ve reached the follow	ving learning resul	ts
Professional Competence				
Knowledge	The students can describe the different vexistence. The students can name different treatmeracture morphologies. The students can describe different mea	nents for the spine a	and hollow bones	s under give
Skills	choose the adequate technique for a given the students can describe the basic has biomechanics.	en task.		
Personal Competence				
Social Competence	The students can, in groups, solve basic	experimental tasks.		
Autonomy	The students can, in groups, solve basic	experimental tasks.		
Workload in Hours	Independent Study Time 62, Study Time	in Lecture 28		
Credit points				
Studienleistung				
Examination Examination duration and scale	Written exam 90 min			
	General Engineering Science (German Focus Biomechanics: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Engineering, Focus Biomechanics: Compulsory General Engineering Science (German Engineering: Compulsory General Engineering Science (English Compulsory General Engineering Science (English Compulsory	program): Specialis program, 7 semes pulsory program, 7 semes program): Specialis	sation Biomedical ter): Specialisatio ster): Specialisation sation Biomedical	Engineerin n Mechanic on Biomedic Engineerin
Assignment for the Following Curricula	Focus Biomechanics: Compulsory General Engineering Science (English Engineering, Focus Biomechanics: Comp General Engineering Science (English Engineering: Compulsory Mechanical Engineering: Specialisation	program, 7 semes oulsory program, 7 semes	ter): Specialisatio	n Mechanic



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 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: E	BIO II: Artificial Joint Repla	cement		
Courses				
Title		Тур	Hrs/wk	СР
Artificial Joint Replacemen	nt (L1306)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of orthopedic and	surgical techniques is recomn	nended.	
Educational Objectives	After taking part successfully, stude	nts have reached the following	learning resul	lts
Professional Competence				
Knowledge	The students can name the differen	t kinds of artificial limbs.		
Skills	The students can explain the advantages and disadvantages of different kinds of endoprotheses.			
Personal Competence				
Social Competence	The students are able to discuss is teachers.	ssues related to endoprothese	with student r	nates and the
Autonomy	The students are able to acquire intwith respect to its credibility.	formation on their own. They ca	an also judge t	he information
Workload in Hours	Independent Study Time 62, Study	Time in Lecture 28		
Credit points	3			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	International Management and E Biotechnology: Elective Compulsor Materials Science: Specialisation N Biomedical Engineering: Specialisa Compulsory Biomedical Engineering: Specialisa Biomedical Engineering: Specialisa Compulsory Biomedical Engineering: Specialisa Compulsory Biomedical Engineering: Specialisa Compulsory Theoretical Mechanical Engineerin Theoretical Mechanical Engineerin Compulsory	y Jano and Hybrid Materials: Electric ation Artificial Organs and Regration Implants and Endoprosthesation Medical Technology artificial Management and Busing: Technical Complementary	ctive Compulso enerative Med eses: Compuls nd Control Th ess Administra Course: Elective	ory licine: Elective sory eory: Elective ation: Elective e Compulsory



Course L1306: Artificial Joint Replacement		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
	Prof. Michael Morlock	
Language		
Cycle		
	Inhalt (deutsch)	
	1. EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenkersatzes)	
	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: F	Feedback Control in Medical Technology		
Wodale Woo43.1	eedback Control in Medical Technology		
Courses			
Title Feedback Control in Medi	Typ Hrs/wk Clical Technology (L0664) Lecture 2 3	P	
Module Responsible	Johannes Kreuzer		
Admission Requirements	INONE		
Recommended Previous Knowledge	Basics in Control, Basics in Physiology		
Educational Objectives	I Affer taking part cliccessfully students have reached the following learning results		
Professional Competence			
	The lecture will introduce into the fascinating area of medical technology with the en point of view. Fundamentals in human physiology will be similarly introduced like k 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 controller or neural networks will be illustrated. The operation of simple equivalent c be discussed.	-	
Skills	Application of modeling, identification, control technology in the field of medical technology	nology.	
Personal Competence			
Social Competence	Students can develop solutions to specific problems in small groups and present the (e.g. during project week)	eir results	
Autonomy	Students are able to find necessary literature and to set it into the context of the lecture and to continuously evaluate their knowledge and to take control of their process. They can combine knowledge from different courses to form a consistent where the context of the lecture and to take control of their process.	r learning	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points			
Studienleistung			
Examination			
Examination duration and scale	120 min		
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compuls Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Com Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine	npulsory e: Elective	
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Co	mpulsory	



Course L0664: Feedba	Course L0664: Feedback 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	 Taking an engineering point of view, the lecture is structured as follows. Introduction to the topic with selected examples Physiology - introduction and overview Regeneration of functions of the cardiovascular system Regeneration of the respiratory functions Closed loop control in anesthesia regeneration of kidney and liver functions regeneration of motorize function/ rehabilitation engineering navigation systems and robotic in medicine The lecture will use knowledge from modeling, simulation and controller design and MATLAB and SIMULINK will be used.		
	Silbernagel/Depopoulos: Taschenatlas der Physiologie, Thieme Verlag Stuttgart Werner: Kooperative und autonome Systeme der Medizintechnik, Oldenburg Verlag M.C.K.Khoo: "Physiological Control System", IEEE Press, 2000		



Courses				
Title		Тур	Hrs/wk	СР
Advanced Topics in Contr Advanced Topics in Contr		Lecture Recitation Section (small)	2	3 3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	H-infinity optimal control, mixed-sensitivi	ty design, linear matrix inequa	alities	
Educational Objectives	After taking part successfully, students h	ave reached the following lea	rning resu	lts
Professional Competence				
Knowledge	 Students can explain the advischeduling approach They can explain the represent systems They can explain how stability formulated as LMI conditions They can explain how griddin synthesis problems for LPV systems They are familiar with polytopic at the basic synthesis techniques at	ation of nonlinear systems in and performance conditions g techniques can be used that and LFT representations of LI associated with each of these reagent systems are agent systems be properties of first order cord synthesis conditions for models.	to solve To systems To syste	of quasi-LPV restems can be analysis and s and some of ctures represent the otocols control loop ant distributed
Skills		in-scheduled controllers; thodels oftware tools (Matlab robust o	ey can c	do this using
	 Students are able to design distreither LTI or LPV dynamics, using Students are able to design distremental 	g Matlab tools provided		



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	6
Studienleistung	None
Examination	
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Avionic and Embedded Systems: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: 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: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory



Course L0661: Advan	ced 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	EN
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	



Specialization Management and Business Administration

Module M0623: Ir	ntelligent Systen	ns in Medicine			
Courses					
Title			Тур	Hrs/wk	СР
ntelligent Systems in Med			Lecture	2	3
ntelligent Systems in Med ntelligent Systems in Med			Project Seminar Recitation Section (small)	2	2
			Recitation Section (Smail)	1	-
	Prof. Alexander Schla	leier			
Admission Requirements	None				
Recommended Previous Knowledge	 principles of math (algebra, analysis/calculus) principles of stochastics principles of programming, Java/C++ and R/Matlab advanced programming skills 				
Educational Objectives	After taking part succe	essfully, students have re	eached the following lea	rning resul	Its
Professional Competence					
·	The students are able to analyze and solve clinical treatment planning and decision suppor problems using methods for search, optimization, and planning. They are able to explain methods for classification and their respective advantages and disadvantages in clinica 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 discus incoorporate feedbac	ss the results of othe k into their work.	r groups, provide help	oful feedb	ack and ca
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 Ti	me 110, Study Time in L	ecture 70		
Credit points	6				
Studienleistung	Compulsory Bonus Yes 10 % Yes 10 %	Form Written elaboration Presentation	Descriptic า	on .	
Examination	Written exam				
Examination duration and scale	90 minutes				
	Electrical Engineering	pecialisation Intelligence g: Specialisation Medica ce and Engineering: Sp	I Technology: Elective C	ompulsory	1



Assignment for the Following Curricula	Riomadical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory - I
	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: Intelligent 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	



Courses				
Title		Тур	Hrs/wk	СР
	ents and Cognitive Robotics (L0341)	Lecture	2	4
ntelligent Autonomous Ag	ents and Cognitive Robotics (L0512)	Recitation Sectio	n (small) 2	2
Module Responsible	Rainer Marrone			
Admission Requirements	None			
Recommended Previous Knowledge	Vectors, matrices, Calculus			
Educational Objectives	After taking part successfully, students h	ave reached the follow	wing learning resu	lts
Professional Competence				
Knowledge	Students can explain the agent abstract and give details about agent design (grain features of environments. The noting in terms of decision problems and algorized uncertainty in real-world scenarios, studemployed as a knowledge representate settings. In addition, students can describe technique problems, and they can recall technique identify techniques for simultaneous letter techniques for achieving desired states decision making in a multi-agent setting functions, voting protocol, and mechanism Students can select an appropriate scenarios. For simplified agent application optimization techniques. For those networks/dynamic Bayesian networks Students can also name and apply scenarios. For simple and complex decisions	goals, utilities, enviror on of adversarial ager or on of adversarial ager or of adversarial ager or of adversarial ager or of adversarial ager or and reasoning for efine decision making plete access to the same of a solving (partials for measuring the value of a solving and mappers. Students can explor or of different to make agent architecture from students can derive applications they and apply bayesian different sampling to	nments). They can not cooperation car ese problems. Fo how Bayesian neormalism in staticing procedures in state of the envirous end envirous end envirous end envirous end envirous end envirous end envirous en	n describe the bediscussed or dealing with tworks can be and dynamic and comment. In this arkov decision. Students can plain planning problems and problems and apply basic ate Bayesian mple queries applified agent.
Chine	policies for concrete settings. In multi finding different equilibria states,e.g., students will apply different voting proto-	-agent situations stud Nash equilibria. Fo	dents will apply t or multi-agent de	techniques fo cision makin
Personal Competence				
Social Competence	Students are able to discuss their solu	tions to problems wit	th others. They co	ommunicate i
Autonomy	Students are able of checking their understanding of complex concepts by solving varaints o concrete problems			
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Studienleistung	None			
Eveninetien	Written exam			
Examination	willen exam			



and scale	
Assignment for the Following Curricula Following Curricula Bion Bion Com Bion Com Thee	mputer Science: Specialisation Intelligence Engineering: Elective Compulsory mputational Science and Engineering: Specialisation Systems Engineering and Robotics: ctive Compulsory mustional Production Management: Specialisation Production Technology: Elective mustional Management and Engineering: Specialisation II. Information Technology: ctive Compulsory chatronics: Technical Complementary Course: Elective Compulsory medical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective mpulsory medical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory medical Engineering: Specialisation Medical Technology and Control Theory: Elective mpulsory medical Engineering: Specialisation Management and Business Administration: Elective mpulsory erretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory erretical Mechanical Engineering: Specialisation Numerics and Computer Science: ctive Compulsory



Тур	Lecture		
Hrs/wk			
СР			
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, Minin algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environme probabilities, conditional probabilities, product rule, Bayes rule, full joint probab distribution, marginalization, summing out, answering queries, complex independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference enumeration), typical-case complexity, pragmatics: reasoning from effect (that can 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, dynai Bayesian networks, Markov assumption, transition model, sensor model, inferer problems: filtering, prediction, smoothing, most-likely explanation, special cashidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decis networks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteratif MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MD 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, Gibba Satterthwaite Impossibility Theorem, Direct mechanisms, expe		
Literature	 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Non-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, Yo 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

Compulsory



Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) **Courses** Title Hrs/wk CP Typ Seminar Nature's Hierarchical Materials (L1663) 3 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Lecture 3 4 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Recitation Section (small) 2 2 (L1877)2 Development and Regulatory Approval of Implants (L1588) Lecture 3 Experimental Methods for the Characterization of Materials (L1580) Lecture 2 3 2 Numerical Methods in Biomechanics (L1583) Seminar 3 Seminar Biomedical Engineering (L1890) Seminar 2 3 Six Sigma (L1130) Lecture 2 3 2 Fluid Mechanics II (L0001) Lecture 4 Ceramics Technology (L0379) Lecture 2 3 Module Responsible Prof. Michael Morlock Admission None Requirements Recommended **Previous Knowledge** Educational After taking part successfully, students have reached the following learning results **Objectives Professional** Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses **Credit points** Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Assignment for the Biomedical Engineering: Specialisation Management and Business Administration: Elective **Following Curricula** Compulsory

Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective



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			
	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: Introdu	ction 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			
Examination duration and scale	30 min		
	Prof. Christian Schuster		
Language			
Cycle			
Content	MiSe This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC) for graduate engineering students that do not have a formal background in electrical engineering. 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 - 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	Typ Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form		
Examination duration and scale	30 min	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1588: Develo	pment and Regulatory Approval of Implants		
Тур	_ecture		
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-iminternet.de/mpg/BJNR196300994.html 		



Course L1580: Experimental Methods for the Characterization of Materials			
Тур	Lecture		
Hrs/wk			
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
Examination duration and scale	90 min		
Lecturer	Prof. Patrick Huber		
Language	DE/EN		
Cycle	SoSe		
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: Numer	ical Methods in Biomechanics		
Тур	Seminar		
Hrs/wk			
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		
СР	3	
Workload in Hours	ndependent 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 Sig	ma		
Тур	Lecture		
Hrs/wk			
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
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 M	echanics II		
Тур	Lecture		
Hrs/wk			
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Examination Form	Klausur		
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 technischer 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 Strömungsvorgängedichtebeständiger 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 L0379: Ceramics Technology			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
Examination duration and scale	90 Minuten		
Lecturer	Dr. Rolf Janßen		
Language	DE/EN		
Cycle	WiSe		
	Introduction to ceramic processing with emphasis on advanced structural cer course focus predominatly on powder-based processing, e.g. "powder-method techniques and sintering (soild state and liquid phase). Also, some aspects of cement science as well as new developments in powderless forming techniques and ceramic composites will be addressed Examples will be discussed in or engineering students an understanding of technology development and specific a 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 t	o 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		

Following Curricula

Compulsory

Compulsory



Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) **Courses** Title Hrs/wk CP Typ Seminar Nature's Hierarchical Materials (L1663) 3 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Lecture 3 4 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Recitation Section (small) 2 2 (L1877)Development and Regulatory Approval of Implants (L1588) 2 Lecture 3 Experimental Methods for the Characterization of Materials (L1580) Lecture 2 3 2 Numerical Methods in Biomechanics (L1583) Seminar 3 Seminar Biomedical Engineering (L1890) Seminar 2 3 Six Sigma (L1130) Lecture 2 3 2 Fluid Mechanics II (L0001) Lecture 4 Ceramics Technology (L0379) Lecture 2 3 Module Responsible Prof. Michael Morlock Admission None Requirements Recommended **Previous Knowledge** Educational After taking part successfully, students have reached the following learning results **Objectives Professional** Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses **Credit points** Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Assignment for the Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective

Biomedical Engineering: Specialisation Management and Business Administration: Elective



Course L1663: Nature's Hierarchical Materials				
Тур	Seminar			
Hrs/wk				
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 Literature Journal publications			



Course L1669: Introdu	ction 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	30 min			
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) for graduate engineering students that do not have a formal background in electrical engineering. 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 - 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		
	Mündliche Prüfung		
Examination duration and scale	30 min		
Lecturer	Prof. Christian Schuster		
Language	DE/EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1588: Develo	pment and Regulatory Approval of Implants		
Тур	Lecture		
Hrs/wk			
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
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-iminternet.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			
Examination duration and scale	90 min		
Lecturer	Prof. Patrick Huber		
Language	DE/EN		
Cycle	SoSe		
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	ndependent Study Time 62, Study Time in Lecture 28			
Examination Form				
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: Semina	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	I schriftliche ausarbeitung und Vortrag (20 min)		
Lecturer	Prof. Michael Morlock		
Language	DE		
Cycle	WiSe		
Content			
Literature	Keine		



Course L1130: Six Sig	ma		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28		
Examination Form			
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 M	echanics II		
Тур	Lecture		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and scale			
Lecturer	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 L0379: Ceram	ics Technology			
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Examination Form				
Examination duration and scale	90 Minuten			
	Dr. Rolf Janßen			
Language	DE/EN			
Cycle	WiSe			
	Introduction to ceramic processing with emphasis on advanced structural ceramics. To course focus predominatly on powder-based processing, e.g. "powder-metauurgi techniques and sintering (soild state and liquid phase). Also, some aspects of glass a cement science as well as new developments in powderless forming techniques of ceram and ceramic composites will be addressed Examples will be discussed in order to gengineering students an understanding of technology development and specific application 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 Ce	ramic Engineering", Marcel Decker, New York, 1992		
	Skript zur Vorlesung			



Courses						
Title	(1.222)		Тур	Hrs/wk	CP	
Microsystem Engineering	(L0680)		Lecture Project-/problem-based	2	4	
Microsystem Engineering	(L0682)		Learning	2	2	
Module Responsible	Prof. Manfred Kasper					
Admission Requirements	None					
Recommended Previous Knowledge	Lacio collicae in phycios	s, mathematics and e	lectric engineering			
Educational Objectives	After taking part success	sfully, students have r	eached the following lea	arning resul	Its	
Professional Competence						
Knowledge	The students know about their applications in sens		technologies and mate	rials of ME	MS as well	
Skills		Students are able to analyze and describe the functional behaviour of MEMS components and to evaluate the potential of microsystems.				
Personal Competence						
Social Competence	Students are able to so accordingly.	Students are able to solve specific problems alone or in a group and to present the result accordingly.				
i	Students are able to acquire particular knowledge using specialized literature and to integrat and associate this knowledge with other fields.					
Autonomy				literature a	nd to integra	
		ledge with other field	s.	literature a	nd to integra	
	and associate this know Independent Study Time	ledge with other field	s.	literature a	nd to integra	
Workload in Hours	and associate this know Independent Study Time 6 Compulsory Bonus	ledge with other field	s.		nd to integra	
Workload in Hours Credit points Studienleistung Examination	and associate this know Independent Study Time 6 Compulsory Bonus No 10 % Written exam	ledge with other field e 124, Study Time in I	s. _ecture 56		nd to integra	
Workload in Hours Credit points Studienleistung	and associate this know Independent Study Time 6 Compulsory Bonus No 10 % Written exam	ledge with other field e 124, Study Time in I Form Presentation	s. _ecture 56 Descriptio		nd to integra	



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

Тур	Lecture			
Hrs/wk	2			
СР				
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28			
Lecturer	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: \	'ibration Theory				
Courses					
Title Vibration Theory (L0701)	Typ Hrs/wk CP Integrated Lecture 4 6				
Module Responsible	Prof. Norbert Hoffmann				
Admission Requirements	INONE				
Recommended Previous Knowledge	 Calculus Linear Algebra Engineering Mechanics 				
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 furthe				
Skills	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					
Studienleistung					
	Written exam				
Examination duration and scale	2 Hours				
	Energy Systems: Core qualification: Elective Compulsory Computational Science and Engineering: Specialisation Scientific Computing: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: 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: Compulsory Naval Architecture and Ocean Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: 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	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 M0768: N	/licrosystems Tech	nology in Theo	ry and Practice		
Courses					
Title			Тур	Hrs/wk	СР
Microsystems Technology	y (L0724)		Lecture	2	4
Microsystems Technology	y (L0725)		Project-/problem-based Learning	2	2
Module Responsible	Prof. Hoc Khiem Trieu				
Admission Requirements	None				
Recommended Previous Knowledge	Basics in physics, chemis	stry, mechanics and s	emiconductor technolo	gy	
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional					
Competence					
	to present and to explain current fabrication techniques for microstructures and especially methods for the fabrication of microsensors and microactuators, as well as the integration thereof in more complex systems				
Knowledge	• to explain in details o	peration principles of	microsensors and micr	roactuators	and
	to discuss the potential and limitation of microsystems in application.				
	Students are capable				
	to analyze the feasibi	lity of microsystems,			
	to develop process flows for the fabrication of microstructures and				
Skills	to apply them.				
Personal Competence					
Social Competence	Students are able to pre present and discuss the r			team work	as well as t
Autonomy	None				
Workload in Hours	Independent Study Time	124, Study Time in Lo	ecture 56		
Credit points	6				
	Compulsory Bonus	Form	Description Studiereno Kleingrup	den fi	ühren ir aborpraktikun
	l	[297]			



Studienleistung	Yes None	Subject theore practical work	etical and durch. Jede Gruppe präsentiert und diskutiert die Theorie sowie die Ergebniise ihrer Labortätigkeit. vor dem gesamten Kurs.
Examination			
Examination duration and scale	30 min		
Assignment for the Following Curricula	Elective Compulsory Electrical Engineering: Computational Science Elective Compulsory International Manage Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory	Specialisation Medicale and Engineering: Specialisation Artification Specialisation Implance: Specialisation Medicale and Engineering: Specialisation Medicale Specialisation Medicale Specialisation Marting: Specialisation	noelectronics and Microsystems Technology: Il Technology: Elective Compulsory recialisation Systems Engineering and Robotics: Ing: Specialisation II. Mechatronics: Elective rotal Organs and Regenerative Medicine: Elective rates and Endoprostheses: Elective Compulsory rdical Technology and Control Theory: Elective reagement and Business Administration: Elective relification: Elective Compulsory

 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, cryc 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) 		microelectronics and microsystems: Core qualification: Elective Compulsory
Typ Lecture Hrs/wk 2 CP 4 Workload in Hours Independent Study Time 92, Study Time in Lecture 28 Lecturer Prof. Hoc Khiem Trieu Language EN Cycle WiSe 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, cryc 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)	Course L0724: Micros	ystems Technology
Hrs/wk 2 CP 4 Workload in Hours Independent Study Time 92, Study Time in Lecture 28 Lecturer Prof. Hoc Khiem Trieu Language EN Cycle WiSe • 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, cryc 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)		
Lecturer Prof. Hoc Khiem Trieu		
Language EN Cycle 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, cryc 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, SUB, 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)	СР	4
Language EN Cycle WiSe 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, cryc 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)	Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
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, cryc 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)	Lecturer	Prof. Hoc Khiem Trieu
 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, cryc 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) 	Language	EN
 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, cryc 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) 	Cycle	WiSe
piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor operating principle and fabrication process)	Comtont	 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; 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:



- 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, topdown 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-onboard, 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

Literature

N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009

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
Finite Element Methods (L Finite Element Methods (L	·		Lecture Recitation Section (large)	2	3 3
Module Responsible			Trockation Gootion (large)	_	
Admission					
Requirements	None				
Recommended Previous Knowledge			als) and Mechanics II (Fequations)	Hydrostatics	s, Kinematic
Educational Objectives	LAffer taking part success	fully, students have	reached the following lea	rning resul	ts
Professional Competence					
Knowledge	The students possess a method and are able t method.	·	ge regarding the derivat of the theoretical and		
Skills	elements, assembling the equations.	-	neering problems by fo stem matrices, and solvin	_	
Personal Competence					
Social Competence	Students can work in sm	iall groups on specif	ic problems to arrive at joi	int solution	S.
Autonomy	develop own finite elem scrutinized.		solve challenging comp ms can be identified and		
Workload in Hours	Independent Study Time	e 124, Study Time in	Lecture 56		
Credit points	6				
Studienleistung	Compulsory Bonus No 20 %	Form Midterm	Description	on	
Examination	Written exam				
Examination duration and scale	1 120 min				
unu scale	Civil Engineering: Core of Energy Systems: Core of Aircraft Systems Engineer	ualification: Elective ering: Specialisation	-	•	-



	Computational Science and Engineering: Specialisation Scientific Computing: Elective
	Compulsory
	International Management and Engineering: Specialisation II. Mechatronics: Elective
	Compulsory
	International Management and Engineering: Specialisation II. Product Development and
	Production: Elective Compulsory
Assignment for the	Mechatronics: Core qualification: Compulsory
	Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective
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	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 Technomathematics: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Compulsory

Course L0291: Finite E	nite 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
Technology Management	(L0849)	Project-/problem-based Learning	3	3
Technology Management	Seminar (L0850)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous Knowledge	Bachelor knowledge in business mana	gement		
Educational Objectives	After taking part successfully, students h	nave reached the following lea	arning resu	lts
Professional Competence				
Knowledge	Students will gain deep insights into: • Technology Timing Strategies • Technology Strategies a • Technology Intelligence • Technology Portfolio Manageme • Technology Portfolio Me • Technology Acquisition a • IP Management • Organizing Technology Develop • Technology Organization • Technology Funding & Co	ent thodology and Exploitation oment n & Management		
Skills	 Develop an understanding of national as well as international Equip students with an un Management (strategic, operati Foster a strategic orientation to as Technology Management an Clarify activities of Technology and exploitation) Strengthen essential communic organizational and financial iss management. Further topics to be Basic concepts, models and to and innovation Innovation as a process (steps, steps, ste	level derstanding of important el onal, organizational and proce problem-solving within the in d its importance for corporate Management (e.g. technolog eation skills and a basic unde sues concerning Technology be discussed include: ols, relevant to the manager	ements o ess-related novation p strategy y sourcing erstanding o	f Technolog aspects) rocess as we , maintenand of manageria on- and R&E
Personal Competence				
Social Competence	Interact within a teamRaise awareness for globabl iss	ues		
Autonomy	Gain access to knowledge sourceInterpret complicated cases	ces		



	Develop presentation skills
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Studienleistung	None
	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	Global Innovation Management: Core qualification: Compulsory 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 L0849: Techno	ology 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 Incovation Management, Elgar Research Collection, Northhampton (MA) 2011

Course L0850: Techno	50: Technology 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	Aspects of and Cases in combination with the content of the lecture.		
Literature	see lecture Technology Management.		



	Control Systems Theory ar			
Courses				
Title	I D ' /I 0050)	Тур	Hrs/wk	CP
Control Systems Theory a Control Systems Theory a		Lecture Recitation Section (small)	2	4 2
	Prof. Herbert Werner	, ,		
Admission				
Requirements	None			
Recommended Previous Knowledge	Introduction to Control Systems			
Educational Objectives	After taking part successfully, stude	nts have reached the following lea	rning resu	Its
Professional Competence				
Knowledge	models; they can interpret the trajectories in state space They can explain the syst relationship to state feedbace They can explain the significe. They can explain observer-tracking and disturbance rejectory. They can extend all of the authors. They can explain the z-trans. They can explain state spansystems They can explain the expension of the expension of the expension.	linear dynamic systems are repries system response to initial states em properties controllability and ack and state estimation, respectivel cance of a minimal realisation based state feedback and how it ection cove to multi-input multi-output system and its relationship with the Lace models and transfer function rimental identification of ARX moderoblem can be solved by solving a late space model can be construction.	or externation observaby can be used terms aplace Transelels of dynamical equals of d	al excitation as ility, and thein sed to achieve ansform f discrete-time amic systems uation
Skills	versa They can assess controllabi They can design LQG control They can carry out a cordomain, and decide which is They can identify transfer fur from experimental data	nsfer function models into state and observability and construction blers for multivariable plants at the stroller design both in continuous appropriate for a given sampling anction models and state space modes tasks using standard softwar on Toolbox, Simulink)	t minimal r s-time and rate dels of dyr	ealisations discrete-time
Personal Competence				
Social Competence	Students can work in small groups	on specific problems to arrive at joi	nt solution	S.
	Students can obtain information documentation, experiment guides)	•		tes, software
Autonomy	They can assess their knowledge progress.	in weekly on-line tests and there	by control	their learning



Workload in Hours
Credit points
Studienleistung
Examination
Examination duration and scale
Assignment for the Following Curricula



-				
	Lecture			
Hrs/wk				
CP				
	Independent Study Time 92, Study Time in Lecture 28			
	Prof. Herbert Werner			
Language				
Cycle				
	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 page 4.			
	• 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			
Content				
	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			
	Werner, H., Lecture Notes "Control Systems Theory and Design" T. Keileth "Linear Systems", Propries Hell, 1989.			
Literature	T. Kailath "Linear Systems", Prentice Hall, 1980 K. L. Astrono, B. Wittenmark "Compartor Controlled Systems", Prontice Hall, 1997.			
	K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997 L. Liung "System Identification, Theory for the Light" Prentice Hall, 1999			
	 L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999 			

Course L0657: Contro	ourse 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	



Module M0867: F	Production Planning & Con	trol and Digital Enterpris	se	
Courses				
Title		Тур	Hrs/wk	СР
The Digital Enterprise (L0	932)	Lecture	2	2
Production Planning and (Lecture	2	2
Production Planning and (Recitation Section (small)		1
Exercise: The Digital Ente	,	Recitation Section (small)	1	1
-	Prof. Hermann Lödding			
Admission Requirements	INOne			
Recommended Previous Knowledge	Fundamentals of Production and Qua	ality Management		
Educational Objectives	After taking part successfully, student	ts have reached the following lea	rning resu	Its
Professional Competence				
Knowledge	Students can explain the contents of	the module in detail and take a c	ritical posit	tion to them.
Skills	Students are capable of choosing a industrial problems.	and applying models and methor	ods from t	the module t
Personal	, 			
Competence				
-	Students can develop joint solutions	in mixed teams and present them	n to others.	
Autonomy		·		
	Independent Study Time 96, Study Ti	me in Lecture 84		
Credit points	6			
Studienleistung	None			
	Written exam			
Examination duration and scale	180 Minuten			
	International Management and Englishment Production: Elective Compulsory			·
	Logistics, Infrastructure and Mobil	ity: Specialisation Production	and Logi	stics: Electiv
	Compulsory Biomedical Engineering: Specialisat	ion Artificial Organs and Regene	rative Med	licina: Flactiv
Assignment for the Following Curricula	Compulsory	ion Artificial Organs and Negerie	ialive ivieu	iiciiie. Liectiv
	Biomedical Engineering: Specialisati	on Implants and Endoprostheses	s: Elective	Compulsory
	Biomedical Engineering: Specialisa	tion Medical Technology and (Control Th	eory: Electiv
	Compulsory			
	Biomedical Engineering: Special	isation Management and Bu	usiness <i>F</i>	Administratio
	Compulsory Product Development, Materials a	and Production: Specialisation	Product	Develonmen
	Elective Compulsory			_ 0.010p111011
	Product Development, Materials and	•		
	Product Development, Materials	and Production: Specialisation	on Mater	ials: Elective
	Compulsory	v. Charialination Draduct David	anmont s	ad Dradiiatia
	Theoretical Mechanical Engineering Elective Compulsory	J. Specialisalion Product Develo	opinent ar	iu Production
	Theoretical Mechanical Engineering	: Technical Complementary Cour	se: Electiv	e 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	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)	
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	ecture		
Hrs/wk			
СР			
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	Typ 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	



Courses				
Title		Тур	Hrs/wk	СР
Electronic Circuits for Med		Lecture	2	3
Electronic Circuits for Med Electronic Circuits for Med		Recitation Section (small) Practical Course	1	2 1
Module Responsible	Prof. Matthias Kuhl			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of electrical engineering			
Educational Objectives	After taking part successfully, students l	nave reached the following lea	rning resul	ts
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 its propagation along an axon Students can exemplify the communication between neurons and electronic 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 implants and artificial eyes 			
Skills	 Students can calculate the time dependent voltage behavior of an action potential Students can give scenarios for further improvement of low-noise and low-powe signal acquisition. Students can develop the block diagrams of prosthetic systems Students can define the building blocks of electronic systems for an articifial eye. 			
Personal Competence				
Social Competence	 Students are trained to solve together with experts with difference of the right time. 	ent professional background. te their specific limitations, so ork in a clear manner and com	o that the	y can ask fo
Autonomy	 Students are able to realistica actions for improvements when Students can break down their work in a realistic way. Students can handle the compleneeding support. 	necessary. work in appropriate work pack	ages and	schedule the



	Students are all experimental wo		a responsible	manner in	all cases and situations of
Workload in Hours	Independent Study Time	e 124, Study T	ime in Lecture	56	
Credit points	6				
	Compulsory Bonus	Form		Descri	ption
Studienleistung	No None	Subject practical w	theoretical ork	and	
	No 20 %	Excercises	3		
Examination	Oral exam				
Examination duration and scale	140 min				
Assignment for the Following Curricula	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				



Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	ndependent 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 Fring (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: Electro	ourse 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	Cycle WiSe	
Content	See interlocking course	
Literature	See interlocking course	



Course L1408: Electronic Circuits for Medical Applications				
Typ Practical Course				
Hrs/wk				
СР				
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/			



Courses				
Title		Тур	Hrs/wk	СР
Continuum Mechanics (L1		Lecture	2	3
Continuum Mechanics Ex	ercise (L1534)	Recitation Section (small)	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous Knowledge	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).			
Educational Objectives	After taking part successfully, students have	reached the following lea	rning result	ts
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 and aspects, both in applied contexts as in resea		nation theo	ry to specifi
Personal Competence				
Social Competence	The students are able to develop solutions, to develop ideas further.	o present them to special	ists in writte	en form and t
Autonomy	The students are able to assess their independently and on their own identify mechanics and acquire the knowledge requi	and solve problems in		-
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Computational Science and Engineering Compulsory Materials Science: Specialisation Modeling: Mechanical Engineering and Management: Mechatronics: Technical Complementary Co Biomedical Engineering: Specialisation Artif Compulsory Biomedical Engineering: Specialisation Impl Biomedical Engineering: Specialisation Mechanical Engineering: Specialisation Mechanical Engineering: Specialisation Mechanical Engineering: Specialisation Machanical Enginee	Elective Compulsory Specialisation Materials: lurse: Elective Compulsor icial Organs and Regene ants and Endoprostheses edical Technology and O	Elective Co ry rative Medi s: Elective C Control The	mpulsory cine: Electiv Compulsory eory: Electiv



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

Theoretical Mechanical Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L1533: Continu	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/EN	
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: Continuum 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/EN	
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 M1151: N	Material Modeling			
Courses				
Title		Тур	Hrs/wk	СР
Material Modeling (L1535) Material Modeling (L1536)		Lecture Recitation Section (small)	2	3 3
		ricolation ocolion (smail)		
Admission	Prof. Christian Cyron			
Requirements	INone			
	Basics of linear and nonlinear continuum Mechanics II and Continuum Mechanics (for strain, free-body principle, linear and nonlinear	ces and moments, stre	ss, linear a	
Educational Objectives	After taking part successfully, students have re	eached the following lea	rning resul	ts
Professional Competence				
Knowledge	The students can explain the fundamentals of	multidimensional consit	tutive mate	rial laws
Skills	The students can implement their own materi students can apply their knowledge to various corresponding material models.			•
Personal				
Competence	! !			
Social Competence	The students are able to develop solutions, ideas further.	to present them to spe	ecialists ar	ia to develo
Autonomy	The students are able to assess their independently and on their own identify and sand acquire the knowledge required to this en	solve problems in the are		-
Workload in Hours	I	ecture 56		
Credit points	<u> </u>			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Computational Science and Engineering: Compulsory Materials Science: Specialisation Modeling: E Mechanical Engineering and Management: S Biomedical Engineering: Specialisation Artific Compulsory Biomedical Engineering: Specialisation Impla Biomedical Engineering: Specialisation Med Compulsory Biomedical Engineering: Specialisation Man Compulsory Product Development, Materials and Production	lective Compulsory pecialisation Materials: I pecialisation Materials: I pecial Organs and Regene and Endoprostheses dical Technology and Cagement and Business	Elective Co rative Med s: Elective (Control The Administra	empulsory icine: Elective Compulsory eory: Elective ation: Elective



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/EN	
Cycle	WiSe	
Content	 fundamentals of finite element methods fundamentals of material modeling introduction to numerical implementation of material laws overview of modelling of different classes of materials combination of macroscopic quantities to material microstructure 	
Literature	D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge G. Gottstein., Physical Foundations of Materials Science, Springer	

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/EN	
Cycle	WiSe	
Content	 fundamentals of finite element methods fundamentals of material modeling introduction to numerical implementation of material laws overview of modelling of different classes of materials combination of macroscopic quantities to material microstructure 	
Literature	D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge G. Gottstein., Physical Foundations of Materials Science, Springer	



Module M1100: A	Advanced Functional Materials			
Module Wil 199. A	idvanced Functional materials			
Courses				
Title		Тур	Hrs/wk	СР
Advanced Functional Mate	erials (L1625)	Lecture	2	6
Module Responsible	Prof. Patrick Huber			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in Materials Science, e.g. N	laterials Science I/II		
Educational Objectives	After taking part successfully, students have r	eached the following lea	rning result	S
Professional				
Competence	The shidents will be able to the state of	ana andra a constant and a second		
Knowledge	The students will be able to explain the purapplications in technology, in particular metal composite materials (biomaterials) and nano	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 microto the macroscale. The students will also gain an overview on modern materials science which enables them to select optimum materials combinations depending on the technica applications.			
Personal				
Competence				
Social Competence	The students are able to present solutions to	specialists and to develo	p ideas furt	her.
	The students are able to			
Autonomy				
Workload in Hours	Independent Study Time 152, Study Time in I	_ecture 28		
Credit points				
Studienleistung	None			
Examination	Presentation			
Examination duration and scale	30 min			
Assignment for the Following Curricula	Materials Science: Core qualification: Compulsory Mechanical Engineering and Management: Specialisation Materials: 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 Materials Science: Elective Compulsory			



Course L1625: Advance	Course L1625: Advanced Functional Materials	
Тур	Lecture	
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/EN	
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	Wird in der Veranstaltung bekannt gegeben	



Courses				
Fitle ntroduction to Biochemisi	try and Molecular Biology (L0386)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, students	have reached the follow	ing learning resu	lts
Professional Competence				
Knowledge	describe basic biomolecules; explain how genetic information explain the connection between			
Skills	The students can recognize the importance of mo describe selected molecular-di explain the relevance of these	agnostic procedures;		ease;
Personal Competence				
Social Competence		sions in research and me	edicine on a techr	ical level.
Autonomy	The students can develop understand by themselves.	ling of topics from the co	ourse, using techr	nical literature
Workload in Hours	Independent Study Time 62, Study Tim	ne in Lecture 28		
Credit points	3			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	160 minutes			
	General Engineering Science (Germ Focus Biomechanics: Compulsory General Engineering Science (Germ Compulsory General Engineering Science (Germ Engineering: Compulsory General Engineering Science (Germ General Engineering Science (Germ General Engineering Science (Germ Germ Focus F	nan program): Specialis	ation Biomedical	Engineering



Engineering: Compulsory
Mechanical Engineering: Specialisation Biomechanics: 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: Core qualification: 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: E	BIO I: Implants and Fracture Healing
Courses	
Title Implants and Fracture He	Typ Hrs/wk CP aling (L0376) Lecture 2 3
Module Responsible	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous Knowledge	It is recommended to participate in "Introduction into Anatomie" before attending "Implants an Fracture Healing".
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can describe the different ways how bones heal, and the requirements for the existence. The students can name different treatments for the spine and hollow bones under give fracture morphologies.
Skills	The students can determine the forces acting within the human body under quasi-stati situations under specific assumptions.
Personal Competence	
Social Competence	The students can, in groups, solve basic numerical modeling tasks for the calculation c internal forces.
Autonomy	The students can, in groups, solve basic numerical modeling tasks for the calculation c internal forces.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Studienleistung	None
Examination	Written exam
Examination duration and scale	90 min
	General Engineering Science (German program): Specialisation Mechanical Engineering Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering Compulsory
Assignment for the Following Curricula	General Engineering Science (English program): Specialisation Mechanical Engineering Focus Biomechanics: 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 Mechanical Engineering: Specialisation Biomechanics: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Electiv



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
Technomathematics: Specialisation III. Engineering Science: Elective Compulsory



ourse L0376: Implan	ts and Fracture Healing		
	Lecture		
Hrs/wk			
CP			
	Independent Study Time 62, Study Time in Lecture 28 Prof. Michael Morlock		
Language			
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		
	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.: Orthonädischa Riamachanik		
	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		
Literature	Nigg, B.: Biomechanics of the musculo-skeletal system		
	Schiebler T.H., Schmidt W.: Anatomie		
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat		



Module M1334: E	BIO II: Biomaterials			
Courses				-
Title Biomaterials (L0593)		Typ Lecture	Hrs/wk	CP 3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of orthopedic and	surgical techniques is recom	nmended.	
Educational Objectives	After taking part successfully, studen	its have reached the following	ng learning resul	ts
Professional Competence				
•	The students can describe the mate medical engineering, and their fields		d the materials	being used in
Skills	The students can explain the advant	tages and disadvantages of	different kinds o	f 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			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	International Management and Er Biotechnology: Elective Compulsory Materials Science: Specialisation Na Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Compulsory Theoretical Mechanical Engineering Theoretical Mechanical Engineering Compulsory	ano and Hybrid Materials: El tion Artificial Organs and Re tion Implants and Endoprost ation Medical Technology ation Management and Bus g: Technical Complementary	ective Compulso egenerative Med heses: Compuls and Control Th iness Administra Course: Elective	ory icine: Elective ory eory: Elective ation: Elective e Compulsory

Course L0593: Biomaterials	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28



Lecturer Language	Prof. Michael Morlock EN		
Cycle	WiSe		
	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. Berlin, Springer,
	1996.



0					
Courses Title	of Delumera (LOSOO)	Typ Lecture	Hrs/wk	СР	
Structure and Properties or Processing and design with the state of the structure of the s		Lecture	2 2	3 3	
Module Responsible	Dr. Hans Wittich				
Admission Requirements	INone				
Recommended Previous Knowledge	I Raeice, cuemietry / puncice / material er	cience			
Educational Objectives	After taking part successfully, students	have reached the follow	ring learning resu	Its	
Professional Competence					
	Students can use the knowledge of pla	stics and define the nec	essary testing and	d analysis.	
	They can explain the complex relations	ships structure-property	relationship and		
Knowledge	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 stiffness, corrosion resistance.	mechanical recycling	problems and si	zing exampl	
Personal Competence					
	Students can				
	- arrive at funded work results in hetero	genius groups and doc	ument them.		
Social Competence	- provide appropriate feedback and ha	ndle feedback on their c	wn performance o	constructively	
	Students are able to				
	- assess their own strengths and weak	nesses.			
Autonomy	- assess their own state of learning in specific terms and to define further work steps on thi basis.				
	- assess possible consequences of the	ir professional activity.			
Workload in Hours	Independent Study Time 124, Study Ti	me in Lecture 56			
Credit points	ļ .				
Studienleistung					
	Written exam				
Examination duration and scale	I 18() min				



	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
Assignment for the	
Following Curricula	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	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	
Content	- Structure and properties of polymers - Structure of macromolecules Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution - Morphology amorph, crystalline, blends - Properties Elasticity, plasticity, viscoelacity - Thermal properties - Electrical properties - Theoretical modelling - Applications	
Litoroturo	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag	
Literature	Linenstein. Fulymer-werkstone, Can 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	



ourses					
itle			Тур	Hrs/wk	СР
egenerative Medicine (LC ecture Tissue Engineerin	347) g - Regenerative Medicine	(I 1664)	Seminar Seminar	2 2	3 3
Module Responsible		(2.00.)	- Communication		
Admission					
Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part succes	sfully, students have r	eached the follow	ing learning resu	lts
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 o tissue engineering. They are able to give a basic overview of methods for the cultivation o 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. After successful completion of the module students are able to use medical databases for acquirierung and presentation of relevant up-to-da				
Skills	data independently • able to present their work results in the form of presentations				
Personal					
Competence					
	Students are able to v discuss their results in t	•		lents to solve giv	ven tasks aı
Social Competence	Students are able to reflect their work orally and discuss it with other students and teachers.				
	After completion of this module, participants will be able to solve a technical problem in teams of approx. 2-4 persons independently including a presentation of the results.				
Workload in Hours	Independent Study Tim	e 124, Study Time in I	_ecture 56		
Credit points	6				
Studienleistung	Compulsory Bonus Yes 20 %	Form Written elaboratio	n Aus	scription arbeitung zu Rin ocol for lecture se	-
			•		



	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:
Assignment for the	Compulsory
	Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective
	Compulsory

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/EN				
Cycle	cle WiSe				
Content	The course deals with the application of biotechnological engineering principles for regeneration 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 M0548: E	Bioelectromagneti	cs: Principles ar	nd Applications					
Courses								
Title Bioelectromagnetics: Principles and Applications (L0371) Bioelectromagnetics: Principles and Applications (L0373)		•	Typ Lecture Recitation Section (small)	Hrs/wk 3	CP 5			
	Prof. Christian Schuster	,	Trockation Gooden (email)		•			
Admission Requirements								
Recommended Previous Knowledge	Basic principles of physics							
Educational Objectives	I Affer taking hart successium, students have reached the following learning results							
Professional Competence								
Knowledge	They can give examples for therapeutic and diagnostic utilization of electromagnetic fields in medical technology.							
Skills	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 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	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).							
Social Competence		F (gg						
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	e 110, Study Time in Lo	ecture 70					
Credit points								
Studienleistung	Compulsory Bonus Yes 10 %	Form Presentation	Descriptio	n				



Examination	
Examination duration and scale	45 min
Assignment for the Following Curricula	I Riomedical Endineering, Specialisation implants and Endonrostheses, Flective Compilisory - I



Course L0371: Bioelec	ctromagnetics: 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	SoSe
	- 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
	- 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)
	- 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: Bioeled	ctromagnetics: Principles and Applications			
Тур	Recitation Section (small)			
Hrs/wk	2			
СР	1			
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28			
	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			
	- 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)			
	- 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)			



Courses						
Title				Тур	Hrs/wk	СР
Robotics and Navigation in Medicine (L0335)				Lecture	2	3
Robotics and Navigation in Medicine (L0338) Robotics and Navigation in Medicine (L0336)				Project Seminar Recitation Section (small)	2	2 1
Module Responsible	•		or.	riconanon cocher (email)	•	·
Admission		Jer Ocmaen	51			
Requirements	None					
Recommended Previous Knowledge	• princi	•	h (algebra, analysis/c gramming, e.g., in Jav o skills	•		
Educational Objectives	I Affer takına n	art success	sfully, students have re	eached the following lea	rning resul	its
Professional Competence						
·	The students systems and	I their comp d safety an	onents in detail. Sys	acking systems in clinica stems can be evaluated nts can assess typical sy	with respe	ect to collision
Skills	The students are able to design and evaluate navigation systems and robotic systems for medical applications.					
Personal Competence						
Social Competence	The student incoorporate	s discuss feedback ii	the results of othe nto their work.	r groups, provide help	oful feedb	ack and ca
Autonomy			et their knowledge an appropriate manner.	nd document the results	of their w	ork. They ca
Workload in Hours	Independent	Study Time	e 110, Study Time in L	ecture 70		
	6					
Credit points	Compulsory	/ Bonus	Form Written elaboration	Descriptio า	n	
		10 % 10 %	Presentation			
Credit points Studienleistung	Yes	10 %				
Credit points Studienleistung	Yes Yes Written exam	10 %	Presentation	e Engineering: Elective (

Compulsory



Assignment for the	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective
Following Curricula	Compuleory
r onoming our nound	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

Course L0335: Robotic	cs 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 M0634: II	ntroduction into	Medica	l Technolo	gy and Systems		
Courses						
Title				Тур	Hrs/wk	СР
	Fechnology and Systems	(L0342)		Lecture	2	3
Introduction into Medical 7	Technology and Systems	(L0343)		Project Seminar	2	2
Introduction into Medical 7	Technology and Systems	(L1876)		Recitation Section (large)	1	1
Module Responsible	Prof. Alexander Schla	.efer				
Admission Requirements	None					
Recommended Previous Knowledge	principles of math (alg principles of stochast principles of program	ics				
Educational Objectives	After taking part succe	essfully, st	udents have re	ached the following lea	rning resu	Its
Professional Competence						
Knowledge	computer aided curas	ery, and m	edical informa	dical technology, inclution systems. They are technology.	-	
Skills	The students are abl applications.	The students are able to evaluate systems and medical devices in the context of clinical applications.				
Personal						
Competence	! !					
Social Competence	The students describe solved in a joint effort.		m in medical te	echnology as a project,	and define	tasks that ar
Autonomy	The students can refl present the results in a			d document the results	of their w	ork. They ca
Workload in Hours	Independent Study Ti	me 110, S	tudy Time in Le	ecture 70		
Credit points	6					
Studienleistung	Compulsory Bonus Yes 10 % Yes 10 %		n en elaboration entation	Descriptio	on	
Examination	Written exam					
Examination duration and scale	190 minutes					
Assignment for the	Compulsory General Engineering Engineering: Compuls Computer Science: Sp Electrical Engineering General Engineering Compulsory General Engineering Engineering: Compuls Computational Scien	Science sory pecialisati g: Core qu Science Science sory	(German proon Computer a alification: Elec (English proo	gram): Specialisation Egram, 7 semester): Special Software Engineering tive Compulsory gram): Specialisation Egram, 7 semester): Specialisation Engineering	pecialisationg: Elective Biomedical	n Biomedica e Compulsory Engineering on Biomedica
Following Curricula	la '' . a.	nce and	Engineering:	Specialisation Comp	uter Scie	nce: Electiv
	I		[221]			



Compulsory
Computational Science and Engineering: Specialisation Mathematics & Engineering Science:
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: Introdu	ction 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: Introdu	ction 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: N	Ionlinear Dynamics			
Courses				
Title Nonlinear Dynamics (L07	02)	Typ Integrated Lecture	Hrs/wk	CP 6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	LNODE			
Recommended Previous Knowledge	Calculus Linear Algebra			
Educational Objectives	After taking part successfully, students have re	eached the following lea	arning resul	ts
Professional Competence				
Knowledge	develop and research new terms and concep	ts.		
Skills	develop novel methods and procedures.	and procesures of No	nlinear Dyr	namics and to
Personal Competence				
Social Competence	Students can reach working results also in gro	•		
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				
Studienleistung	None	None		
Examination	Written exam			
Examination duration and scale	2 Hours			
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Computational Science and Engineering: Specialisation Scientific Computing: Electory International Management and Engineering: Specialisation II. Mechatronics: Electory International Management and Engineering: Specialisation III. Mechatronics: Electory 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: Electory Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Electory Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Electory 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		ting: Elective nics: Elective e Compulsory sory icine: Elective Compulsory eory: Elective ation: 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				
itle		Тур	Hrs/wk	СР
Semiconductor Technolog		Lecture	4	4
Semiconductor Technolog		Practical Course	2	2
	Prof. Hoc Khiem Trieu			
Admission Requirements	None			
	Basics in physics, chemistry, ma	terial science and semiconducto	r devices	
Educational Objectives	I Attar taking nart eliccaeetiilly etii	dents have reached the following	g learning resu	Its
Professional				
Competence				
Knowledge	·	-	rocess flows a	
Skills	to select and to evaluate prod	ess parameters on the processin cesses and the fabrication of semiconductor		
Personal Competence				
Social Competence	Students are able to prepare a present and discuss the results i		s in team work	as well as
Autonomy	None			
	Independent Study Time 96, Stu	dy Time in Lecture 84		
Workload in Hours				
Workload in Hours Credit points	6			
	J			
Credit points	None			



Following Curricula	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: Specialisation Microelectronics Complements: Elective Compulsory
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Тур
Hrs/wk
СР
Workload in Hours
Lecturer
Language
Cycle
Content



	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	



Courses						
Title Humanoid Robotics (L066	63)			Typ Seminar	Hrs/wk	CP
Module Responsible		(Göttech				
Admission		Caolisen				
Requirements	None					
Recommended Previous Knowledge	•	Introduction to co Control theory an	•			
Educational Objectives	After to	aking part success	ully, students h	nave reached the follow	ing learning resu	Its
Professional Competence						
Knowledge	•	Students can exp Students learn to		robots. ntrol concepts for differe	ent tasks in huma	noid robotics
Skills	 Students acquire knowledge about selected aspects of humanoid robotics, based or specified literature Students generalize developed results and present them to the participants Students practice to prepare and give a presentation 					
Personal Competence						
Social Competence	•	them		oping solutions in inter		
Autonomy	 Students evaluate advantages and drawbacks of different forms of presentation for specific tasks and select the best solution Students familiarize themselves with a scientific field, are able of introduce it and follow presentations of other students, such that a scientific discussion develops 					
Workload in Hours	Indepe	endent Study Time	32, Study Time	e in Lecture 28		
Credit points	2					
Studienleistung	None					
Examination	Prese	ntation				
Examination duration and scale	30 mir	า				
Assignment for the	Mecha Mecha Biome Comp Biome	atronics: Specialisa atronics: Specialisa edical Engineering: ulsory edical Engineering: edical Engineering	tion Intelligent tion System D Specialisation Specialisation	Control and Power Systems and Robotics: esign: Elective Compuls Artificial Organs and Foundation Implants and Endopron Medical Technology	Elective Compul sory Regenerative Med stheses: Elective	sory licine: Electiv 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 L0663: Human	oid 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 Sys	tem Identification (L0660)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	State space methodsDiscrete-time systemsLinear algebra, singul	uency response, root locus) ar value decomposition ut stochastic processes		
Educational Objectives	After taking part successfully,	students have reached the follow	ing learning resu	lts
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 or 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 g	roups on specific problems to arri	ve at joint solutio	ns.
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 62, Study Time in Lecture 28			
Credit points				
Studienleistung	None			
Examination	Oral exam			
Examination duration and scale	30 min			
	Mechatronics: Specialisation	alisation Control and Power Syste Intelligent Systems and Robotics: System Design: Elective Compuls	Elective Compul	



	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective
Assignment for the	Compulsory
Following Curricula	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
	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					Тур	Hrs/wk	СР
Optimal and Robust Contr Optimal and Robust Contr		-			Lecture Recitation Section (small)	2	3 3
Module Responsible	Prof. H	lerbert Werne	r				
Admission Requirements	None						
Recommended Previous Knowledge	•	State space	ntrol (frequency methods ora, singular val	·	·		
Educational Objectives	After ta	aking part suc	cessfully, stude	nts have rea	ached the following lea	rning resul	lts
Professional Competence							
Knowledge	•	LQ problems They can e estimation. They can ex performance They can ex an H2 design They can ex to robust cor They can ex guarantee st They unders	explain the dual plain how the he constraints. Explain how an Less of the constraints of the constraint how modes of the constraint how and perfect the constraint has a constraint how and the constraint has a constra	ality between H2 and H-in LQG design lel uncertain lased on the cormance for lysis and sy	of the matrix Riccati equal of the matrix Riccati equal of the matrix Riccati equal of the matrix norms are used from the can be formulated and the company of the can be represented an uncertain plant. The conditions on some some conditions on some can be conditioned and the condit	back and to represer llated as s in a way the	optimal stant stability are pecial case anat lends itsecontroller case
Skills	 Students are capable of designing and tuning LQG controllers for multivariable models. They are capable of representing a H2 or H-infinity design problem in the form generalized plant, and of using standard software tools for solving it. They are capable of translating time and frequency domain specifications for coloops into constraints on closed-loop sensitivity functions, and of carrying out a missensitivity design. They are capable of constructing an LFT uncertainty model for an uncertain systand of designing a mixed-objective robust controller. They are capable of formulating analysis and synthesis conditions as linear minequalities (LMI), and of using standard LMI-solvers for solving them. They can carry out all of the above using standard software tools (Matlab robust cotoolbox). 		the form of ons for contr g out a mixed ertain syster s linear matr				
Personal Competence							
-	Studer	nts can work i			problems to arrive at join sources provided		
·							



Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Studienleistung	None
Examination	
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Energy Systems: Core qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: 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 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: Optima	l 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



Courses				
Title Marketing of Innovations	(1 2009)	Typ Lecture	Hrs/wk	CP 4
PBL Marketing of Innovati		Project-/problem-based Learning	1	2
Module Responsible	Prof. Christian Lüthje	Learning		
Admission Requirements	None			
Recommended Previous Knowledge	theory, project managemen Bachelor-level Marketing K Strategies, Basics of Buying Unerstanding the difference	iness administration principles (str t, international business) (nowledge (Marketing Instruments g Behavior) es beweetn B2B and B2C marketin tance of managing innovation in g	s, Market a	nd Competit
Educational Objectives	I ATTOM TOKING NOME CHACCESTILLIVE CTING	nts have reached the following lea	arning resul	Its
Professional Competence				
Knowledge	 Approaches for analyzing development The gathering of information Concepts and approaches service development proces Approaches and tools for products and innovative ser Marketing mix elements the challenges of innovative processing methods for new proc	the marketing of innovative poroducty the current market situation in about future customer needs and to integrate lead users and their isses ensuring customer-orientation in vices take into consideration the special take into consideration the special take into services and services and services as sales forces and personal selling and instruments for new products and	and the frequirement needs into the developecific requirements	future markents o product a pment of ne
Skills	 Analyze markets by applyin Conduct forecasts and deve Translate customer needs successfully apply advanced development Use adequate methods to form the Choose suitable pricing strates and the conduction of the co	students will be able to: isions regarding marketing and integrated and technology portfolioselop compelling scenarios as a base into concepts, prototypes and sed methods for customer-orient ester efficient diffusion of innovativategies and communication activities ions for products and services e management (i.e. customer value)	sis for strate marketab ed product e products es for innov (i.e. selec	egic planning le offers and t and services and services vations ction of sal
Personal Competence				



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	6
Studienleistung	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: Market	ing 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) 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, 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
Literature	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 Ma	arketing 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	



lechanical Design Methodology	у		
	Тур	Hrs/wk	СР
dology (L1523)	Lecture	3	4
dology (L1524)	Recitation Section (small)	1	2
Prof. Josef Schlattmann			
None			
After taking part successfully, students have	e reached the following lea	rning resul	ts
Science-based working on product design design techniques	considering targeted appli	cation of sp	ecific produc
Independent Study Time 124, Study Time i	n Lecture 56		
6			
None			
Oral exam			
30 min			
Production: Elective Compulsory Mechatronics: Specialisation System Design Biomedical Engineering: Specialisation Are Compulsory Biomedical Engineering: Specialisation Im Biomedical Engineering: Specialisation Materials and Elective Compulsory Product Development, Materials and Elective Compulsory Product Development, Materials and Compulsory Product Development, Materials and Compulsory Product Development, Materials and Compulsory	gn: Elective Compulsory tificial Organs and Regene plants and Endoprostheses Medical Technology and (Management and Business Production: Specialisation Production: Specialisatio Production: Specialisatio	rative Med s: Elective (Control Th Administra Product n Product on Materi	icine: Elective Compulsory eory: Elective ation: Elective Development tion: Elective als: Elective
	dology (L1523) dology (L1524) Prof. Josef Schlattmann None After taking part successfully, students hav Science-based working on product design design techniques Creative handling of processes used for product design problems / Application theoretical aspects. Independent Study Time 124, Study Time i 6 None Oral exam 30 min International Management and Engineer Production: Elective Compulsory Mechatronics: Specialisation System Design Biomedical Engineering: Specialisation in Biomedical Engineering: Specialisation in Some Compulsory Biomedical Engineering: Specialisation in Specialisation in Specialisation in Specialisation in Specialisation in Compulsory Biomedical Engineering: Specialisation in Specialisation in Specialisation in Compulsory Biomedical Engineering: Specialisation in Specialisation in Specialisation in Compulsory Biomedical Engineering: Specialisation in Specialisatio	dology (L1523) dology (L1524) Prof. Josef Schlattmann None After taking part successfully, students have reached the following lea Science-based working on product design considering targeted appli design techniques Creative handling of processes used for scientific preparation and product design problems / Application of various product desig theoretical aspects. Independent Study Time 124, Study Time in Lecture 56 None Oral exam 30 min International Management and Engineering: Specialisation II. Pro Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regene Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses Biomedical Engineering: Specialisation Medical Technology and of Compulsory Biomedical Engineering: Specialisation Management and Business Compulsory Product Development, Materials and Production: Specialisation Elective Compulsory Product Development, Materials and Production: Specialisatio	dology (L1523) dology (L1524) Recitation Section (small) 1 Prof. Josef Schlattmann None After taking part successfully, students have reached the following learning result design techniques Creative handling of processes used for scientific preparation and formulation product design problems / Application of various product design techniques Creative handling of processes used for scientific preparation and formulation product design problems / Application of various product design techniques Independent Study Time 124, Study Time in Lecture 56 None Oral exam 30 min International Management and Engineering: Specialisation II. Product Deveroduction: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Med Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control The Compulsory Biomedical Engineering: Specialisation Management and Business Administration Compulsory Product Development, Materials and Production: Specialisation Product Elective Compulsory Product Development, Materials and Production: Specialisation Materials of Product Development, Materials and Production: Specialisation Materials and Production: Specialisation Materials Compulsory Product Development, Materials and Production: Specialisation Materials Mechanical Engineering: Specialisation Product Development, Materials and Production: Specialisation Materials Product Development and Product Development and Product Development Development Development Development Development Development Development Development Development Devel



Course L1523: Mecha	nical Design Methodology
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Josef Schlattmann
Language	DE
Cycle	SoSe
Content	 Systematic reflection and analysis of the mechanical design process Process structuring in sections (task, functions, acting principles, design-elements and total construction) as well as levels (working-, controlling-, and deciding-levels) Creativity (basics, methods, practical application in mechatronics) Diverse methods applied as tools (function structure, GALFMOS, AEIOU method, GAMPFT, simulation tools, TRIZ) Evaluation and selection (technical-economical evaluation, preference matrix) Value analysis, cost-benefit analysis Low-noise design of technical products Project monitoring and leading (leading projects / employees, organisation in product development, creating ideas / responsibility and communication) Aesthetic product design (industrial design, colouring, specific examples / exercises)
Literature	 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: Mechai	nical Design Methodology
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Josef Schlattmann
Language	DE
Cycle	SoSe
Content	 Systematic reflection and analysis of the mechanical design process Process structuring in sections (task, functions, acting principles, design-elements and total construction) as well as levels (working-, controlling-, and deciding-levels) Creativity (basics, methods, practical application in mechatronics) Diverse methods applied as tools (function structure, GALFMOS, AEIOU method, GAMPFT, simulation tools, TRIZ) Evaluation and selection (technical-economical evaluation, preference matrix) Value analysis, cost-benefit analysis Low-noise design of technical products Project monitoring and leading (leading projects / employees, organisation in product development, creating ideas / responsibility and communication) Aesthetic product design (industrial design, colouring, specific examples / exercises)
Literature	 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



Courses				
Title		Тур	Hrs/wk	CP
Bioprocess Engineering -		Lecture	2	3
Bioprocess Engineering- F Bioprocess Engineering -	Fundamentals (L0842) Fundamental Practical Course (L0843)	Recitation Section (large) Practical Course	2	1 2
Module Responsible			_	
Admission Requirements				
Recommended Previous Knowledge	none, module "organic chemistry", module "fundamentals for process engineering"			
Educational Objectives	After taking part successfully, students ha	ave reached the following lea	rning resul	Its
Professional Competence				
	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	 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	After completion of this module porticing	anta abauld ba abla ta dabaa	to toobnigo	l guantiana ir
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		
			_	



	practical work
	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Process Engineering: Compulsory General Engineering Science (German program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess 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: Bioprocess 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, fedbatch 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 	



Tvp Recita	tation Section (large)
71	and rection (large)
Hrs/wk 2	
CP 1	
Workload in Hours Indep	pendent Study Time 2, Study Time in Lecture 28
Lecturer Prof. A	Andreas Liese, Prof. An-Ping Zeng
Language DE	
Cycle SoSe	
2. Enz 3. Sto 4. Mic 5. Rho 6. Ma 7. Co 8. Ste 9. Do	roduction (Prof. Liese, Prof. Zeng) zymatic kinetics (Prof. Liese) pichiometry I + II (Prof. Liese) crobial Kinetics I+II (Prof. Zeng) neology (Prof. Liese) ass transfer in bioprocess (Prof. Zeng) ontinuous culture (Chemostat) (Prof. Zeng) erilisation (Prof. Zeng) ownstream processing (Prof. Liese) Repetition (Reserve) (Prof. Liese, Prof. Zeng)
Literature siehe	

Course L0843: Bioprod	cess 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 Anatomy (I	Typ Hrs/wk CP L0384) Lecture 2 3	
Module Responsible	Prof. Udo Schumacher	
Admission Requirements	None	
Recommended Previous Knowledge		
Educational Objectives	I Affer taking part successium, students have reached the following learning results	
Professional Competence		
Knowledge	The students can describe basal structures and functions of internal organs and th 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 professional level.	
Autonomy	The students are able to access anatomical knowledge by themselves, can participate i 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	
Studienleistung	None	
	Written exam	
Examination duration and scale	90 minutes	
	General Engineering Science (German program): Specialisation Mechanical Engineering Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering	
Assignment for the Following Curricula	Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering Compulsory General Engineering Science (English program 7 computer): Specialisation Mechanics	



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

Hrs/wk 2 CP 3 Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Lecturer Prof. Tobias Lange	Тур	_ecture	
Morkload in Hours Independent Study Time 62, Study Time in Lecture 28	Hrs/wk	2	
Lecturer Language DE Cycle SoSe General Anatomy 1st week: The Eucaryote Cell 2nd week: The Tissues 3rd week: Cell Cycle, Basics in Development 4th week: Musculoskeletal System 5th week: Cardiovascular System 6th week: Respiratory System 7th week: Genito-urinary System 8th week: Immune system 8th week: Digestive System I	СР	3	
Language DE Cycle SoSe General Anatomy 1st week: The Eucaryote Cell 2nd week: The Tissues 3rd week: Cell Cycle, Basics in Development 4th week: Musculoskeletal System 5th week: Cardiovascular System 6th week: Respiratory System 7th week: Genito-urinary System 8th week: Immune system 9th week: Digestive System I	Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28	
Cycle General Anatomy 1st week: The Eucaryote Cell 2nd week: The Tissues 3rd week: Cell Cycle, Basics in Development 4th week: Musculoskeletal System 5th week: Cardiovascular System 6th week: Respiratory System 7th week: Genito-urinary System 8th week: Immune system 9th week: Digestive System	Lecturer	Prof. Tobias Lange	
General Anatomy 1st week: The Eucaryote Cell 2nd week: The Tissues 3rd week: Cell Cycle, Basics in Development 4th week: Musculoskeletal System 5th week: Cardiovascular System 6th week: Respiratory System 7th week: Genito-urinary System Content 8th week: Immune system 9th week: Digestive System I	Language	DE	
1st week: The Eucaryote Cell 2nd week: The Tissues 3rd week: Cell Cycle, Basics in Development 4th week: Musculoskeletal System 5th week: Cardiovascular System 6th week: Respiratory System 7th week: Genito-urinary System 8th week: Immune system 9th week: Digestive System I	Cycle	SoSe	
11 th week: Endocrine System 12 th week: Nervous System 13 th week: Exam	Content	The Eucaryote Cell 2nd week: The Tissues 3rd week: Cell Cycle, Basics in Development 4th week: Musculoskeletal System 5th week: Cardiovascular System 6th week: Respiratory System 7th week: Genito-urinary System 8th week: Immune system 9th week: Digestive System II 10th week: Digestive System II 11th week: Endocrine System 12th week: Nervous System	
	Literature	Adolf Faller/Michael Schünke, Der Körper des Mensc Stuttgart, 2012	- hen, 16. Auflage, Thieme Ve



Courses				
Title		Тур	Hrs/wk	СР
	and Radiation Therapy (L0383)	Lecture	2	3
Module Responsible Admission				
Requirements	None			
Recommended Previous Knowledge	LINANA			
Educational Objectives	After taking part successfully, studen	ts have reached the follo	wing learning resu	lts
Professional Competence				
	Therapy The students can distinguish different in radiation therapy.			
	The students can explain treatme contexts (e.g. surgery, internal media The students can describe the pa	cine).		·
	follow-up care.			
	Diagnostics			مالد داد ما داد ما
Knowledge	The students can illustrate the tech angiography and mammography, as			
	The students can explain the diagnosmell as the technical basis for those	•	ic use of imaging t	echniques, a
	The students can choose the right transfer and needs.	eatment method dependi	ng on the patient's	clinical histor
	The student can explain the influence	e of technical errors on th	e imaging techniq	ues.
	The student can draw the right con error protocol.	clusions based on the in	nages' diagnostic f	indings or th
	Therapy The students can distinguish curative that conclusion.	e and palliative situations	s and motivate why	they came t
	The students can develop adequate aspects.	e therapy concepts and re	elate it to the radia	tion biologica
	The students can use the therapeuti	c principle (effects vs adv	erse effects)	
Skills	The students can distinguish differe on the situation (location of the to (irradiation planning).			•
	The student can assess what an incup treatment, sports, social help group			
	Diagnostics			
	The students can suggest solutions error analyses.	for repairs of imaging in	strumentation afte	r having don



	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.
Autonomy	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. 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
Studienleistung	
	Written exam
Examination duration and scale	I 9() minutes
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering: Specialisation Biomechanics: Compulsory General 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



	l _{eaca}
Cycle	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



Courses				
Title Introduction to Physiology	(L0385)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Dr. Roger Zimmermann			
Admission Requirements	None			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, students	have reached the followi	ing learning resul	ts
Professional				
Competence	The students can			
Knowledge	 describe the basics of the energy describe physiological relation and sensory physiology. 		nuscle, heart/circu	ılation, neuro
Skills	The students can describe the effects processing of information, development technical systems.	•	, ,	
Personal				
Competence				1
Social Competence	The students can conduct discussions The students can find solutions to pr metrological.			
Autonomy	The students can derive answers to quareas, using technical literature, by the		course and other	physiologica
Workload in Hours	Independent Study Time 62, Study Tim	e in Lecture 28		
Credit points	3			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	60 minutes			
	General Engineering Science (German Focus Biomechanics: Compulsory General Engineering Science (German Compulsory General Engineering Science (German Engineering: Compulsory General Engineering Science (German Engineering, Focus Biomechanics: Compulsory General Engineering: Specialisation of General Engineering Science (English Focus Biomechanics: Compulsory General Engineering Science (English Focus Biomechanics)	an program): Specialisa an program, 7 semeste an program, 7 semeste mpulsory Medical Technology: Ele sh program): Specialisa	ation Biomedical er): Specialisatio er): Specialisatio ctive Compulsory ation Mechanical	Engineering n Biomedica n Mechanica Engineering
	Compulsory General Engineering Science (Engli Engineering, Focus Biomechanics: Co General Engineering Science (Engli	mpulsory		



Engineering: Compulsory
Mechanical 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: Core qualification: 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. Roger Zimmermann	
Language	DE	
Cycle	SoSe	
Content		
	Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme	
Literature	Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier	



Courses			
		T	Una hode CD
Title Experimental Methods in I	Biomechanics (L0377)	Typ Lecture	Hrs/wk CP 2 3
Module Responsible	Prof. Michael Morlock		
Admission Requirements	None		
Recommended Previous Knowledge	It is recommended to participate "Experimentelle Methoden".	in "Implantate und Fr	akturheilung" before attendin
Educational Objectives	After taking part successfully, studen	its have reached the follow	ving learning results
Professional Competence			
Knowledge	The students can describe the difference existence. The students can name different to fracture morphologies. The students can describe different choose the adequate technique for a	reatments for the spine a	and hollow bones under give
Skills	The students can describe the bas biomechanics.	sic handling of several e	xperimental techniques used i
Personal Competence			
Social Competence	The students can, in groups, solve b	asic experimental tasks.	
Autonomy	The students can, in groups, solve b	asic experimental tasks.	
Workload in Hours	Independent Study Time 62, Study T	ime in Lecture 28	
Credit points	3		
Studienleistung			
Examination Examination duration and scale	Written exam 90 min		
Assignment for the Following Curricula	General Engineering Science (Gereaus Biomechanics: Compulsory General Engineering Science (Gereausering Engineering Science (Gereausering, Focus Biomechanics: General Engineering Science (Gereausering: Compulsory General Engineering Science (Engineering Engineering Science (Engineering Engineering Science (Engineering Engineering Science (Engineering Engineering Science (Engineering, Focus Biomechanics: General Engineering Science (Engineering Engineering Science (Engineering: Compulsory	rman program): Specialis rman program, 7 semes Compulsory rman program, 7 semes glish program): Specialis glish program): Specialis glish program, 7 semes Compulsory	sation Biomedical Engineering ster): Specialisation Mechanical ster): Specialisation Biomedical sation Biomedical Engineering sation Mechanical Engineering ster): Specialisation Mechanical



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 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: E	BIO II: Artificial Joint Repla	cement		
Courses				
Title		Тур	Hrs/wk	СР
Artificial Joint Replacemen	nt (L1306)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of orthopedic and	d surgical techniques is recomm	ended.	
Educational Objectives	After taking part successfully, stude	ents have reached the following	learning resu	lts
Professional				
Competence		attinala afamifiaiattinala		
Knowledge	The students can name the differer	nt kinds of artificial limbs.		
Skills	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 in with respect to its credibility.	formation on their own. They ca	n also judge t	he information
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Credit points	3			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	International Management and E Biotechnology: Elective Compulsor Materials Science: Specialisation N Biomedical Engineering: Specialis Compulsory Biomedical Engineering: Specialis Biomedical Engineering: Specialis Compulsory Biomedical Engineering: Specialis Compulsory Theoretical Mechanical Engineering Theoretical Mechanical Engineering Compulsory	ry Nano and Hybrid Materials: Electration Artificial Organs and Regardation Implants and Endoprosthe sation Medical Technology and sation Management and Busing: Technical Complementary	etive Compulso enerative Med eses: Compulso d Control Th ess Administr ourse: Electiv	ory licine: Elective sory leory: Elective ation: Elective e Compulsory



Course L1306: Artificial Joint Replacement		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
1	Prof. Michael Morlock	
Language		
Cycle		
	Inhalt (deutsch)	
	1. EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenkersatzes)	
	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.	
	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	



Medule MOOAF, F	Toodhook Control in Modical Tooknology		
Module M0645: F	Feedback Control in Medical Technology		
Courses			
Title Feedback Control in Medi	Typ Hrs/wk C lical Technology (L0664) Lecture 2 3	Р	
Module Responsible	Johannes Kreuzer		
Admission Requirements	INONE		
Recommended Previous Knowledge	Basics in Control, Basics in Physiology		
Educational Objectives	I Affar taking nart circocctilily ctildente nava reached the following learning recilite		
Professional Competence			
	The lecture will introduce into the fascinating area of medical technology with the enpoint of view. Fundamentals in human physiology will be similarly introduced like k 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 controller or neural networks will be illustrated. The operation of simple equivalent c be discussed.	-	
Skills	Application of modeling, identification, control technology in the field of medical technology	nology.	
Personal Competence			
Social Competence	Students can develop solutions to specific problems in small groups and present the (e.g. during project week)	eir results	
Autonomy	Students are able to find necessary literature and to set it into the context of the lecture and to continuously evaluate their knowledge and to take control of their process. They can combine knowledge from different courses to form a consistent where the context of the lecture and to take control of their process.	r learning	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points			
Studienleistung			
Examination			
Examination duration and scale	120 min		
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compuls Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Com Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine	npulsory e: Elective	
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Co	mpulsory	



Course L0664: Feedback 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	 Taking an engineering point of view, the lecture is structured as follows. Introduction to the topic with selected examples Physiology - introduction and overview Regeneration of functions of the cardiovascular system Regeneration of the respiratory functions Closed loop control in anesthesia regeneration of kidney and liver functions regeneration of motorize function/ rehabilitation engineering navigation systems and robotic in medicine The lecture will use knowledge from modeling, simulation and controller design and MATLAB and SIMULINK will be used.	
Literature	Silbernagel/Depopoulos: Taschenatlas der Physiologie, Thieme Verlag Stuttgart Werner: Kooperative und autonome Systeme der Medizintechnik, Oldenburg Verlag M.C.K.Khoo: "Physiological Control System", IEEE Press, 2000	



Courses				
Γitle		Тур	Hrs/wk	СР
Advanced Topics in Contr Advanced Topics in Contr		Lecture Recitation Section (small)	2	3 3
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	H-infinity optimal control, mixed-sensitiv	ity design, linear matrix inequ	alities	
Educational Objectives	After taking part successfully, students h	ave reached the following lea	rning resu	lts
Professional Competence				
Knowledge	 Students can explain the ad scheduling approach They can explain the represent systems They can explain how stability formulated as LMI conditions They can explain how griddin synthesis problems for LPV syste They are familiar with polytopic the basic synthesis techniques at the b	tation of nonlinear systems in and performance conditions and techniques can be used tems and LFT representations of Liessociated with each of these reagent systems are agent systems are agent systems are are are representations for the synthesis conditions for the models.	to solve PV systems model struct used to usensus proformation fally invariance rray ed real le	of quasi-LP' restems can be analysis and s and some of ctures represent the otocols control loop ant distributes
Skills	 Students are capable of construmixed-sensitivity design of gapolytopic, LFT or general LPV m They are able to use standard stasks 	ain-scheduled controllers; th odels	ey can c	lo this using
GNIIS	 Students are able to design dist either LTI or LPV dynamics, usin 		or groups	of agents wit
	 Students are able to design distrusing the Matlab MD-toolbox 	ibuted controllers for spatially	interconne	ected systems



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	6
Studienleistung	None
Examination	
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Avionic and Embedded Systems: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: 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: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory



Course L0661: Advance	ced 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	EN
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: Advan	ourse 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		



Specialization Medical Technology and Control Theory

Module M0623: I	ntelligent S	Systems	in Medicine			
Courses						
Title Intelligent Systems in Med Intelligent Systems in Med Intelligent Systems in Med	dicine (L0334)			Typ Lecture Project Seminar Recitation Section (small)	Hrs/wk 2 2	CP 3 2
Module Responsible	<u> </u>	lor Schlaofo	r	· · · · · · · · · · · · · · · · · · ·	-	·
Admission Requirements	None	iei odinaeie	<u> </u>			
Recommended Previous Knowledge	princi	ples of stoch	(algebra, analysis/ca nastics ramming, Java/C++ a nming skills	·		
Educational Objectives	I Atter takına n	art successf	ully, students have re	eached the following lea	rning resu	Its
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		nd prediction	on. They can assess	ting and adapting me the methods based on		
Personal Competence						
Social Competence				r groups, provide help	oful feedb	ack and can
Autonomy			their knowledge and appropriate manner.	d document the results	of their w	ork. They can
Workload in Hours	Independent	Study Time	110, Study Time in L	ecture 70		
Credit points	6					
Studienleistung	Compulsory Yes Yes	Bonus 10 % 10 %	Form Written elaboration Presentation	Descriptio	on	
Examination	Written exam					
Examination duration and scale	190 minutes					
	Electrical En	gineering: Sp al Science a	pecialisation Medical	e Engineering: Elective (I Technology: Elective C ecialisation Systems En	ompulsory	1



Assignment for the	Rigmedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory I
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0331: Intellige	ent 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	



Courses				
Title		Тур	Hrs/wk	СР
-	ents and Cognitive Robotics (L0341)	Lecture	2	4
	ents and Cognitive Robotics (L0512)	Recitation Section	n (small) 2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Vectors, matrices, Calculus			
Educational Objectives	After taking part successfully, students h	ave reached the follow	wing learning resu	Its
Professional Competence				
Knowledge	context, students can describe technique problems, and they can recall technique identify techniques for simultaneous lot techniques for achieving desired state decision making in a multi-agent setting functions, voting protocol, and mechanism Students can select an appropriate scenarios. For simplified agent application optimization techniques. For those networks/dynamic Bayesian networks Students can also name and apply	oals, utilities, enviror on of adversarial ager or of adversarial ager of and reasoning for acceptance of acceptance of acceptance of acceptance of a comparison o	nments). They can not cooperation can ese problems. Fo how Bayesian neormalism in staticing procedures in state of the envirolly observable) Malue of information oing, and can explain coordination types of equilibrial for concrete age e decision trees at can also create reasoning for sirechniques for sires	n describe the be discussed of dealing with tworks can be and dynamic and imment. In this arkov decision. Students can plain planning problems and apply basic ate Bayesian mple queries applified agent
Skills	scenarios. For simple and complex dec policies for concrete settings. In multi finding different equilibria states,e.g., students will apply different voting protoc	agent situations stud Nash equilibria. Fo	dents will apply t r multi-agent dec	techniques fo cision makin
Personal Competence				
Social Competence	Students are able to discuss their solu English	tions to problems wit	th others. They co	ommunicate i
Autonomy	Students are able of checking their und concrete problems	erstanding of complex	x concepts by solv	ing varaints o
Workload in Hours	Independent Study Time 124, Study Tim	e in Lecture 56		
Credit points	6			
Studienleistung	None			
	Written exam			
Examination duration				





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, Minin algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environme probabilities, conditional probabilities, product rule, Bayes rule, full joint probab distribution, marginalization, summing out, answering queries, complex independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference enumeration), typical-case complexity, pragmatics: reasoning from effect (that can 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, dyna Bayesian networks, Markov assumption, transition model, sensor model, inferer problems: filtering, prediction, smoothing, most-likely explanation, special cashidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decisinetworks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteratify MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MD 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, Gibba Satterthwaite Impossibility Theorem, Direct mechanisms, expe
Literature	 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Non-Prentice Hall, 2010, Chapters 2-5, 10-11, 13-17 Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005



Course L0512: Intellige	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		

Following Curricula

Compulsory

Compulsory



Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) **Courses** Title Hrs/wk CP Typ Seminar Nature's Hierarchical Materials (L1663) 3 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Lecture 3 4 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Recitation Section (small) 2 2 (L1877)Development and Regulatory Approval of Implants (L1588) Lecture 2 3 Experimental Methods for the Characterization of Materials (L1580) Lecture 2 3 2 Numerical Methods in Biomechanics (L1583) Seminar 3 Seminar Biomedical Engineering (L1890) Seminar 2 3 Six Sigma (L1130) Lecture 2 3 2 Fluid Mechanics II (L0001) Lecture 4 Ceramics Technology (L0379) Lecture 2 3 Module Responsible Prof. Michael Morlock Admission None Requirements Recommended **Previous Knowledge** Educational After taking part successfully, students have reached the following learning results **Objectives Professional** Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses **Credit points** Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Assignment for the Biomedical Engineering: Specialisation Management and Business Administration: Elective

Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective



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



	Lecture
Hrs/wk	
CP	
	Independent Study Time 78, Study Time in Lecture 42
Examination Form	
Examination duration and scale	
	Prof. Christian Schuster
Language	
Cycle	
Content	- 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)



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	
Examination duration and scale	30 min
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	WiSe
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	
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-iminternet.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	
Examination duration and scale	90 min
Lecturer	Prof. Patrick Huber
Language	DE/EN
Cycle	SoSe
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: Numer	ical Methods in Biomechanics
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	
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	
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 M	echanics II
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Klausur
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 L0379: Ceramics Technology		
Тур	Lecture	
Hrs/wk	(2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form		
Examination duration and scale	90 Minuten	
Lecturer	Dr. Rolf Janßen	
Language	<u>.</u>	
Cycle	WiSe	
	Introduction to ceramic processing with emphasis on advanced structural ceramics. course focus predominatly on powder-based processing, e.g. "powder-metauurg techniques and sintering (soild state and liquid phase). Also, some aspects of glass cement science as well as new developments in powderless forming techniques of ceran and ceramic composites will be addressed Examples will be discussed in order to gengineering students an understanding of technology development and specific application of ceramic components.	ical and nics give
	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	

Assignment for the

Following Curricula

Compulsory

Compulsory



Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) **Courses** Title Hrs/wk CP Typ Seminar Nature's Hierarchical Materials (L1663) 3 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Lecture 3 4 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility Recitation Section (small) 2 2 (L1877)Development and Regulatory Approval of Implants (L1588) Lecture 2 3 Experimental Methods for the Characterization of Materials (L1580) Lecture 2 3 2 Numerical Methods in Biomechanics (L1583) Seminar 3 Seminar Biomedical Engineering (L1890) Seminar 2 3 Six Sigma (L1130) Lecture 2 3 2 Fluid Mechanics II (L0001) Lecture 4 Ceramics Technology (L0379) Lecture 2 3 Module Responsible Prof. Michael Morlock Admission None Requirements Recommended **Previous Knowledge** Educational After taking part successfully, students have reached the following learning results **Objectives Professional** Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses **Credit points** 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

Biomedical Engineering: Specialisation Management and Business Administration: Elective



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: Introdu	ction 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
	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	
Content	This course is intended as an introduction to the topics of wave propagation, guiding, and receiving as well as Electromagnetic Compatibility (EMC) for graduate engineering students that do not have a formal background in electrical engineering. 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
	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	WiSe
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-iminternet.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		
Examination duration and scale	90 min	
Lecturer	Prof. Patrick Huber	
Language	DE/EN	
Cycle	SoSe	
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		
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	lechriffliche augarheifung und Vortrag (20 min)	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	WiSe	
Content		
Literature	Keine	



Course L1130: Six Sigma		
Typ Lecture		
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Examination Form		
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		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Examination Form	Klausur	
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 L0379: Ceram	ics Technology		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form			
Examination duration and scale	90 Minuten		
	Dr. Rolf Janßen		
Language	1		
Cycle	WiSe		
	Introduction to ceramic processing with emphasis on advanced structural ceramics. course focus predominatly on powder-based processing, e.g. "powder-metauur techniques and sintering (soild state and liquid phase). Also, some aspects of glass cement science as well as new developments in powderless forming techniques of cera and ceramic composites will be addressed Examples will be discussed in order to engineering students an understanding of technology development and specific application 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 t	o Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials	Handbook Vol.4 "Ceramics and Glasses", 1991	
Literature	D.W. Richerson, "Modern Ce	eramic Engineering", Marcel Decker, New York, 1992	
	Skript zur Vorlesung		



Module M0746: N	/licrosystem Engin	neering			
Courses					
Title			Тур	Hrs/wk	СР
Microsystem Engineering	(L0680)		Lecture	2	4
Microsystem Engineering	(L0682)		Project-/problem-based Learning	2	2
Module Responsible	Prof. Manfred Kasper				
Admission Requirements	None				
Recommended Previous Knowledge	Basic courses in physics	s, mathematics and el	ectric engineering		
Educational Objectives	After taking part success	sfully, students have re	eached the following lea	rning resul	ts
Professional Competence					
Knowledge	The students know aboutheir applications in sens		technologies and mate	rials of ME	MS as well as
Skills	Students are able to analyze and describe the functional behaviour of MEMS components and to evaluate the potential of microsystems.				
Personal Competence					
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.				
Workload in Hours	Independent Study Time	e 124, Study Time in L	ecture 56		
Credit points	6				
Studienleistung	Compulsory Bonus No 10 %	Form Presentation	Description	on	
Examination	Written exam				
Examination duration and scale	2h				
Assignment for the Following Curricula	Compulsory Mechanical Engineering Mechatronics: Specialisa Biomedical Engineering Compulsory Biomedical Engineering Biomedical Engineering Compulsory Biomedical Engineering Compulsory Biomedical Engineering	and Engineering: Spent and Engineering: nent and Engineering: g and Management: Specialisation Artification Specialisation Implag: Specialisation Medication Management Specialisation Manage Speciali	ecialisation Systems Er Specialisation II. Electring: Specialisation II. pecialisation Mechatron Elective Compulsory cial Organs and Regeneration and Endoprosthese dical Technology and agement and Business	Mechatronics: Elective erative Med	ering: Elective nics: Elective e Compulsory icine: Elective Compulsory eory: Elective
	Microelectronics and Mic	crosystems: Core qua	untication: Elective Comp	oulsory	



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

Тур	Lecture			
Hrs/wk	2			
СР	4			
Workload in Hours	ndependent Study Time 92, Study Time in Lecture 28			
Lecturer	Prof. Manfred Kasper			
Language	EN			
Cycle				
	Object and goal of MEMS Scaling Rules Lithography			
	Film deposition Structuring and etching Energy conversion and force generation			
Content	Electromagnetic Actuators Reluctance motors			
	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			
Literature	M. Kasper: Mikrosystementwurf, Springer (2000) 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 M0751: \	ibration Theory
Courses	
Title Vibration Theory (L0701)	Typ Hrs/wk CP Integrated Lecture 4 6
Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	INONE
Recommended Previous Knowledge	 Calculus Linear Algebra Engineering Mechanics
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 furthe
Skills	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	
Studienleistung	
	Written exam
Examination duration and scale	2 Hours
_	Energy Systems: Core qualification: Elective Compulsory Computational Science and Engineering: Specialisation Scientific Computing: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: 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: Compulsory Naval Architecture and Ocean Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory



Course L0701: Vibration	on 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.



Courses						
itle		Тур		Hrs/wk	СР	
licrosystems Technology	y (L0724)	Lecture		2	4	
licrosystems Technolog	y (L0725)	Project-/p Learning	oroblem-based	2	2	
Module Responsible	Prof. Hoc Khiem Trieu					
Admission Requirements	None					
Recommended Previous Knowledge	Basics in physics, chemis	try, mechanics and semicond	uctor technolo	gy		
Educational Objectives	After taking part successf	ully, students have reached th	e following lea	rning resul	ts	
Professional						
Competence						
Knowledge	to present and to explain current fabrication techniques for microstructures and especially methods for the fabrication of microsensors and microactuators, as well as the integration thereof in more complex systems					
Knowleage	to explain in details operation principles of microsensors and microactuators and					
	to discuss the potential and limitation of microsystems in application.					
	Students are capable					
	• to analyze the feasibil	ity of microsystems,				
	to develop process flows for the fabrication of microstructures and					
Skills	to apply them.					
Personal Competence						
Social Competence		pare and perform their lab exesults in front of audience.	xperiments in	team work	as well as	
Autonomy	None					
Workload in Hours	Independent Study Time	124, Study Time in Lecture 56				
Credit points	6					
	Compulsory Bonus	Form	Description			



Studienleistung	Yes None	Subject theoretical practical work	and durch. Jede Gruppe präsentiert und diskutiert die Theorie sowie die Ergebniise ihrer Labortätigkeit. vor dem gesamten Kurs.
Examination			
Examination duration and scale	30 min		
Assignment for the Following Curricula	Elective Compulsory Electrical Engineering: Computational Science Elective Compulsory International Manage Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory Biomedical Engineerin Compulsory	: Specialisation Medical Teche and Engineering: Specialisement and Engineering: Specialisement and Engineering: Specialisation Artificial Orang: Specialisation Implants arang: Specialisation Medical	ctronics and Microsystems Technology: nnology: Elective Compulsory sation Systems Engineering and Robotics: Specialisation II. Mechatronics: Elective rgans and Regenerative Medicine: Elective and Endoprostheses: Elective Compulsory Technology and Control Theory: Elective ment and Business Administration: Elective ion: Elective Compulsory

	Microelectronics and Microsystems: Core quantication: Elective Compulsory
Course L0724: Micros	ystems 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
Contont	 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; 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
Content	operating principle and fabrication process)



- 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, topdown 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-onboard, 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

Literature

N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009

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
Technology Management	(L0849)	Project-/problem-based Learning	3	3
Technology Management	Seminar (L0850)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous Knowledge	Bachelor knowledge in business mana	gement		
Educational Objectives	After taking part successfully, students	nave reached the following lea	arning resu	lts
Professional Competence				
Knowledge	Students will gain deep insights into: • Technology Timing Strategies • Technology Strategies a • Technology Intelligence • Technology Portfolio Managem • Technology Portfolio Me • Technology Acquisition • IP Management • Organizing Technology Develop • Technology Organizatio • Technology Funding & C	ent thodology and Exploitation oment n & Management)	
Skills	 Develop an understanding of the importance of Technology Management - on national as well as international level Equip students with an understanding of important elements of Technolog Management (strategic, operational, organizational and process-related aspects) Foster a strategic orientation to problem-solving within the innovation process as we as Technology Management and its importance for corporate strategy 			
Personal Competence				
Social Competence	Interact within a teamRaise awareness for globabl iss	sues		
Autonomy	Gain access to knowledge sourInterpret complicated cases	ces		



	Develop presentation skills		
Workload in Hours	ndependent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Studienleistung	None		
	Written exam		
Examination duration and scale	90 minutes		
Assignment for the Following Curricula	Global Innovation Management: Core qualification: Compulsory 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 L0849: Techno	ology 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 Incovation Management, Elgar Research Collection, Northhampton (MA) 2011

Course L0850: Technology 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	Aspects of and Cases in combination with the content of the lecture.	
Literature	see lecture Technology Management.	



Courses							
Fitle Control Systems Theory a Control Systems Theory a				Typ Lect Rec		Hrs/wk 2 2	CP 4 2
Module Responsible		,			· ,		
Admission Requirements	None						
Previous Knowledge	Introduction	on to Control S	Systems				
Educational Objectives	After takir	ng part succes	sfully, students	have reach	ed the following lea	rning resul	ts
Professional Competence							
Knowledge	mitra Tre Tre Tre Tre Tre Tre Tre T	odels; they can ajectories in stancy can explai lationship to some explainates and distance and distance and explainates can explainate can e	in interpret the sate space with the system tate feedback and the significant in observer-basturbance reject deall of the aboven the z-transfortin state space in the experimentification probin how a state	properties and state est ace of a mining sed state fer ion are to multi-in and its rel models an antal identifi lem can be s	c systems are repronse to initial states controllability and imation, respectivel mal realisation edback and how it put multi-output systationship with the Ltd transfer function cation of ARX modesolved by solving a led can be constructed.	or externation observability can be use stems aplace Transmodels of the discontinuity of the	Il excitation a lity, and the ed to achiev ansform discrete-tim amic system uation
Skills	ve • Tr • Tr da • Tr fra • Tr	ersa ney can assess ney can design They can carr omain, and den ney can identif om experiment ney can carry	s controllability n LQG controlle y out a contro cide which is a y transfer functi tal data	and observa rs for multiva ller design ppropriate for ion models a tasks using	both in continuous or a given sampling and state space mo	t minimal restime and rate are dels of dyr	ealisations discrete-tim
Personal Competence							
Social Competence	Students	can work in sn	nall groups on s	specific prob	olems to arrive at jo	int solution	S.
					ided sources (le n solving given pro		tes, softwai



Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Studienleistung	None
	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy Systems: Core qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Compulsory Aircraft Systems Engineering: Specialisation Avionic and Embedded Systems: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: Elective Compulsory Computational Science and Engineering: Specialisation Kernfächer Ingenieurswissenschaften (2 Kurse): 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 Mechanical 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: Contro	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
	State space methods (single-input single-output)
Content	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: 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	



Module M0867: P	Production Planning & Control a	nd Digital Enterpris	se	
Courses				
Title The Digital Enterprise (LOP Production Planning and COP Production Planning and COP Exercise: The Digital Enterprise (LOP Production Planning and COP Production Pla	Control (L0929) Control (L0930)	Typ Lecture Lecture Recitation Section (small) Recitation Section (small)		CP 2 2 1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous Knowledge	Fundamentals of Production and Quality Ma	anagement		
Educational Objectives	After taking part successfully, students have	e reached the following lea	rning resul	lts
Professional Competence Knowledge Skills			•	
Personal Competence Social Competence Autonomy	Students can develop joint solutions in mixe	ed teams and present them	n to others.	
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points				
Studienleistung				
Examination Examination duration and scale	I I XII Miniifen			
Assignment for the Following Curricula	International Management and Engineer Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation, Art Compulsory Biomedical Engineering: Specialisation Art Compulsory Biomedical Engineering: Specialisation Impulsory Biomedical Engineering: Specialisation Modern Compulsory Biomedical Engineering: Specialisation Modern Compulsory Product Development, Materials and Pelective Compulsory Product Development, Materials and Product Development, Materials and Product Development, Materials and Compulsory Theoretical Mechanical Engineering: Speelective Compulsory Theoretical Mechanical Engineering: Technology	pecialisation Production ificial Organs and Regene plants and Endoprostheses Medical Technology and O Management and Bu roduction: Specialisation ction: Specialisation Production: Specialisation Production: Specialisation cialisation Product Develo	and Logis rative Med s: Elective (Control Th usiness A Product uction: Con on Mater	stics: Elective licine: Elective Compulsory eory: Elective Administration: Development: npulsory ials: Elective ad Production:



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)		
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	WiSe	
Content	See interlocking course	
Literature	Siehe korrespondierende Vorlesung See interlocking course	



Module MU921: E	Electronic Circuits for Medio	ai Applications		
Courses				
Title		Тур	Hrs/wk	СР
	dical Applications (L0696) dical Applications (L1056)	Lecture Recitation Section (2 small) 1	3 2
	dical Applications (L1408)	Practical Course	1	1
Module Responsible	Prof. Matthias Kuhl			
Admission Requirements	INONA			
Recommended Previous Knowledge	Lindamontale of alactrical anginoari	ng		
Educational Objectives		ts have reached the followir	ng learning resu	lts
Professional Competence				
Knowledge	 Students can explain the banervous system Students are able to explain along an axon Students can exemplify the construction Students can describe the applications Students can explain the function Students are able to discuss artificial eyes 	the build-up of an action ommunication between neu special features of low- ctions of prostheses, e. g. an	potential and ir rons and electronoise amplifier	ts propagatio onic devices s for medica
Skills	 Students can calculate the ti Students can give scenario signal acquisition. Students can develop the blo Students can define the build 	s for further improvement ock diagrams of prosthetic s	of low-noise a	ind low-powe
Personal Competence				
Social Competence	 Students are trained to solv together with experts with diff Students are able to recog assistance to the right time. Students can document their a way that others can be invo 	erent professional backgrounize their specific limitation work in a clear manner and	ind. ns, so that the d communicate	y can ask fo
Autonomy	 Students are able to realisti actions for improvements whe Students can break down the work in a realistic way. Students can handle the conneeding support. 	en necessary. eir work in appropriate work	packages and	schedule the



	 Students are able to act in a responsible manner in all cases and situations of experimental work. 				
	Independent Study Time	124, Study T	ime in Lecture	56	
Credit points	6				
	Compulsory Bonus	Form		Descri	ption
Studienleistung	No None	Subject practical w	theoretical ork	and	
	No 20 %	Excercises			
Examination	Oral exam				
Examination duration and scale	14() min				
Assignment for the Following Curricula	Biomedical Engineering Compulsory Biomedical Engineering Biomedical Engineering Biomedical Engineering Compulsory Microelectronics and M Compulsory Theoretical Mechanical Compulsory	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: Specialisation Bio- and Medical Technology: Elective			



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 Fring (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, Springe 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: Electro	ourse 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: Electro	nic 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/		



Courses				
Title		Тур	Hrs/wk	СР
Continuum Mechanics (L1	533)	Lecture	2	3
Continuum Mechanics Ex	ercise (L1534)	Recitation Section (small)	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of linear continuum mechanics as moments, stress, linear strain, free-body energy).			
Educational Objectives	After taking part successfully, students have	e reached the following lea	rning resul	ts
Professional Competence				
Knowledge	The students can explain the fundamental concepts to calculate the mechanical behavior o materials.			
Skills	The students can set up balance laws a aspects, both in applied contexts as in rese		nation thec	ry to specifi
Personal Competence				
Social Competence	The students are able to develop solutions develop ideas further.	, to present them to special	ists in writte	en form and t
Autonomy	The students are able to assess the independently and on their own identify mechanics and acquire the knowledge req	and solve problems in		•
Workload in Hours	Independent Study Time 124, Study Time i	n Lecture 56		
Credit points	6			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Computational Science and Engineering Compulsory Materials Science: Specialisation Modeling Mechanical Engineering and Management Mechatronics: Technical Complementary Compulsory Biomedical Engineering: Specialisation Im Biomedical Engineering: Specialisation Im Biomedical Engineering: Specialisation Modeling Compulsory Biomedical Engineering: Specialisation Modeling Specialisation Modeling Specialisation Modeling Specialisation Modeling Specialisation Modeling Specialisation Modeling Modeling Specialisation Modeling Modeling Specialisation Modeling Modeling Modeling Specialisation Modeling Modeling Modeling Modeling Specialisation Modeling Modeling Modeling Modeling Modeling Modeling Specialisation Modeling Model	g: Elective Compulsory t: Specialisation Materials: Course: Elective Compulsor tificial Organs and Regene plants and Endoprostheses Medical Technology and	Elective Co ry rative Medi s: Elective (Control The	mpulsory cine: Elective Compulsory eory: 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

Theoretical Mechanical Engineering: Core qualification: 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/EN			
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: Continu	Course L1534: Continuum 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/EN				
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 M1151: N	Material Modeling			
Courses				
Title Material Modeling (L1535)		Typ Lecture	Hrs/wk	CP 3
Material Modeling (L1536)		Recitation Section (small)	2	3
Module Responsible Admission	Prof. Christian Cyron			
Requirements	None			
	Basics of linear and nonlinear continuum Mechanics II and Continuum Mechanics (for strain, free-body principle, linear and nonlinear	ces and moments, stre	ss, linear a	
Educational Objectives	After taking part successfully, students have re	eached the following lea	rning result	s
Professional Competence				
Knowledge	The students can explain the fundamentals of	multidimensional consi	tutive mater	ial laws
Skills	The students can implement their own materi students can apply their knowledge to various corresponding material models.			
Personal				
Competence	! !			
Social Competence	The students are able to develop solutions, ideas further.	to present them to spe	ecialists an	d to develo
Autonomy	The students are able to assess their independently and on their own identify and s and acquire the knowledge required to this en	solve problems in the ar		-
Workload in Hours	I Independent Study Time 124, Study Time in L	ecture 56		
Credit points	<u> </u>			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	145 min			
Assignment for the Following Curricula	Computational Science and Engineering: Compulsory Materials Science: Specialisation Modeling: E Mechanical Engineering and Management: S Biomedical Engineering: Specialisation Artific Compulsory Biomedical Engineering: Specialisation Impla Biomedical Engineering: Specialisation Mec Compulsory Biomedical Engineering: Specialisation Man Compulsory Product Development, Materials and Production	lective Compulsory pecialisation Materials: ial Organs and Regenents and Endoprostheses dical Technology and cagement and Business	Elective Co rative Medi s: Elective C Control The Administra	mpulsory cine: Elective Compulsory eory: Elective tion: Elective



Course L1535: Materia	ourse 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/EN				
Cycle	WiSe				
Content	 fundamentals of finite element methods fundamentals of material modeling introduction to numerical implementation of material laws overview of modelling of different classes of materials combination of macroscopic quantities to material microstructure 				
Literature	D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge G. Gottstein., Physical Foundations of Materials Science, Springer				

Course L1536: Materia	ourse 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/EN				
Cycle	WiSe				
Content	 fundamentals of finite element methods fundamentals of material modeling introduction to numerical implementation of material laws overview of modelling of different classes of materials combination of macroscopic quantities to material microstructure 				
Literature	D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge G. Gottstein., Physical Foundations of Materials Science, Springer				



Module M1199: A	dvanced Functional Materia	le		
Module Wil 199. A	idvanced i unctional materia	15		
Courses				
Title		Тур	Hrs/wk	СР
Advanced Functional Mate	erials (L1625)	Lecture	2	6
Module Responsible	Prof. Patrick Huber			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in Materials Science,	e.g. Materials Science I/I	I	
Educational Objectives	After taking part successfully, students I	nave reached the following	ng learning resul	ts
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 microto 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 solution	ons to specialists and to o	develop ideas fur	ther.
	The students are able to			
Autonomy	assess their own strengths andgather new necessary expertise			
Workload in Hours	Independent Study Time 152, Study Tir	ne in Lecture 28		
Credit points				
Studienleistung	None			
Examination	Presentation			
Examination duration and scale	30 min			
Assignment for the Following Curricula	Materials Science: Core qualification: Compulsory Mechanical Engineering and Management: Specialisation Materials: 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 Materials Science: Elective Compulsory			



Course L1625: Advanced Functional Materials		
Тур	Lecture	
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/EN	
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	Wird in der Veranstaltung bekannt gegeben	



Courses	
Title Introduction to Biochemist	try and Molecular Biology (L0386) Typ Lecture Hrs/wk CP 2 3
Module Responsible	Prof. Hans-Jürgen Kreienkamp
Admission Requirements	INone
Recommended Previous Knowledge	INONA
Educational Objectives	I Affar taking nart cliccocctillive ctilgante nava reached the following learning recilite
Professional Competence	
Knowledge	 explain now 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 discussions in research and medicine on a technical level.
Autonomy	The students can develop understanding of topics from the course, using technical literature by themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Studienleistung	None
Examination	Written exam
Examination duration and scale	160 minutes
	General Engineering Science (German program): Specialisation Mechanical Engineerin



Engineering: Compulsory
Mechanical Engineering: Specialisation Biomechanics: 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: Core qualification: 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: E	BIO I: Implants and Fracture	Healing	
Courses			
Title Implants and Fracture He	aling (L0376)	Typ Lecture	Hrs/wk CP 2 3
Module Responsible	Prof. Michael Morlock		
Admission Requirements	None		
Recommended Previous Knowledge	It is recommended to participate in "In Fracture Healing".	troduction into Anatomie'	before attending "Implants and"
Educational Objectives	After taking part successfully, students	s have reached the follow	ring learning results
Professional Competence			
Knowledge	The students can describe the differe existence. The students can name different tre fracture morphologies.	•	·
Skills	The students can determine the for situations under specific assumptions	_	uman body under quasi-statio
Personal Competence			
Social Competence	The students can, in groups, solve internal forces.	basic numerical modeli	ng tasks for the calculation o
Autonomy	The students can, in groups, solve internal forces.	basic numerical modeli	ng tasks for the calculation o
Workload in Hours	Independent Study Time 62, Study Tir	ne in Lecture 28	
Credit points	3		
Studienleistung	None		
	Written exam		
Examination duration and scale	90 min		
	General Engineering Science (Gern Focus Biomechanics: Compulsory General Engineering Science (Gern Compulsory General Engineering Science (Gern Engineering, Focus Biomechanics: Co General Engineering Science (Gern	nan program): Specialis nan program, 7 semest ompulsory	eation Biomedical Engineering
Assignment for the Following Curricula	Engineering: Compulsory General Engineering Science (Engl Compulsory General Engineering Science (Engl Focus Biomechanics: Compulsory General Engineering Science (Engl Engineering, Focus Biomechanics: Co General Engineering Science (Engl Engineering: Compulsory Mechanical Engineering: Specialisatio Biomedical Engineering: Specialisatio	ish program): Specialisa lish program, 7 semest ompulsory lish program, 7 semest on Biomechanics: Compu	ation Mechanical Engineering er): Specialisation Mechanica ter): Specialisation Biomedica



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



	ts and Fracture Healing
	Lecture
Hrs/wk	
CP Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Michael Morlock
Language	DE
Cycle	WiSe
	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
	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
Literature	Nigg, B.: Biomechanics of the musculo-skeletal system
	Schiebler T.H., Schmidt W.: Anatomie
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat



Module M1334: B	IO II: Biomaterials				
Courses					
Title		Тур	Hrs/wk	СР	
Biomaterials (L0593)		Lecture	2	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, 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 Ti	me in Lecture 28			
Credit points	3				
Studienleistung	None				
Examination	Written exam				
Examination duration and scale	90 min				
Assignment for the Following Curricula	International Management and Engliotechnology: Elective Compulsory Materials Science: Specialisation Na Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Biomedical Engineering: Specialisation Biomedical Engineering: Specialisation Compulsory Biomedical Engineering: Specialisation Compulsory Theoretical Mechanical Engineering: Theoretical Mechanical Engineering Compulsory	no and Hybrid Materials: El on Artificial Organs and Re on Implants and Endoprosi tion Medical Technology tion Management and Bus Technical Complementary	lective Compulso egenerative Med theses: Compulso and Control The siness Administr	ory licine: Elective sory eory: Elective ation: Elective e Compulsory	

Course L0593: Biomaterials		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	



Lecturer Language	Prof. Michael Morlock EN
Cycle	WiSe
	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, S.-W: Biokompatible Werkstoffe und Bauweisen. Berlin, Springer, 1996.



amics) nematics I, II, III (in par r taking part successfu	rticular differential		Hydrostatics			
. Otto von Estorff e hanics I (Statics, Me amics) nematics I, II, III (in par r taking part successfu	rticular differential	Recitation Section (large) rials) and Mechanics II (Fequations)	2 Hydrostatics	3 s, Kinematic		
e hanics I (Statics, Me amics) nematics I, II, III (in part taking part successful students possess and	rticular differential	rials) and Mechanics II (F	Hydrostatics	s, Kinematic		
e hanics I (Statics, Me amics) nematics I, II, III (in par r taking part successfu	rticular differential	equations)				
hanics I (Statics, Me amics) nematics I, II, III (in par r taking part successfu students possess an	rticular differential	equations)				
amics) nematics I, II, III (in par r taking part successfu	rticular differential	equations)				
students possess an	ully, students have	e reached the following lea	rning resul	te		
-			After taking part successfully, students have reached the following learning results			
-						
nod and are able to	•	dge regarding the derivat w of the theoretical and				
·			-			
lents can work in sma	ıll groups on spec	ific problems to arrive at jo	int solution	S.		
pendent Study Time	124, Study Time in	n Lecture 56				
npulsory Bonus 20 %	Form Midterm	Description	on			
ten exam						
min						
ne de et et e	ents can work in small students are able elop own finite elementarized. pendent Study Time pendent Study Time appulsory Bonus 20 % en exam min Engineering: Core quaft Systems: Core quaft Systems Engineering	ents can work in small groups on spect students are able to independently elop own finite element routines. Problem 20 % Midterm Engineering: Core qualification: Compay Systems: Core qualification: Electivant Systems Engineering: Specialisation	nents, assembling the corresponding system matrices, and solvinations. ents can work in small groups on specific problems to arrive at journal students are able to independently solve challenging compelop own finite element routines. Problems can be identified and timized. pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56 pendent Study Time 124, Study Time in Lecture 56	ents can work in small groups on specific problems to arrive at joint solutions students are able to independently solve challenging computational pelop own finite element routines. Problems can be identified and the result tinized. pendent Study Time 124, Study Time in Lecture 56 pulsory Bonus Form Description 20 % Midterm en exam min Engineering: Core qualification: Compulsory ray Systems: Core qualification: Elective Compulsory raft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory		



	Computational Science and Engineering: Specialisation Scientific Computing: Elective
	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
Following Curricula	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
	Technomathematics: Core qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Core qualification: Compulsory

Course L0291: Finite E	lement 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: P	Polymers					
Courses						
Title Structure and Properties of Processing and design with the processing and the processing and design with the processing and the processing an		Typ Lecture Lecture	Hrs/wk 2 2	CP 3 3		
Module Responsible						
Admission Requirements	None					
Recommended Previous Knowledge	Basics: chemistry / physics / material science	ce				
Educational Objectives	After taking part successfully, students have	e reached the followi	ng learning resul	ts		
Professional Competence						
	Students can use the knowledge of plastics	s and define the nece	ssary testing and	l analysis.		
Knowledge	They can explain the complex relationships	s structure-property re	elationship and			
Mowieage	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 weakness	ses.				
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, Study Time i	n Lecture 56				
Credit points	6					
Studienleistung						
	Written exam					
Examination duration and scale	180 min					
	Materials Science: Specialisation Engineer Biomedical Engineering: Specialisation Im	-		ory		



	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory						
	Biomedical Engineering: Specialisation Management and Business Administration: Elective						
	Compulsory Diamodical Engineering Specialization Medical Technology and Control Theory Flority						
Assignment for the	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective						
Following Curricula	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	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		
Content	- Structure and properties of polymers - Structure of macromolecules Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution - Morphology amorph, crystalline, blends - Properties Elasticity, plasticity, viscoelacity - Thermal properties - Electrical properties - Theoretical modelling - Applications		
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag		



Course L1892: Proces	sing 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



Courses					
litle little			Тур	Hrs/wk	СР
Regenerative Medicine (Li Lecture Tissue Engineerin	0347) Ig - Regenerative Medicine	(L1664)	Seminar Seminar	2 2	3 3
Module Responsible		,			
A dmission					
Recommended Previous Knowledge	None				
Educational Objectives	After taking part success	sfully, students ha	ve reached the follow	ing learning resu	Its
Professional Competence					
Knowledge	of regenerative medicintissue engineering. The animal and human cells	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 o tissue engineering. They are able to give a basic overview of methods for the cultivation o 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. After successful completion of the module students are				
Skills	 able to use medical databases for acquirierung and presentation of relevant up-to-dat data independently able to present their work results in the form of presentations able to carry out basic cell culture methods and the corresponding analysi independently able to analyse and evaluate current research topics for Tissue Engineering an regenerative medicine. 				
Personal					
Competence	Students are able to work together as a team with 2-4 students to solve given tasks and				
	discuss their results in the			ients to solve gi	ven tasks ar
Social Competence	Students are able to reflect their work orally and discuss it with other students and teachers.				
Autonomy	After completion of this roof approx. 2-4 persons in			·	blem in tean
	Independent Study Time	e 124, Study Time	in Lecture 56		
Credit points					
Studienleistung	Compulsory Bonus Yes 20 %	Form Written elabora	Aus Aus	scription arbeitung zu Rit tocol for lecture se	-
			1		
Examination	Presentation				



	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory				
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine:				
Accienment for the	Compulsory				
Following Curricule	Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory				
Following Curricula	Compulsory				
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective				
	Compulsory				

Course L0347: Regen	erative 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/EN
Cycle	WiSe
Content	The course deals with the application of biotechnological engineering principles for regeneration 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	e 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



Courses					
-	ciples and Applications (L0371 ciples and Applications (L0373		Typ Lecture Recitation Section (small)	Hrs/wk 3 2	CP 5 1
	Prof. Christian Schuster				
Admission Requirements	None				
Recommended Previous Knowledge		:			
Educational Objectives	I ATTER TAKING NART SUICCESSTU	lly, students have re	eached the following lea	rning resul	its
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.				
Skills	Students know how to applieds in biological tissue. solutions of Maxwell's Equimodels predict for biological and frequency, respectivel develop validation strategelectromagnetic fields for choice.	In order to do this the lations. They are ab cal tissue, they can y, and they can ana gies for their predic	ey can relate to and ma le to assess the most im order the effects corre lyze them in a quantitati ctions. They are able to	ke use of the portant efforts of the sponding way. The evaluate	he elementa ects that thes to waveleng ney are able the effects
Personal Competence		together on subjec	t related tasks in small (arouns Th	ev are able
Social Competence	present their results effecti	_			cy are able
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 1	10, Study Time in L	ecture 70		
Credit points	6				
Studienleistung	Compulsory Bonus Yes 10 %	Form Presentation	Descriptio	n	



Examination	ral exam		
Examination duration and scale	145 min		
Assignment for the Following Curricula	I Riomedical Engineering. Specialication implants and Engoprostheses, Flective Compilisory - I		



Course L0371: Bioeled	ctromagnetics: 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)
	- 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: Bioeled	ctromagnetics: Principles and Applications
Тур	Recitation Section (small)
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
	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
Comtout	- 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)
	- A. Vorst, A. Rosen, Y. Kotsuka, "RF/Microwave Interaction with Biological Tissues", Wile (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)



Courses						
Title				Тур	Hrs/wk	СР
Robotics and Navigation in Medicine (L0335)				Lecture	2	3
Robotics and Navigation in Medicine (L0338) Robotics and Navigation in Medicine (L0336)				Project Seminar Recitation Section (small)	2	2 1
Module Responsible	•	-	ar	· · · · · · · · · · · · · · · · · · ·	•	
Admission		der Ociliaeie	51			
Requirements	None					
Recommended Previous Knowledge	• princi	•	n (algebra, analysis/c gramming, e.g., in Jav skills	•		
Educational Objectives	I After takına n	art success	fully, students have r	eached the following lea	rning resul	ts
Professional Competence						
·	The students systems and	their comp d safety an	onents in detail. Sys	acking systems in clinica stems can be evaluated nts can assess typical sy	with respe	ect to collision
Skills	medical appl		to design and evalu	ate navigation systems	and robot	ic systems t
Personal Competence						
Social Competence	The student incoorporate	s discuss feedback ir	the results of othe nto their work.	r groups, provide help	oful feedb	ack and ca
Autonomy			t their knowledge an appropriate manner.	d document the results	of their w	ork. They ca
Workload in Hours	Independent	Study Time	110, Study Time in L	ecture 70		
- ا - ا - ما ما المام	6					
Credit points	Compulsory Yes	Bonus 10 % 10 %	Form Written elaboration Presentation	Descriptio	n	
Studienleistung	Yes	10 /0				
Studienleistung	Yes Written exam					
Studienleistung	Written exam	l		e Engineering: Elective (



Assignment for the	Compulcory
Following 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: Robotic	cs 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 M0634: li	ntroduction into M	ledical Technol	ogy and Systems		
Courses					
Title			Tun	Hrs/wk	СР
	Гесhnology and Systems (L	0342)	Typ Lecture	nrs/wk	3
	Fechnology and Systems (L	·	Project Seminar	2	2
Introduction into Medical 7	Technology and Systems (L	1876)	Recitation Section (large)	1	1
Module Responsible	Prof. Alexander Schlae	fer			
Admission Requirements	None				
	principles of math (alge)		
	principles of stochastic				
Frevious Knowleage	principles of programmi	ing, R/Maliab			
Educational Objectives	After taking part succes	sfully, students have r	eached the following lea	rning resul	ts
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.				
	applications.	The students are able to evaluate systems and medical devices in the context of clinica applications.			
Personal					
Competence	<u> </u>	n problem in modical t	technology as a project,	and dofina	tacke that are
Social Competence	solved in a joint effort.	a problem in inedicari	ecimology as a project,	and deline	וומו מוכ
Autonomy		The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.			ork. They can
Workload in Hours	Independent Study Tim	e 110, Study Time in L	ecture 70		
Credit points	6				
	Compulsory Bonus	Form	Description	n	
Studienleistung		Written elaboration	n		
	Yes 10 %	Presentation			
Examination	Written exam				
Examination duration and scale	90 minutes				
Assignment for the Following Curricula	Compulsory General Engineering Sengineering: Compulsory Computer Science: Specification of the Computer Science Specification of the Compulsory General Engineering Sengineering: Compulsory Computational Science Compulsory	Science (German propry ecialisation Computer Core qualification: Ele Science (English pro Science (English propry e and Engineering:	ogram): Specialisation E ogram, 7 semester): Special Software Engineering ective Compulsory ogram): Specialisation E ogram, 7 semester): Specialisation Engineering	pecialisationg: Elective Biomedical pecialisation	n Biomedica Compulsory Engineering n Biomedica
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Compulsory
Computational Science and Engineering: Specialisation Mathematics & Engineering Science:
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: Introdu	ction 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: Introdu	ction 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: N	Ionlinear Dynamics			
Courses				
Title Nonlinear Dynamics (L07	02)	Typ Integrated Lecture	Hrs/wk 4	CP 6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous Knowledge	CalculusLinear AlgebraEngineering Mechanics			
Educational Objectives	After taking part successfully, students have re	eached the following le	arning resul	ts
Professional Competence				
Knowledge	Students are able to reflect existing terms develop and research new terms and concep	ts.		
Skills	Students are able to apply existing methods develop novel methods and procedures.	and procesures of No	onlinear Dyr	namics and to
Personal Competence				
Social Competence	Students can reach working results also in gr	·		
Autonomy	Students are able to approach given researd novel research tasks by themselves.	th tasks individually and	d to identify	and follow up
	Independent Study Time 124, Study Time in L	ecture 56		
Credit points				
Studienleistung				
	Written exam			
Examination duration and scale	2 Hours			
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Computational Science and Engineering: Specialisation Scientific Computing: Elect Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elect 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: Elect Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elect Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elect 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		ting: Elective nics: Elective e Compulsory sory icine: Elective Compulsory eory: Elective ation: 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 Title			Туј		Hrs/wk	CP
Semiconductor Technolog				ture ctical Course	4	4 2
Semiconductor Technolog	1		Fla	Clical Course	2	2
Module Responsible		m Trieu				
Admission Requirements	None					
Recommended Previous Knowledge	Basics in phys	sics, chemistry, ma	terial science and	semiconductor	devices	
Educational Objectives	After taking pa	rt successfully, stu	udents have reach	ed the following	ı learning resu	lts
Professional						
Competence						
	Students are a	ıble				
	 to describe 	and to explain cu	ırrent fabrication te	echniques for Si	and GaAs sub	ostrates,
Knowledge	 to discus 	ss in details the r	elevant fabricatio	n processes, pr	ocess flows a	nd the impa
		fabrication of sem				
	to present in	integrated process	s flows.			
	Students are c	apable				
	to analyze the impact of process parameters on the processing results,					
Skills						
		•				
	to develop	process flows for	the fabrication of s	semiconductor c	levices.	
Personal						
Competence						
	Students are a	able to prepare a	nd perform their I	ab experiments	in team work	as well as
Social Competence	present and di	scuss the results i	in front of audienc	e.		
Autonom	Nana					
Autonomy Workload in Hours		Study Time OF Stu	dy Time in Locture	a 84		
Credit points		Judy Tille 30, Slu	ay Time in Leciul	∪ 1		
Studienleistung						
	Oral exam					
⊏xamination	Olai Okaiii					
Examination Examination						



Assignment for the Following Curricula	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: Specialisation Microelectronics Complements: Elective Compulsory
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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
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: H	lumanoid	Robotics			
Courses					
Title Humanoid Robotics (L066	3)		Typ Seminar	Hrs/wk 2	CP 2
Module Responsible	Patrick Götts	ch			
Admission Requirements	None				
Recommended Previous Knowledge	• Introd	luction to control system of theory and design	ems		
Educational Objectives	After taking p	part successfully, stud	ents have reached the followir	ng learning resul	ts
Professional Competence					
Knowledge		ents can explain huma ents learn to apply ba	anoid robots. sic control concepts for differer	nt tasks in huma	noid robotics.
Skills	 Students acquire knowledge about selected aspects of humanoid robotics, based or specified literature Students generalize developed results and present them to the participants Students practice to prepare and give a presentation 				
Personal Competence					
Social Competence	them • They		developing solutions in interdinate feedback and ha		
Autonomy	 Students evaluate advantages and drawbacks of different forms of presentation specific tasks and select the best solution Students familiarize themselves with a scientific field, are able of introduce it and followers presentations of other students, such that a scientific discussion develops 		e it and follo		
Workload in Hours	Independent	Study Time 32, Study	y Time in Lecture 28		
Credit points	2				
Studienleistung	None				
Examination	Presentation				
Examination duration and scale	30 min				
Assignment for the Following Curricula	Mechatronic Mechatronic Biomedical E Compulsory Biomedical E	s: Specialisation Intells: Specialisation Systems: Specialisering: Specialis	tion Control and Power System ligent Systems and Robotics: It em Design: Elective Compulso sation Artificial Organs and Re sation Implants and Endoprost lisation Medical Technology	Elective Compulsory egenerative Med theses: Elective	sory icine: Electiv 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 L0663: Human	oid 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				
Fitle Linear and Nonlinear Syst	em Identification (L0660)	Typ Lecture	Hrs/wk	CP 3
Module Responsible	Prof. Herbert Werner			
Admission Requirements				
Recommended Previous Knowledge	 State space methods 			
Educational Objectives	After taking part successfully, s	students have reached the follow	ring learning resu	Its
Professional Competence				
Knowledge	 Students can explain the general framework of the prediction error method and is application to a variety of linear and nonlinear model structures They can explain how multilayer perceptron networks are used to model nonline 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 Kalma realisation theory 			
Skills	 Students are capable of applying the predicition error method to the experimen identification of linear and nonlinear models for dynamic systems They are capable of implementing a nonlinear predictive control scheme based or neural network model They are capable of applying subspace algorithms to the experimental identification linear models for dynamic systems They can do the above using standard software tools (including the Matlab Syste Identification Toolbox) 			
Personal Competence				
Social Competence	Students can work in mixed gr	oups on specific problems to arri	ive at joint solution	ns.
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 62, S	tudy Time in Lecture 28		
Credit points				
Studienleistung	None			
Examination	Oral exam			
Examination duration and scale	30 min			
	Mechatronics: Specialisation I	lisation Control and Power Systentelligent Systems and Robotics: System Design: Elective Compuls	: Elective Compul	



	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective
Assignment for the	Compulsory
Following Curricula	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
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
	Theoretical Mechanical Engineering: Core qualification: Elective Compulsory

Course L0660: Linear	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 		



	J		ust Control				
Courses							
Fitle Optimal and Robust Contr Optimal and Robust Contr		•		Typ Lecti Reci	ure ation Section (small)	Hrs/wk 2 2	CP 3 3
Module Responsible	Prof. H	erbert Werner					
Admission Requirements							
Recommended Previous Knowledge	•	State space m	rol (frequency re ethods a, singular value				
Educational Objectives	After ta	king part succe	essfully, students	s have reache	d the following lea	arning resul	ts
Professional Competence							
Knowledge	•	LQ problems. They can expesimation. They can explement of they can explement of they can explement of they can expess to robust control of they can expess of the they can ex	plain the dualit ain how the H2 constraints. lain how an LQ problem. lain how model oller design lain how - base polity and perforr	and H-infinity G design prol uncertainty co ed on the sm mance for an o is and synthe	e matrix Riccati ed ptimal state feed norms are used plem can be formulan be represented all gain theorem uncertain plant.	lback and to represer ulated as s I in a way th - a robust	optimal stant stability are pecial case nat lends itsecontroller case
Skills	 Students are capable of designing and tuning LQG controllers for multivariable models. They are capable of representing a H2 or H-infinity design problem in the form generalized plant, and of using standard software tools for solving it. They are capable of translating time and frequency domain specifications for oloops into constraints on closed-loop sensitivity functions, and of carrying out an sensitivity design. They are capable of constructing an LFT uncertainty model for an uncertain sy and of designing a mixed-objective robust controller. They are capable of formulating analysis and synthesis conditions as linear inequalities (LMI), and of using standard LMI-solvers for solving them. They can carry out all of the above using standard software tools (Matlab robust of toolbox). 		the form of ons for contr g out a mixe ertain system s linear mate				
Personal Competence							
Social Competence				•	-		
•	OL .I.	to are able to	final carriers of the	formation in	sources provided	(lacture no	too litorotur



Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Studienleistung	None
Examination	
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Energy Systems: Core qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: 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 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: Optima	I 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



Courses				
Title Marketing of Innovations	(L2009)	Typ Lecture	Hrs/wk 4	CP 4
PBL Marketing of Innovat	ions (L0862)	Project-/problem-based Learning	1	2
Module Responsible	Prof. Christian Lüthje			
Admission Requirements	INOne			
Recommended Previous Knowledge	theory, project management Bachelor-level Marketing Kr Strategies, Basics of Buying Unerstanding the differences	ness administration principles (str , international business) nowledge (Marketing Instruments Behavior) s beweetn B2B and B2C marketir ance of managing innovation in g	s, Market a	nd Competit
Educational Objectives	After taking part successfully, studer	nts have reached the following lea	arning resu	lts
Professional Competence				
Knowledge	 Approaches for analyzing development The gathering of information Concepts and approaches service development proces Approaches and tools for exproducts and innovative service. Marketing mix elements the challenges of innovative promotes are pricing methods for new promotes. The organization of complexes. Communication concepts and 	ensuring customer-orientation in vices at take into consideration the specific ducts and services ducts and services a sales forces and personal selling and instruments for new products a	and the direquirement of needs into the developecific required	future mark ents o product ar pment of ne uirements ar
Skills	 Analyze markets by applying Conduct forecasts and deve Translate customer needs successfully apply advance development Use adequate methods to fo Choose suitable pricing stration Make strategic sales decision 	students will be able to: sions regarding marketing and in g market and technology portfolior lop compelling scenarios as a ba into concepts, prototypes and ed methods for customer-orient ster efficient diffusion of innovativ tegies and communication activiti sions for products and services e management (i.e. customer value	s sis for strate marketab red product e products es for innov	egic planning le offers and t and services and services vations ction of sale
Personal				
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	6
Studienleistung	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: Market	ing 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	
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) III. Methods and approaches of strategic marketing planning patterns of industrial development, patent and technology portfolios IIII. 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
Literature	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 Ma	arketing 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	



•				
Courses				
Title Bioprocess Engineering -	Fundamentals (L0841)	Typ Lecture	Hrs/wk 2	CP 3
Bioprocess Engineering- I		Recitation Section (large)	_	1
Bioprocess Engineering -	Fundamental Practical Course (L0843)	Practical Course	2	2
Module Responsible	Prof. Andreas Liese			
Admission Requirements	None			
Recommended Previous Knowledge	none, module "organic chemistry", modu	le "fundamentals for process	engineerin	ıg"
Educational Objectives	After taking part successfully, students ha	ave reached the following lea	rning resul	ts
Professional Competence				
Knowledge	Students are able to describe the basic classify different types of kinetics for enzidifferent types of inhibition. The paramet mass transport processes in bioreacto explain fundamental bioprocess manaprocessing in detail.	rymes and microorganisms, a ters of stoichiometry and rhed rs can be explained. The s	as well as to plogy can b students a	to differentiate be named and re capable to
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 redo equivalents and growth inhibition on the fermentation process analyze bioprocesses on basis of stoichiometry and to set up / solve metabolic flu equations distinguish between scale-up criteria for different bioreactors and bioprocesse (anaerobic, aerobic as well as microaerobic) to compare them as well as to apply then 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	After completion of this module porticing	anta abauld ba abla ta dabas	to toobnioo	l quantiana i
Social Competence	After completion of this module participal small teams to enhance the ability to tall capacity for teamwork in engineering and	ke position to their own opin		•
Autonomy	After completion of this module participa independently by organizing their workfloor		•	
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
	· · · · · · · · · · · · · · · · · · ·			



	practical work
	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Process Engineering: Compulsory General Engineering Science (German program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess 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: Biopro	Course L0841: Bioprocess 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, fedbatch 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	
Content	 Introduction (Prof. Liese, Prof. Zeng) Enzymatic kinetics (Prof. Liese) Stoichiometry I + II (Prof. Liese) Microbial Kinetics I+II (Prof. Zeng) Rheology (Prof. Liese) Mass transfer in bioprocess (Prof. Zeng) Continuous culture (Chemostat) (Prof. Zeng) Sterilisation (Prof. Zeng) Downstream processing (Prof. Liese) Repetition (Reserve) (Prof. Liese, Prof. Zeng) 	
	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	



Module M1143: N	Mechanical Design Methodology	1		
Courses				
Title		Тур	Hrs/wk	СР
Mechanical Design Metho Mechanical Design Metho		Lecture Recitation Section (small)	3	4 2
		rectation section (smail)	'	
Admission	Prof. Josef Schlattmann			
Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following lea	rning result	S
Professional				
Competence Knowledge	Science-based working on product design of design techniques	considering targeted applic	cation of sp	ecific product
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 Autonomy				
-	I Independent Study Time 124, Study Time in	Lecture 56		
Credit points				
Studienleistung				
Examination				
Examination duration and scale	30 min			
Assignment for the Following Curricula	II.Amnilieary			



Course L1523: Mechanical Design Methodology		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Josef Schlattmann	
Language	DE	
Cycle	SoSe	
Content	 Systematic reflection and analysis of the mechanical design process Process structuring in sections (task, functions, acting principles, design-elements and total construction) as well as levels (working-, controlling-, and deciding-levels) Creativity (basics, methods, practical application in mechatronics) Diverse methods applied as tools (function structure, GALFMOS, AEIOU method, GAMPFT, simulation tools, TRIZ) Evaluation and selection (technical-economical evaluation, preference matrix) Value analysis, cost-benefit analysis Low-noise design of technical products Project monitoring and leading (leading projects / employees, organisation in product development, creating ideas / responsibility and communication) Aesthetic product design (industrial design, colouring, specific examples / exercises) 	
Literature	 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: Mechanical Design Methodology			
Тур	Recitation Section (small)		
Hrs/wk			
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Josef Schlattmann		
Language	DE		
Cycle	SoSe		
Content	 Systematic reflection and analysis of the mechanical design process Process structuring in sections (task, functions, acting principles, design-elements and total construction) as well as levels (working-, controlling-, and deciding-levels) Creativity (basics, methods, practical application in mechatronics) Diverse methods applied as tools (function structure, GALFMOS, AEIOU method, GAMPFT, simulation tools, TRIZ) Evaluation and selection (technical-economical evaluation, preference matrix) Value analysis, cost-benefit analysis Low-noise design of technical products Project monitoring and leading (leading projects / employees, organisation in product development, creating ideas / responsibility and communication) Aesthetic product design (industrial design, colouring, specific examples / exercises) 		
Literature	 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 		



Courses			
Title Introduction to Anatomy (I	Typ Hrs/wk CP L0384) Lecture 2 3		
Module Responsible	Prof. Udo Schumacher		
Admission Requirements	None		
Recommended Previous Knowledge			
Educational Objectives	I Affer taking part successium, 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 professional level.		
Autonomy	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	3		
Studienleistung	None		
	Written exam		
Examination duration and scale	90 minutes		
Assignment for the	It-charal Engineering Science (English program / comester): Specialization Machanica		
Following Curricula	Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedica Engineering: Compulsory Mechanical 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 L0384: Introdu	ction to Anatom	пу
Тур	Lecture	
Hrs/wk		
СР		
	-	udy Time 62, Study Time in Lecture 28
	Prof. Tobias Lai	nge
Language		
Cycle		
	General Anator 1 st week: 2 nd week:	The Eucaryote Cell The Tissues
	3 rd week:	Cell Cycle, Basics in Development Musculoskeletal System
	5 th week:	Cardiovascular System
Content	6 th week: 7 th week: 8 th week:	Respiratory System Genito-urinary System Immune system
	9 th week:	Digestive System II
	11 th week:	Endocrine System
	12 th week: 13 th week:	Nervous System Exam
Literature	Adolf Faller/Mid Stuttgart, 2012	chael Schünke, Der Körper des Menschen, 16. Auflage, Thieme Verlag



		siology		
Courses				
Title Introduction to Physiology	(L0385)	Typ Lecture	Hrs/wk 2	CP 3
Module Responsible	Dr. Roger Zimmermann			
Admission Requirements	None			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, studen	ts have reached the follow	wing learning resul	ts
Professional Competence				
	The students can			
Knowledge	 describe the basics of the end describe physiological relation and sensory physiology. 		muscle, heart/circu	ılation, neuro
Skills	The students can describe the effe processing of information, developm technical systems.		•	
Personal				
Competence	The state of the s			1
Social Competence	The students can conduct discussion The students can find solutions to metrological.			
Autonomy	The students can derive answers to questions arising in the course and other physiological areas, using technical literature, by themselves.			
Workload in Hours	Independent Study Time 62, Study T	ime in Lecture 28		
Credit points	3			
Studienleistung	None			
Examination	Written exam			
Examination duration and scale	60 minutes			
	General Engineering Science (Ger Focus Biomechanics: Compulsory General Engineering Science (Ger Compulsory General Engineering Science (Ger Engineering: Compulsory General Engineering Science (Ger Engineering, Focus Biomechanics: Celectrical Engineering: Specialisation General Engineering Science (Eng Focus Biomechanics: Compulsory General Engineering Science (Eng Compulsory	rman program): Speciali rman program, 7 semes rman program, 7 semes Compulsory n Medical Technology: El glish program): Specialis	sation Biomedical ster): Specialisatio ster): Specialisatio lective Compulsory sation Mechanical sation Biomedical	Engineering n Biomedica n Mechanica , Engineering
	General Engineering Science (Engineering, Focus Biomechanics: C		ster): Specialisatio	n Mechanica



Engineering: Compulsory
Mechanical 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: Core qualification: 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. Roger Zimmermann	
Language	DE	
Cycle	SoSe	
Content		
	Taschenatlas der Physiologie, Silbernagl Despopoulos, ISBN 978-3-135-67707-1, Thieme	
Literature	Repetitorium Physiologie, Speckmann, ISBN 978-3-437-42321-5, Elsevier	



Courses				
Fitle		Тур	Hrs/wk	СР
	and Radiation Therapy (L0383)	Lecture	2	3
Module Responsible Admission				
Requirements	None			
Recommended Previous Knowledge	None			
Educational Objectives	After taking part successfully, studer	its have reached the follow	wing learning resu	lts
Professional Competence				
Competence	Therapy			
	The students can distinguish difference in radiation therapy.	nt types of currently used	equipment with res	spect to its us
	The students can explain treatme contexts (e.g. surgery, internal media		tion therapy in in	terdisciplina
	The students can describe the pa follow-up care.	tients' passage from the	eir initial admittan	ce through t
	Diagnostics			
Knowledge	The students can illustrate the tech angiography and mammography, as			
	The students can explain the diagnowell as the technical basis for those	•	ic use of imaging	echniques, a
	The students can choose the right transaction and needs.	eatment method dependir	ng on the patient's	clinical histor
	The student can explain the influenc	e of technical errors on th	e imaging techniq	ues.
	The student can draw the right con error protocol.	clusions based on the in	nages' diagnostic	indings or th
	Therapy The students can distinguish curative that conclusion.	re and palliative situations	s and motivate wh	y they came t
	The students can develop adequate aspects.	e therapy concepts and re	elate it to the radia	tion biologica
	The students can use the therapeuti	c principle (effects vs adve	erse effects)	
Skills	The students can distinguish differe on the situation (location of the to (irradiation planning).			•
	The student can assess what an inc			
	Diagnostics			
	The students can suggest solutions error analyses.	for repairs of imaging in	strumentation afte	r having don



	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.
Autonomy	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. 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
Studienleistung	None
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering: Specialisation Medical Technology: Elective Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): 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: 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	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



Courses			
Title		Тур	Hrs/wk CP
Experimental Methods in I	Biomechanics (L0377)	Lecture	2 3
Module Responsible	Prof. Michael Morlock		
Admission Requirements	None		
Recommended Previous Knowledge	It is recommended to participate "Experimentelle Methoden".	in "Implantate und Fr	akturheilung" before attendin
Educational Objectives	After taking part successfully, studen	ts have reached the follow	wing learning results
Professional Competence			
Knowledge	The students can describe the differ existence. The students can name different tr fracture morphologies. The students can describe different	reatments for the spine measurement techniques	and hollow bones under give
Skills	choose the adequate technique for a The students can describe the bas biomechanics.		xperimental techniques used i
Personal Competence			
Social Competence	The students can, in groups, solve ba	asic experimental tasks.	
Autonomy	The students can, in groups, solve ba	asic experimental tasks.	
Workload in Hours	Independent Study Time 62, Study T	ime in Lecture 28	
Credit points	3		
Studienleistung	None		
Examination Examination duration and scale	Written exam 90 min		
Assignment for the Following Curricula	General Engineering Science (Ger Focus Biomechanics: Compulsory General Engineering Science (Ger Compulsory General Engineering Science (Ger Engineering, Focus Biomechanics: C General Engineering Science (Ger Engineering: Compulsory General Engineering Science (Eng Compulsory General Engineering Science (Eng Focus Biomechanics: Compulsory General Engineering Science (Eng Engineering, Focus Biomechanics: C General Engineering Science (Eng Engineering: Compulsory	rman program): Specialisman program, 7 semes Compulsory rman program, 7 semes glish program): Specialis glish program): Specialis glish program, 7 semes Compulsory	sation Biomedical Engineering ster): Specialisation Mechanical ster): Specialisation Biomedical sation Biomedical Engineering sation Mechanical Engineering ster): Specialisation Mechanical



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 L0377: Experi	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: E	BIO II: Artificial Joint Repl	acement		
Courses				
Title	. (1.4000)	Тур	Hrs/wk	СР
Artificial Joint Replacemen		Lecture	2	3
	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of orthopedic ar	nd surgical techniques is recomm	ended.	
Educational Objectives	After taking part successfully, stud	lents have reached the following	learning resu	Its
Professional Competence				
Knowledge	The students can name the differe	ent kinds of artificial limbs.		
Skills	The students can explain the endoprotheses.	advantages and disadvantaç	ges of diffe	rent kinds o
Personal Competence				
Social Competence	The students are able to discuss teachers.	issues related to endoprothese	with student	mates and the
Autonomy	The students are able to acquire i with respect to its credibility.	nformation on their own. They ca	n also judge t	he informatior
Workload in Hours	Independent Study Time 62, Stud	y Time in Lecture 28		
Credit points	3			
Studienleistung	None			
	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	International Management and Biotechnology: Elective Compulsor Materials Science: Specialisation Biomedical Engineering: Speciali Compulsory Biomedical Engineering: Speciali Biomedical Engineering: Special Compulsory Biomedical Engineering: Special Compulsory Theoretical Mechanical Engineering Theoretical Mechanical Engineering Compulsory	Nano and Hybrid Materials: Elect sation Artificial Organs and Regestation Implants and Endoprosthe lisation Medical Technology and isation Management and Busine ing: Technical Complementary Compleme	tive Compulse enerative Med ses: Compulse d Control The ess Administr	ory licine: Elective sory eory: Elective ation: Elective



Course L1306: Artificial 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		
Cycle		
	Inhalt (deutsch)	
	1. EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenkersatzes)	
	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.	
	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: F	Feedback Control in Medical Technology		
Courses			
Courses Title	Тур	Hrs/wk	СР
Feedback Control in Medi		2	3
Module Responsible	Johannes Kreuzer		
Admission Requirements	INone		
Recommended Previous Knowledge	Basics in Control, Basics in Physiology		
Educational Objectives	I Affer taking part successfully students have reached the following	learning resul	ts
Professional			
Competence	The lecture will introduce into the fascinating area of medical technology with the engineer point of view. Fundamentals in human physiology will be similarly introduced like knowled in control theory.		
Knowledge	Internal control loops of the human body will be discussed in the external closed loop system fo example in for anesthesia control.	same way like	the design of
	The handling of PID controllers and modern controller like procontroller or neural networks will be illustrated. The operation of s be discussed.		-
Skills	Application of modeling, identification, control technology in the fies	ld of medical t	echnology.
Personal Competence			
Social Competence	Students can develop solutions to specific problems in small grou (e.g. during project week)	ips and prese	nt their results
Autonomy	Students are able to find necessary literature and to set it into the are able to continuously evaluate their knowledge and to tak process. They can combine knowledge from different courses to for	ce control of	their learning
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points			
Studienleistung			i
Examination duration			
Examination duration and scale	120 min		
Assignment for the Following Curricula	Electrical Engineering: Specialisation Medical Technology: Electrical Engineering: Specialisation Control and Power Systems Biomedical Engineering: Specialisation Implants and Endoprosther Biomedical Engineering: Specialisation Artificial Organs and Regard Compulsory Biomedical Engineering: Specialisation Management and Busin Compulsory	: Elective Comeses: Elective (enerative Med	ipulsory Compulsory icine: Elective
	Biomedical Engineering: Specialisation Medical Technology and	Control Theory	: Compulsory



Course L0664: Feedback 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	 Taking an engineering point of view, the lecture is structured as follows. Introduction to the topic with selected examples Physiology - introduction and overview Regeneration of functions of the cardiovascular system Regeneration of the respiratory functions Closed loop control in anesthesia regeneration of kidney and liver functions regeneration of motorize function/ rehabilitation engineering navigation systems and robotic in medicine The lecture will use knowledge from modeling, simulation and controller design and MATLAB and SIMULINK will be used.	
	Silbernagel/Depopoulos: Taschenatlas der Physiologie, Thieme Verlag Stuttgart Werner: Kooperative und autonome Systeme der Medizintechnik, Oldenburg Verlag M.C.K.Khoo: "Physiological Control System", IEEE Press, 2000	



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Module M0832: A	Advanced Topics in Cont	rol		
Courses				
Title Advanced Topics in Conti	rol (I 0661)	Typ Lecture	Hrs/wk 2	CP 3
Advanced Topics in Contr		Recitation Section (small)		3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	I H-Intinity ontimal control mived-c	ensitivity design, linear matrix inequa	alities	
Educational Objectives	After taking part successfully, stuc	lents have reached the following lea	rning resu	Its
Professional Competence				
	scheduling approach They can explain the repsystems They can explain how staformulated as LMI condition They can explain how esynthesis problems for LP They are familiar with poly	gridding techniques can be used	n the form for LPV sy to solve PV system	of quasi-LP\ estems can be analysis and s and some o
Knowledge	communication topology c They can explain the conv	rergence properties of first order consists and synthesis conditions for	ısensus pr	otocols
	systems that are discretize They can explain (in ou	state space representation of spatied according to an actuator/sensor at tline) the extension of the bounded associated synthesis conditions for	rray ed real le	mma to suc
	mixed-sensitivity design polytopic, LFT or general I	constructing LPV models of nonlinea of gain-scheduled controllers; th LPV models dard software tools (Matlab robust o	ey can d	do this using
Skills	 Students are able to design 	gn distributed formation controllers f s, using Matlab tools provided	or groups	of agents witl
	Students are able to design using the Matlab MD-toolb	n distributed controllers for spatially oox	interconne	ected systems



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	6
Studienleistung	None
Examination	
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Avionic and Embedded Systems: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: 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: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory



Course L0661: Advanced 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	EN	
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



Thesis

Module M-002: M	Agetor Thosis	
iviodule ivi-002. ivi		
Courses		_
Title	Typ Hrs/wk CP	_
Module Responsible	Professoren der TUHH	_
Admission Requirements		ns
Recommended Previous Knowledge		
Educational Objectives	I After taking nart euccessfully, students have reached the following learning results	
Professional Competence		
Knowledge	 The students can use specialized knowledge (facts, theories, and methods) of th subject competently on specialized issues. The students can explain in depth the relevant approaches and terminologies in o or more areas of their subject, describing current developments and taking up a critic position on them. The students can place a research task in their subject area in its context and descri and critically assess the state of research. 	ne cal
Skills	 The students are able: To select, apply and, if necessary, develop further methods that are suitable for solvi the specialized problem in question. To apply knowledge they have acquired and methods they have learnt in the course their studies to complex and/or incompletely defined problems in a solution-orient way. To develop new scientific findings in their subject area and subject them to a critic assessment. 	of ed
Personal Competence		ļ
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Students can	
Social Competence	 Both in writing and orally outline a scientific issue for an expert audience accurate understandably and in a structured way. Deal with issues competently in an expert discussion and answer them in a manr that is appropriate to the addressees while upholding their own assessments a viewpoints convincingly. 	ner
	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 t 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
Studienleistung	None
Examination	Thesis
Examination duration and scale	LACCORDING TO General Regulations
Assignment for the Following Curricula	