Module Manual

Master of Science (M.Sc.)

Biomedical Engineering

Cohort: Winter Term 2021

Updated: 31st May 2021

Table of Contents

Table of Conte		2
Program descr		5
Core qualificat		6
	Business & Management	6
	Non-technical Courses for Master	7
	Applied Statistics	9
	Medical Imaging Systems Medical Basics and Pathology	11
	Practical Course Product Development, Materials and Production	15
	Case Studie and Clinical Internship	17
Module M1214:		19
	Implants and Endoprostheses	20
	Intelligent Systems in Medicine	20
	Selected Topics of Biomedical Engineering - Option A (6 LP)	22
Module M1241:	Selected Topics of Biomedical Engineering - Option B (12 LP)	29
	Intelligent Autonomous Agents and Cognitive Robotics	36
Module M0775:		38
	Vibration Theory	39
	Finite Elements Methods Technology Management	40 42
	Microsystems Technology in Theory and Practice	44
	Control Systems Theory and Design	46
	Production Planning & Control and Digital Enterprise	48
	Electronic Circuits for Medical Applications	50
	Continuum Mechanics	53
	Materials Modeling	56
	Advanced Functional Materials	58
	MED II: Introduction to Biochemistry and Molecular Biology	59
	BIO II: Biomaterials	60
Module M1342:		62
	Regenerative Medicine	64
	BIO I: Implants and Fracture Healing Robotics and Navigation in Medicine	66 68
	Case Studies for Regenerative Medicine and Tissue Engineering	70
	Introduction into Medical Technology and Systems	71
	Nonlinear Dynamics	73
	Semiconductor Technology	74
	Humanoid Robotics	76
Module M0838:	Linear and Nonlinear System Identifikation	77
	Optimal and Robust Control	79
	Marketing (Sales and Services / Innovation Marketing)	81
	Applied Design Methodology in Mechatronics	83
	Bioprocess Engineering - Fundamentals MED II: Introduction to Physiology	85 88
	MED I: Introduction to Physiology	89
	MED I: Introduction to Radiology and Radiation Therapy	91
	BIO II: Artificial Joint Replacement	93
	Feedback Control in Medical Technology	94
Module M0832:	Advanced Topics in Control	95
Module M0548:	Bioelectromagnetics: Principles and Applications	97
	Artificial Organs and Regenerative Medicine	99
Module M0623:	Intelligent Systems in Medicine	99
Module M1241:	Selected Topics of Biomedical Engineering - Option B (12 LP)	101
	Selected Topics of Biomedical Engineering - Option A (6 LP)	108
Module M0629: Module M0775:	Intelligent Autonomous Agents and Cognitive Robotics	115 117
	Vibration Thoon,	118
	Technology Management	119
	Control Systems Theory and Design	121
Module M0867:	Production Planning & Control and Digital Enterprise	123
Module M0921:	Electronic Circuits for Medical Applications	125
	Continuum Mechanics	128
	Materials Modeling	131
	Advanced Functional Materials	133
	MED II: Introduction to Biochemistry and Molecular Biology	134
	BIO II: Biomaterials Finite Elements Methods	135 137
Module M0808:		137
	Regenerative Medicine	141
	BIO I: Implants and Fracture Healing	143
	Microsystems Technology in Theory and Practice	145

Module M1384: Case Studies for Regenerative Medicine and Tissue Engineering Module M0634: Introduction into Medical Technology and Systems Module M0752: Nonlinear Dynamics Module M0761: Semiconductor Technology Module M0835: Humanoid Robotics Module M0838: Linear and Nonlinear System Identifikation Module M0840: Optimal and Robust Control Module M0840: Optimal and Robust Control Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0832: Advanced Topics in Control Module M0848: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0751: Vibration Theory	149 150 152 153 155 156 160 162 164 167 171 172 173 174 176 178 180
Module M0752: Nonlinear Dynamics Module M0761: Semiconductor Technology Module M0835: Humanoid Robotics Module M0838: Linear and Nonlinear System Identifikation Module M0840: Optimal and Robust Control Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	152 153 155 156 158 160 162 164 167 171 172 173 174 176 178 178
Module M0761: Semiconductor Technology Module M0835: Humanoid Robotics Module M0838: Linear and Nonlinear System Identifikation Module M0840: Optimal and Robust Control Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	153 155 156 158 160 162 164 167 169 171 172 173 174 176 178
Module M0835: Humanoid Robotics Module M0838: Linear and Nonlinear System Identifikation Module M0840: Optimal and Robust Control Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	155 156 158 160 162 164 167 169 171 172 173 174 176 178
Module M0838: Linear and Nonlinear System Identifikation Module M0840: Optimal and Robust Control Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	156 158 160 162 164 167 169 171 172 173 174 176 178
Module M0840: Optimal and Robust Control Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	158 160 162 164 167 169 171 172 173 174 176 178
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	160 162 164 167 169 171 172 173 174 176 178
Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	164 167 169 171 172 173 174 176 178
Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	167 169 171 172 173 174 176 178 178
Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	169 171 172 173 174 176 178 178
Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	171 172 173 174 176 178 178
Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	172 173 174 176 178 178
Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	173 174 176 178 178 180
Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	174 176 178 178 180
Module M0548: Bioelectromagnetics: Principles and Applications Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	176 178 178 180
Specialization Management and Business Administration Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	178 178 180
Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	178 180
Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	180
Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics	187
Module M0775: Ergonomics	
	194
Modula M0751: Vibration Theory	196
	197
Module M0808: Finite Elements Methods	198
Module M0814: Technology Management Module M0768: Microsystems Technology in Theory and Practice	200 202
Module M0766: Microsystems Technology in Theory and Fractice Module M0846: Control Systems Theory and Design	204
Module M0867: Production Planning & Control and Digital Enterprise	204
Module M0921: Electronic Circuits for Medical Applications	208
Module M1150: Continuum Mechanics	211
Module M1151: Materials Modeling	214
Module M1199: Advanced Functional Materials	216
Module M1279: MED II: Introduction to Biochemistry and Molecular Biology	217
Module M1334: BIO II: Biomaterials	218
Module M1342: Polymers	220
Module M0632: Regenerative Medicine	222 224
Module M1333: BIO I: Implants and Fracture Healing Module M0630: Robotics and Navigation in Medicine	224
Module M1384: Case Studies for Regenerative Medicine and Tissue Engineering	228
Module M0634: Introduction into Medical Technology and Systems	229
Module M0752: Nonlinear Dynamics	231
Module M0761: Semiconductor Technology	232
Module M0835: Humanoid Robotics	234
Module M0838: Linear and Nonlinear System Identifikation	235
Modulo M0040, Ontimal and Dobuct Control	
Module M0840: Optimal and Robust Control	237
Module M0855: Marketing (Sales and Services / Innovation Marketing)	239
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics	239 241
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED Is Introduction to Apatemy	239 241 243
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy	239 241 243 246
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy	239 241 243
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement	239 241 243 246 248
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology	239 241 243 246 248 250
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control	239 241 243 246 248 250 251
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications	239 241 243 246 248 250 251 252 253 255
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory	239 241 243 246 248 250 251 252 253 255
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine	239 241 243 246 248 250 251 252 253 255 257
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP)	239 241 243 246 248 250 251 252 253 255 257 257
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP)	239 241 243 246 248 250 251 252 253 255 257 257 266
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics	239 241 243 246 248 250 251 252 253 255 257 257 259
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0775: Ergonomics Module M0775: Ergonomics	239 241 243 246 248 250 251 252 253 255 257 257 257 266 273 275
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0751: Vibration Theory	239 241 243 246 248 250 251 252 253 255 257 257 259
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0751: Vibration Theory	239 241 243 246 248 250 251 252 253 255 257 257 259 266 273 275 276
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0751: Vibration Theory	239 241 243 246 248 250 251 252 253 255 257 257 266 273 275 276
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0775: Vibration Theory Module M0814: Technology Management Module M0868: Microsystems Technology in Theory and Practice Module M0886: Control Systems Theory and Design Module M0867: Production Planning & Control and Digital Enterprise	239 241 243 246 248 250 251 252 253 255 257 259 266 273 275 279
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1230: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0775: Ergonomics Module M0761: Vibration Theory Module M0814: Technology Management Module M0768: Microsystems Technology in Theory and Practice Module M0867: Production Planning & Control and Digital Enterprise Module M0867: Production Planning & Control and Digital Enterprise Module M0921: Electronic Circuits for Medical Applications	239 241 243 246 248 250 251 252 253 255 257 257 266 273 275 279 281 283 285
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1230: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0775: Vibration Theory Module M0814: Technology Management Module M0846: Control Systems Technology in Theory and Practice Module M0867: Production Planning & Control and Digital Enterprise Module M0921: Electronic Circuits for Medical Applications Module M1150: Continuum Mechanics	239 241 243 246 248 250 251 252 253 255 257 257 266 273 275 279 281 283 285 288
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0775: Vibration Theory Module M0814: Technology Management Module M0814: Technology Management Module M0866: Control Systems Technology in Theory and Practice Module M0867: Production Planning & Control and Digital Enterprise Module M0891: Electronic Circuits for Medical Applications Module M1150: Continuum Mechanics Module M1151: Materials Modeling	239 241 243 246 248 250 251 252 253 255 257 257 266 273 275 279 281 283 285 288
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0845: Feedback Control in Medical Technology Module M0842: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0523: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M1241: Selected Topics of Biomedical Engineering - Option B (12 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0775: Vibration Theory Module M0814: Technology Management Module M0814: Technology Management Module M0866: Microsystems Technology in Theory and Practice Module M0867: Production Planning & Control and Digital Enterprise Module M0867: Production Planning & Control and Digital Enterprise Module M0921: Electronic Circuits for Medical Applications Module M1150: Continuum Mechanics Module M1151: Materials Modeling Module M1199: Advanced Functional Materials	239 241 243 246 248 250 251 252 253 255 257 257 266 273 275 279 281 283 285 288 291 293
Module M0855: Marketing (Sales and Services / Innovation Marketing) Module M1143: Applied Design Methodology in Mechatronics Module M0938: Bioprocess Engineering - Fundamentals Module M1277: MED I: Introduction to Anatomy Module M1278: MED I: Introduction to Radiology and Radiation Therapy Module M1280: MED II: Introduction to Physiology Module M1335: BIO II: Artificial Joint Replacement Module M0845: Feedback Control in Medical Technology Module M0832: Advanced Topics in Control Module M0548: Bioelectromagnetics: Principles and Applications Specialization Medical Technology and Control Theory Module M0623: Intelligent Systems in Medicine Module M0623: Intelligent Systems in Medicine Module M1230: Selected Topics of Biomedical Engineering - Option A (6 LP) Module M0629: Intelligent Autonomous Agents and Cognitive Robotics Module M0775: Ergonomics Module M0775: Vibration Theory Module M0814: Technology Management Module M0814: Technology Management Module M0866: Control Systems Technology in Theory and Practice Module M0867: Production Planning & Control and Digital Enterprise Module M0891: Electronic Circuits for Medical Applications Module M1150: Continuum Mechanics Module M1151: Materials Modeling	239 241 243 246 248 250 251 252 253 255 257 257 266 273 275 279 281 283 285 288

Module M1342: Polymers	299
Module M0632: Regenerative Medicine	301
Module M1333: BIO I: Implants and Fracture Healing	303
Module M0630: Robotics and Navigation in Medicine	305
Module M1384: Case Studies for Regenerative Medicine and Tissue Engineering	307
Module M0634: Introduction into Medical Technology and Systems	308
Module M0752: Nonlinear Dynamics	310
Module M0761: Semiconductor Technology	311
Module M0835: Humanoid Robotics	313
Module M0838: Linear and Nonlinear System Identifikation	314
Module M0840: Optimal and Robust Control	
Module M0855: Marketing (Sales and Services / Innovation Marketing)	
Module M1143: Applied Design Methodology in Mechatronics	320
Module M0938: Bioprocess Engineering - Fundamentals	
Module M1277: MED I: Introduction to Anatomy	
Module M1278: MED I: Introduction to Radiology and Radiation Therapy	
Module M1280: MED II: Introduction to Physiology	
Module M1335: BIO II: Artificial Joint Replacement	
Module M0845: Feedback Control in Medical Technology	
Module M0635: Medical Technology Lab	
Module M0832: Advanced Topics in Control	
Module M0548: Bioelectromagnetics: Principles and Applications	335
Thesis	337
Module M-002: Master Thesis	337

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: Busin	ess & Management
Module Responsible	Prof. Matthias Meyer
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge Skills	 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. 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 Autonomy	 Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems Students are capable of acquiring necessary knowledge independently by means of research and preparation of material.
Workload in Hours	Depends on choice of courses
Credit points	6

Courses

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

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

Professional Competence

Knowledge 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

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 goaloriented 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.

Skills 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
- · 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	
Social Competence	Personal Competences (Social Skills)
	 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.
Autonomy	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 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: Appli	ed Statistics	,					
Courses							
Title					Тур	Hrs/wk	СР
Applied Statistics (L1584)		Lecture 2 3					
Applied Statistics (L1586) Applied Statistics (L1585)	Project-/problem-based Learning 2 2 Recitation Section (small) 1 1						1
• •	Prof. Michael Morlock						
Admission Requirements	None						
Recommended Previous	Basic knowledge of statistical methods						
Knowledge	•						
Educational Objectives	After taking part successfully, students have reached the following learning results						
Professional Competence							
Knowledge	Students can explain the statistical methods and the conditions of their use.						
Skills	Students are able to use the statistics program to solve statistics problems and to interpret and depict the results						
Personal Competence							
Social Competence	Team Work, joined presentation of results						
4.4	To understand and interpret the question and solve						
Autonomy	To understand ar	na interpret the	e question and soi	ve			
Workload in Hours	Independent Stud	dy Time 110, S	Study Time in Lect	ure 70			
Credit points	6						
Course achievement	Compulsory Bonus	Form		Description			
	Yes None	Written	elaboration				
Examination	Written exam	Written exam					
Examination duration and	90 minutes, 28 questions						
scale							
Assignment for the	Mechanical Engin	neering and Ma	anagement: Specia	alisation Manage	ment: Elective Compulsory		
Following Curricula	Mechatronics: Sp	ecialisation Sy	stem Design: Elec	ctive Compulsory			
					ective Compulsory		
	-		ualification: Comp	•			
				•	n: Elective Compulsory		
		-	-		ourse: Elective Compulsory		
	Theoretical Mech	anical Enginee	ering: Specialisatio	on Bio- and Medio	cal Technology: Elective Compu	ılsory	

Course L1584: Applied Statis	tice					
	Lecture					
Hrs/wk						
СР						
	lependent Study Time 62, Study Time in Lecture 28					
	of. Michael Morlock					
Language						
Cycle	ViSe					
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					
	1 - 2					
	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					
	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 Statis	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 Statis	stics
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

COLUMNO	
courses	
itle	Typ Hrs/wk CP
ledical Imaging Systems (L0819)	Lecture 4 6
Module Responsible	
Admission Requirements	
Recommended Previous	
Knowledge	
	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	
	Students can:
	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 equation
	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	Students are able to:
	Explain the physical processes of images and assign to the systems the basic mathematical or physical equations req
	 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.
	Section independently for inner connect issue a measuring system can be assu-
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and	90 min
scale	
Assignment for the	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
Following Curricula	Biomedical Engineering: Core qualification: Compulsory
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0819: Medical Imagi	ing Systems				
Тур	Lecture				
Hrs/wk	4				
СР	6				
Workload in Hours	lependent Study Time 124, Study Time in Lecture 56				
Lecturer	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: Medic	cal Basics and Pathology					
Courses						
Title		Тур	Hrs/wk	СР		
Medical Basics and Pathology I (L15	599)	Lecture	2	2		
Medical Basics and Pathology II (L1	600)	Lecture	2	2		
Medical Basics and Pathology III (LI	1602)	Lecture	2	2		
Module Responsible	Prof. Michael Morlock					
Admission Requirements	None					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part successfully, students have	After taking part successfully, students have reached the following learning results				
Professional Competence						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Time 96, Study Time in Lo	ecture 84				
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	International Management and Engineering:	Specialisation II. Process Engineering and I	Biotechnology: Elective	Compulsory		
Following Curricula	Biomedical Engineering: Core qualification: C	ompulsory				

Course L1599: Medical Basic	s 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, minilaparoscopy and our ICU as well as out patient clinics.
Literature	Wird in der Veranstaltung bekannt gegeben

Course L1600: Medical Basics	s 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
likeh	
Literature	Wird in der Veranstaltung bekannt gegeben

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

•						
Courses						
Title Practical Course Product Developm	ent, Materials and Production (L1566)	Typ Practical Course	Hrs/wk 6	CP 6		
Module Responsible		Tractical Course	Ü	0		
Admission Requirements						
Recommended Previous						
Knowledge						
	Lectures: Structure and Properties of Poly Composites Production: Lecture: Production Engineering Lectures: Forming and Cutting Technology Lectures: Machine Tools and Robotic		posites, Manufactur	ing of Polymers an		
Educational Objectives	After taking part successfully, students have reac	hed the following learning results				
Professional Competence						
Knowledge	Students can					
	represent more complex context of differe describe functionality of modern measurer		nologies.			
Skills	Students are capable of					
	 applying theoretical knowledge for practical applying provided experimental methods for analyzing and evaluating experimental residence applying modern measurement instrumental 	or examining contexts of different fields ults by using provided methods.	of study.			
Personal Competence						
Social Competence	Students can					
	carry out and document experimental work present and discuss experimental results in		:			
Autonomy	Students are able to					
	 carry out parts of experimental work indep choose and apply suitable instruments. assess own strengths and weaknesses. 	endently guided by teachers.				
Workload in Hours	Independent Study Time 96, Study Time in Lectur	re 84				
Credit points	6					
Course achievement	None					
Examination	Written elaboration					
Examination duration and scale						
Assignment for the	Biomedical Engineering: Core qualification: Comp	ulsory				
Following Curricula	Product Development, Materials and Production:	Core qualification: Compulsory				

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

Module M1180: Case	Studie and Clinical Internship				
Courses					
Title		Тур	Hrs/wk	СР	
Casestudies Surgery and Internal M	ledicine (L1603)	Seminar	5	5	
Clinical Internship (L1587)		Practical Course	1	1	
Module Responsible					
Admission Requirements					
	The lectures addressing medical issues from the	concentration Biomedical Engineering in	the respective BSc P	rograms.	
Knowledge					
	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	The students learn the process of clinical practice regarding medical history, diagnosis and treatment decision with representative				
	surgical and medical diseases in the various de	partments, and get an insight into the d	aily patient care throu	ugh case studies in a	
	hospital.				
Skills	Interpreting and explaining the medical history and medical records of a patient.				
	Dealing with patients.				
	Dealing with patients.				
Personal Competence					
Social Competence	Dealing with patients.				
Autonomy					
	Independent Study Time 96, Study Time in Lectu	ure 84			
Credit points	, ,				
Course achievement	None				
Examination	Written elaboration				
Examination duration and	5 Pages (10 Case studies)				
scale					
Assignment for the	Biomedical Engineering: Core qualification: Com	pulsory			
Following Curricula					

Course L1603: Casestudies S	urgery 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
Content	Die Fallstudien werden in einem 2-wöchentlichen Blockkurs in der Innere und Chirurgie demonstriert. Alle 1-2 Tage wechseln die
	Stationen hierzu gehören:
	- Notaufnahme
	- Intensivstation
	- Pneumologie
	- Gastroenterologie
	- Kardiologie
	- Transfusionsmedizin
	- Poliklinik/Ambulanz
	- Dialyse
	- Unfallchirugie
Literature	keine spezifische

Course L1587: Clinical Intern	ıship
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: Study	y work				
Courses					
Title	Typ Hrs/wk CP				
Module Responsible	Prof. Michael Morlock				
Admission Requirements	None				
Recommended Previous	Subjects of the Master program and the specialisations.				
Knowledge					
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				
Course achievement	None				
Examination	Study work				
Examination duration and	according to FSPO				
scale					
Assignment for the	Biomedical Engineering: Core qualification: Compulsory				
Following Curricula					

Specialization Implants and Endoprostheses

Module M0623: Intell	igent Systems	in Medicine				
Courses						
Title			Тур		Hrs/wk	СР
Intelligent Systems in Medicine (L0331)			Lecture	9	2	3
Intelligent Systems in Medicine (L0	334)		Project	Seminar	2	2
Intelligent Systems in Medicine (L0	333)		Recitat	ion Section (small)	1	1
Module Responsible	Prof. Alexander Schla	efer				
Admission Requirements	None					
Recommended Previous	principles of m	ath (algebra, analysis/ca	culus)			
Knowledge	principles of st		caias,			
		rogramming, Java/C++ ar	nd R/Matlab			
	advanced prog					
Educational Objectives	After taking part succ	essfully, students have r	eached the following learr	ning results		
Professional Competence						
Knowledge			inical treatment planning			
			xplain methods for classif			
		·	different methods for re			
			allenges due to the clinica	al nature of the data	a and its acquisition	and due to privacy
	and safety requireme	ents.				
Skills	The students can giv	e reasons for selecting a	nd adapting methods for	classification, regre	ession, and predicti	on. They can assess
	the methods based on actual patient data and evaluate the implemented methods.					
Personal Competence						
•	The students discuss	the results of other arous	os, provide helpful feedba	ck and can incoorne	orate feedback into	their work
Social Competence	The students discuss	the results of other group	os, provide neipidi reedba	ck and can incoorpe	orate reedback into	their work.
Autonomy	The students can ref	lect their knowledge and	document the results of	their work. They ca	in present the resu	Its in an appropriate
	manner.					
Workload in Hours	Independent Study T	ime 110, Study Time in L	ecture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes 10 %	Written elaboration				
	Yes 10 %	Presentation				
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the			ce Engineering: Elective C			
Following Curricula			Technology: Elective Com	-		
		·	computational Methods in		: Compulsory	
			ns and Robotics: Elective			
	_	• ,	al Organs and Regenerativ		e Compulsory	
	_		ts and Endoprostheses: El			
	_		l Technology and Control			
	•		ement and Business Admi			
			Complementary Course: ation Bio- and Medical Tec			
	meoretical Mechanic	ai Engineering: Specialisa	ition bio- and Medical Tec	imology: Elective Co	ompuisory	

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

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

Module M1230: Selec	ted Topics of Biomedical Engineering	g - Option A (6 LP)		
Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L16	663)	Seminar	2	3
Introduction to Waveguides, Antenr	nas, and Electromagnetic Compatibility (L1669)	Lecture	3	4
ntroduction to Waveguides, Antenr	nas, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2
Development and Regulatory Appro	oval of Medical Devices (L1588)	Lecture	2	3
Experimental Methods in Biomecha	nics (L0377)	Lecture	2	3
Experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	3
Numerical Methods in Biomechanic	s (L1583)	Seminar	2	3
Seminar Biomedical Engineering (L	1890)	Seminar	2	3
Fluid Mechanics II (L0001)		Lecture	2	4
System Simulation (L1820)		Lecture	2	2
System Simulation (L1821)		Recitation Section (large)	1	2
Ceramics Technology (L0379)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points				
Assignment for the	Biomedical Engineering: Specialisation Implants and E	Endoprostheses: Elective Compulsory		
Following Curricula	Biomedical Engineering: Specialisation Medical Techn	ology and Control Theory: Elective Com	pulsory	
ronowing curricula	Biomedical Engineering: Specialisation Management a	and Business Administration: Elective Co	ompulsorv	

Course L1663: Nature's Hiera	archical 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

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	30 min
scale	
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well of Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequen 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 - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques
Literature	- Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999)
	- J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012)
	- D. M. Pozar, "Microwave Engineering", Wiley (2011)
	- Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008)
	- H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009)
	- A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)

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

Course L1588: Development and Regulatory Approval of Medical Devices		
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	90 Minuten	
scale		
Lecturer	Dr. Roman Nassutt	
Language	DE	
Cycle	WiSe	
Content		
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik - Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html 	

Course L0377: Experimental Methods in Biomechanics	
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	90 min
scale	
Lecturer	Prof. Michael Morlock
Language	DE
Cycle	SoSe
Content	
Literature	Wird in der Veranstaltung bekannt gegeben

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

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

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

Tim	Lecture
Тур	
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Klausur
xamination 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 The same allowed by the Popular Facilities in the same and the same and the same allowed by the Popular Facilities in the same and the sam
	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	1. Drawe H. Cavadla and de Finahana and Mahanhanakai awara Mada Cavadii ada Asaya Farabi at (MA) 1071
	1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.
	2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.
	3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.
	 Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelber 2006.
	5. 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 Strömungs Springer Verlag, Berlin, Heidelberg, New York, 2006.
	7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GW
	Fachverlage GmbH, Wiesbaden, 2008.
	8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007
	 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubne GWV Fachverlage GmbH, Wiesbaden, 2009.
	10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.
	11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Spring
	Verlag, Berlin, Heidelberg, 2008.
	12. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.

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

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

Course L0379: Ceramics Tecl	hnology		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28	
Examination Form	Klausur		
Examination duration and	90 Minuten		
scale			
	Dr. Rolf Janßen		
Language			
Cycle			
Content	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	
		3. Powder fabrication	
		4. Powder processing	
		5. Shape-forming processes	
		6. Densification, sintering	
		7. Glass and Cement technology	
		8. Ceramic-metal joining techniques	
Literature	W.D. Kingery, "Introduction to 0	Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Han	dbook Vol.4 "Ceramics and Glasses", 1991	
	D.W. Richerson, "Modern Cerar	nic Engineering", Marcel Decker, New York, 1992	
	Skript zur Vorlesung		

Module M1241: Selec	ted Topics of Biomedical Engineering	g - Option B (12 LP)		
Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L16	563)	Seminar	2	3
ntroduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1669)	Lecture	3	4
ntroduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2
Development and Regulatory Appro	oval of Medical Devices (L1588)	Lecture	2	3
Experimental Methods in Biomecha	nics (L0377)	Lecture	2	3
experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	3
Numerical Methods in Biomechanic	s (L1583)	Seminar	2	3
Seminar Biomedical Engineering (L	1890)	Seminar	2	3
Fluid Mechanics II (L0001)		Lecture	2	4
System Simulation (L1820)		Lecture	2	2
System Simulation (L1821)		Recitation Section (large)	1	2
Ceramics Technology (L0379)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	12			
Assignment for the	Biomedical Engineering: Specialisation Artificial Organ	ns and Regenerative Medicine: Elective	Compulsory	
Following Curricula	Biomedical Engineering: Specialisation Implants and E	Endoprostheses: Elective Compulsory		
Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory				

Course L1663: Nature's Hiera	archical 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

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

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

Course L1588: Development	Course L1588: Development and Regulatory Approval of Medical Devices		
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	90 Minuten		
scale			
Lecturer	Dr. Roman Nassutt		
Language	DE		
Cycle	WiSe		
Content			
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik - Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html 		

Course L0377: Experimental Methods in Biomechanics		
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	90 min	
scale		
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content		
Literature	Wird in der Veranstaltung bekannt gegeben	

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

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

ourse 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	schriftliche ausarbeitung und Vortrag (20 min)	
scale		
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	WiSe	
Content		
Literature	Keine	

Tree	Lecture
Тур	
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Klausur
xamination 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 Handa Language to the Company 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	
	1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.
	2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.
	3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.
	 Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelber 2006.
	5. 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 Strömunge Springer Verlag, Berlin, Heidelberg, New York, 2006.
	7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GV
	Fachverlage GmbH, Wiesbaden, 2008.
	8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007
	 Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubne GWV Fachverlage GmbH, Wiesbaden, 2009.
	10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.
	11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Spring
	Verlag, Berlin, Heidelberg, 2008.
	12. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.

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

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

Course L0379: Ceramics Tecl	Course L0379: Ceramics Technology						
Тур	Lecture						
Hrs/wk	2						
СР	3						
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28						
Examination Form	Klausur						
Examination duration and	90 Minuten						
scale							
	Dr. Rolf Janßen						
Language	DE/EN						
Cycle	WiSe						
Content	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					
		3. Powder fabrication					
	4. Powder processing						
		5. Shape-forming processes					
		6. Densification, sintering					
	7. Glass and Cement technology						
		8. Ceramic-metal joining techniques					
Literature	W.D. Kingery, "Introduction to	Ceramics", John Wiley & Sons, New York, 1975					
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991						
	D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992						
	Skript zur Vorlesung						

Courses						
Courses						
Title	0 11 0 1 11 (10040)	Тур	Hrs/wk	CP		
ntelligent Autonomous Agents and ntelligent Autonomous Agents and		Lecture Recitation Section (small)	2	4 2		
	-	Recitation Section (small)	2	2		
Module Responsible						
Admission Requirements						
	Vectors, matrices, Calculus					
Knowledge	AG I - I - I - I - I - I - I - I - I -					
	After taking part successfully, students have r	reached the following learning results				
Professional Competence	Students can explain the agent abstraction of	define intelligence in terms of rational behavio	r and give details	s about agent des		
Knowieuge	Students can explain the agent abstraction, define intelligence in terms of rational behavior, and give details about agent					
	(goals, utilities, environments). They can describe the main features of environments. The notion of adversarial agent cooperatical can be discussed in terms of decision problems and algorithms for solving these problems. For dealing with uncertainty in re					
	world scenarios, students can summarize how Bayesian networks can be employed as a knowledge representation and reasonir					
	formalism in static and dynamic settings. In addition, students can define decision making procedures in simple and sequentia					
	settings, with and with complete access to the state of the environment. In this context, students can describe techniques for					
	solving (partially observable) Markov decision problems, and they can recall techniques for measuring the value of information					
	Students can identify techniques for simulta	neous localization and mapping, and can exp	lain planning tech	iniques for achiev		
	desired states. Students can explain coordination problems and decision making in a multi-agent setting in term of different types					
	of equilibria, social choice functions, voting protocol, and mechanism design techniques.					
Ckilla						
SKIIIS	s Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent application students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesia					
	networks/dynamic Bayesian networks and apply bayesian reasoning for simple queries. Students can also name and apply					
	different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the					
	best action or policies for concrete settings. In multi-agent situations students will apply techniques for finding different equilibr					
	states, e.g., Nash equilibria. For multi-agent decision making students will apply different voting protocols and compare and expla					
	the results.					
Personal Competence						
Social Competence	Students are able to discuss their solutions to	problems with others. They communicate in E	nglish			
Autonomy	Students are able of checking their understan	ding of complex concepts by solving varaints of	f concrete probler	ns		
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56				
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	Computer Science: Specialisation II: Intelligen	ce Engineering: Elective Compulsory				
Following Curricula	International Management and Engineering: S	Specialisation II. Information Technology: Electi	ve Compulsory			
	Mechatronics: Technical Complementary Course: Elective Compulsory					
	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory					
		al Organs and Regenerative Medicine: Elective	Compulsory			
	Biomedical Engineering: Specialisation Implar					
		al Technology and Control Theory: Elective Con				
		gement and Business Administration: Elective C	ompulsory			
	Theoretical Mechanical Engineering: Technica	l Complementary Course: Elective Compulsory				
		ation Robotics and Computer Science: Elective				

Tvn	Lecture
	2
-	4
	Independent Study Time 92, Study Time in Lecture 28
	Rainer Marrone
Language	
Cycle	WiSe
Content	 Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, produce rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference by enumeration), typical-case complexity, pragmatics: reasoning from effect (that can be perceived by an agent) to cause (that cannot be directly perceived). Probabilistic reasoning over time: Environmental state may change even without the agent performing actions, dynamic Bayesian networks, Marko assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation special cases: hidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decision networks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteration, MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks Simultaneous Localization and Mapping Planning Game theory (Golden Balls: Split or Share) Decisions with multiple agents, Nash equilibrium, Bayes-Nash equilibrium Social Choice Voting protocols, preferences, paradoxes, Arrow's Theorem, Mechanism Design Fundamentals, dominant strategy implementation, Reve
Literature	Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Norvig, Prentice Hall, 2010, Chapters 2-5, 1
	11, 13-17
	2. Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005
	3. Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press, 2009

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

Module M0775: Ergon	nomics			
Courses				
Title		Тур	Hrs/wk	СР
Ergonomics (L0653)		Lecture	2	3
Module Responsible	Dr. Armin Bossemeyer			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 62, Study Time in Lec	ture 28		
Credit points	3			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	International Management and Engineering: Sp	pecialisation II. Product Development and	Production: Elective Co	ompulsory
Following Curricula	Biomedical Engineering: Specialisation Implant		•	
	Biomedical Engineering: Specialisation Artificia			
	Biomedical Engineering: Specialisation Manage	ement and Business Administration: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation Medica	Technology and Control Theory: Elective	e Compulsory	

Course L0653: Ergonomics	ourse L0653: Ergonomics	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Armin Bossemeyer	
Language	DE	
Cycle	WiSe	
Content		
Literature		

Module M0751: Vibra	tion Theory			
Courses				
Title		Тур	Hrs/wk	СР
Vibration Theory (L0701)		Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous	Calculus			
Knowledge	Linear Algebra			
	Engineering Mechanics			
	2 Engineering Meenanies			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students are able to denote terms and concepts of Vibra	tion Theory and develop them furt	ther.	
Skills	Students are able to denote methods of Vibration Theory	and develop them further.		
Personal Competence				
Social Competence	Students can reach working results also in groups.			
Autonomy	Students are able to approach individually research task	s in Vibration Theory.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 Hours			
scale				
Assignment for the	Energy Systems: Core qualification: Elective Compulsory			
Following Curricula	International Management and Engineering: Specialisation	on II. Mechatronics: Elective Comp	ulsory	
	Mechanical Engineering and Management: Specialisation	Mechatronics: Elective Compulso	ry	
	Mechatronics: Core qualification: Compulsory			
	Biomedical Engineering: Specialisation Artificial Organs a	•		
	Biomedical Engineering: Specialisation Implants and End			
	Biomedical Engineering: Specialisation Medical Technolo	•		
	Biomedical Engineering: Specialisation Management and		Compulsory	
	Product Development, Materials and Production: Core qu			
	Naval Architecture and Ocean Engineering: Core qualific			
	Theoretical Mechanical Engineering: Technical Complem	•	У	
	Theoretical Mechanical Engineering: Core qualification: E	nective Compulsory		

Course L0701: Vibration The	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.		

Courses				
Title		Тур	Hrs/wk	СР
Finite Element Methods (L0291)		Lecture	2	3
Finite Element Methods (L0804)		Recitation Section (large)	2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Materia	als) and Mechanics II (Hydrostatics, Kinematics, Dy	namics)	
Knowledge	Mathematics I, II, III (in particular differen	tial equations)		
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	The students possess an in-depth know overview of the theoretical and methodic	rledge regarding the derivation of the finite elem al basis of the method.	ent method and	are able to give
Skills	The students are capable to handle engi system matrices, and solving the resultin	neering problems by formulating suitable finite elegations.	ements, assemblir	ng the correspondi
Personal Competence Social Competence	Students can work in small groups on spe	ecific problems to arrive at joint solutions.		
Autonomy	The students are able to independently Problems can be identified and the result	r solve challenging computational problems and s are critically scrutinized.	develop own fini	te element routino
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points				
Course achievement	Compulsory Bonus Form	Description		
	No 20 % Midterm			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Core qualification: Com	pulsory		
Following Curricula	Energy Systems: Core qualification: Elect	ive Compulsory		
	Aircraft Systems Engineering: Specialisat	ion Aircraft Systems: Elective Compulsory		
	Aircraft Systems Engineering: Specialisati	ion Air Transportation Systems: Elective Compulsor	у	
	Aircraft Systems Engineering: Core qualif	ication: Elective Compulsory		
	International Management and Engineeri	ng: Specialisation II. Mechatronics: Elective Compul	sory	
		ng: Specialisation II. Product Development and Proc		ompulsory
	Mechatronics: Core qualification: Compul-			
	Biomedical Engineering: Specialisation Im			
	3 3 1	anagement and Business Administration: Elective C	Compulsorv	
		edical Technology and Control Theory: Elective Con		
		tificial Organs and Regenerative Medicine: Elective		
	Product Development, Materials and Product	· ·	Compaison y	
		conc quamication, compaisory		
	Technomathematics: Specialisation III. En	gineering Science: Flective Compulsory		

Course L0291: Finite Elemen	t 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 Elemen	ourse 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 M0814: Techr	nology Management			
	lology Hanagement			
Courses				
Title		Тур	Hrs/wk	СР
Technology Management (L0849) Technology Management Seminar	(10050)	Lecture Project-/problem-based Learning	3	3
		Project-/problem-based Learning	2	
	Prof. Cornelius Herstatt			
Admission Requirements				_
	Bachelor knowledge in business management			
Knowledge	After taking part successfully, students have reached the fe	llowing loarning results		
-	After taking part successfully, students have reached the fo	nowing learning results		
Professional Competence	Students will asia does incidhts into			
Knowieage	Students will gain deep insights into:			
	International R&D-Management			
	 Technology Timing Strategies 			
	 Technology Strategies and Lifecycle Managem 	ent (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	The course aims to:			
	Develop an understanding of the importance of Tech	nology Management - on a national a	s well as inter	national level
	 Equip students with an understanding of impor 			
	organizational and process-related aspects)			
	Foster a strategic orientation to problem-solving wit	hin the innovation process as well as	s Technology I	Management and its
	importance for corporate strategy			
	 Clarify activities of Technology Management (e.g. technology) 	hnology sourcing, maintenance and	exploitation)	
	 Strengthen essential communication skills and a b 	asic understanding of managerial, o	organizational	and financial issues
	concerning Technology-, Innovation- and R&D-manag	gement. Further topics to be discusse	d include:	
	Pasis consents, models and tools, relevant to the ma	nagement of technology, RSD and in	novation	
	Basic concepts, models and tools, relevant to the ma Innovation as a precess (ctops activities and results)		novation	
	 Innovation as a process (steps, activities and results) 			
Personal Competence				
Social Competence	Later and Miller and an			
	Interact within a team			
	Raise awareness for globabl issues			
Autonomy	Colin consents because the			
	Gain access to knowledge sources Discuss recent research debates in the context of To	shaplagu and learnities Maria		
	Discuss recent research debates in the context of Te Develop presentation skills	Chilology and Innovation Managemen	L	
	 Develop presentation skills Discussion of international cases in R&D-Managemer 	.+		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination				
Examination duration and				
scale	· · · · · · · · · · · · · · · · · · ·			
Assignment for the	Global Innovation Management: Core qualification: Compuls	sory		
Following Curricula	· · · · · · · · · · · · · · · · · · ·	•	mpulsorv	
	Mechanical Engineering and Management: Specialisation M	•	,	
	Biomedical Engineering: Specialisation Artificial Organs and		npulsorv	
	Biomedical Engineering: Specialisation Implants and Endopi		,	
	Biomedical Engineering: Specialisation Medical Technology		sory	
	Biomedical Engineering: Specialisation Management and Bu		,	
	3 3 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2			

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

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

Courses							
Title			Typ Lecture	Hrs/wk 2	CP 4		
Microsystems Technology (L0724) Microsystems Technology (L0725)			Project-/problem-based Learning	2	2		
Module Responsible	Prof. Hoc Khiem Trieu						
Admission Requirements	None						
Recommended Previous	Basics in physics, chemistry, mechanics at	nd semiconductor tech	hnology				
Knowledge							
Educational Objectives	After taking part successfully, students ha	ve reached the follow	ing learning results				
Professional Competence							
Knowledge	Students are able						
	to present and to explain current famicrosensors and microactuators, as well			lly methods fo	or the fabrication		
	to explain in details operation principl	es of microsensors an	d microactuators and				
	to discuss the potential and limitation	of microsystems in ap	oplication.				
Skills	Students are capable						
	to analyze the feasibility of microsystems,						
	to develop process flows for the fabrication of microstructures and						
	to apply them.						
Personal Competence Social Competence	Students are able to prepare and perform of audience.	their lab experiments	s in team work as well as to preso	ent and discus:	s the results in fro		
Autonomy	None						
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56					
Credit points	6						
Course achievement	Compulsory Bonus Form Yes None Subject theoretic practical work		n führen in Kleingruppen ein La und diskutiert die Theorie sowie o amten Kurs.				
Examination	Oral exam						
Examination duration and	30 min						
scale							
Assignment for the	Electrical Engineering: Specialisation Nand			mpulsory			
Following Curricula	Electrical Engineering: Specialisation Medi						
	International Management and Engineering Biomedical Engineering: Specialisation Imp						
	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 Art	ificial Organs and Reg	enerative Medicine: Elective Com	npulsory			
	Microelectronics and Microsystems: Core of	qualification: Elective (Compulsory				

Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-general lithography, nano-imprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; (techniques: APCVD, LPECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etch anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop technique plasma processes, dry etching; back sputtering, plasma etching, Rile, Bosch process, cryo process, Xe72 etching) Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measure 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 thermor modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pi junction, MTC and PTC; thermal anemome mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sen piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular is sensor: operating principle and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular is sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor sensors: radiote semiconductor gas sensor, tambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosen
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
Literature	Pr. Pladou. I unadimentals of Pherolaphication, CNC 11033, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010
	1. P. Addins, N. A. Layton Introductory Pillins, Springer, 2010
	G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L0725: Microsystems	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			

Module M0846: Contr	rol Systems Theory and Design				
Courses					
Title		Тур	Hrs/wk	СР	
Control Systems Theory and Design		Lecture	2	4	
Control Systems Theory and Design		Recitation Section (small)	2	2	
Module Responsible					
Admission Requirements	Introduction to Control Systems				
Knowledge	incloduction to control systems				
Educational Objectives	After taking part successfully, students have read	thed the following learning results			
Professional Competence					
Knowledge	Students can explain how linear dynamic	systems are represented as state space	madala, thay can	interpret the system	
Skills	response to initial states or external excita They can explain the system properties or estimation, respectively They can explain the significance of a mini They can explain observer-based state fee They can extend all of the above to multi-i They can explain the z-transform and its re They can explain state space models and to they can explain the experimental identificate be solved by solving a normal equation They can explain how a state space model Students can transform transfer function of the can assess controllability and observed they can design LQG controllers for multived they can carry out a controller design both for a given sampling rate They can identify transfer function models They can carry out all these tasks using	controllability and observability, and their research their resear	racking and disturb rstems and how the ident npulse response rsa main, and decide	pance rejection dification problem can which is appropriate	
	Simulink) Students can work in small groups on specific pro Students can obtain information from provided when solving given problems. They can assess their knowledge in weekly on-lin	sources (lecture notes, software documen	·	nt guides) and use it	
Workload in Hours	Independent Study Time 124, Study Time in Lect	uro 56			
Credit points		· · · ·			
Course achievement					
	Written exam				
Examination duration and					
scale					
Assignment for the	Electrical Engineering: Core qualification: Compul	lsory			
Following Curricula	Energy Systems: Core qualification: Elective Com	pulsory			
	Aircraft Systems Engineering: Core qualification: Computational Science and Engineering: Speciali: International Management and Engineering: Speciali: International Management and Engineering: Specialised Mechanical Engineering and Management: Specialised Mechatronics: Core qualification: Compulsory Biomedical Engineering: Specialisation Artificial Computational Engineering: Specialisation Implants as	sation II. Engineering Science: Elective Con cialisation II. Electrical Engineering: Elective cialisation II. Mechatronics: Elective Compu alisation Mechatronics: Elective Compulsory organs and Regenerative Medicine: Elective	e Compulsory Isory		
	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				

	ms Theory and Design	
Тур	Lecture	
,		
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	Prof. Herbert Werner	
Language	EN	
Cycle	WiSe	
Content	State space methods (single-input single-output)	
	State space models and transfer functions, state feedback	
	Coordinate basis, similarity transformations	
	Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem	
	Controllability and pole placement	
	State estimation, observability, Kalman decomposition	
	Observer-based state feedback control, reference tracking	
	Transmission zeros	
	Optimal pole placement, symmetric root locus	
	Multi-input multi-output systems	
	Transfer function matrices, state space models of multivariable systems, Gilbert realization	
	les 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	a Warner II. Leetuve Notes, Central Systems Theory and Design"	
	Werner, H., Lecture Notes "Control Systems Theory and Design" T. Kailath "Linear Systems", Prentice Hall, 1990.	
	T. Kailath "Linear Systems", Prentice Hall, 1980 K. L. Astron, R. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997.	
	K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997 L. Liver "Greater Identification." The system Head Report in Hall, 1999	
	 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: Produ	iction Planning & Control and	l Digital Enterprise			
Courses					
Title		Тур	Hrs/wk	СР	
The Digital Enterprise (L0932)		Lecture	2	2	
Production Planning and Control (LC	0929)	Lecture	2	2	
Production Planning and Control (LC	0930)	Recitation Section (small)	1	1	
Exercise: The Digital Enterprise (L0	933)	Recitation Section (small)	1	1	
Module Responsible	Prof. Hermann Lödding				
Admission Requirements	None				
Recommended Previous	Fundamentals of Production and Quality M	anagement			
Knowledge					
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge	Students can explain the contents of the n	nodule in detail and take a critical position to them			
Skills	Students are capable of choosing and appl	lying models and methods from the module to indu	ıstrial problems.		
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 Lecture 84				
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	180 Minuten				
scale					
Assignment for the	International Management and Engineering	g: Specialisation II. Product Development and Prod	uction: Elective Co	ompulsory	
Following Curricula	Logistics, Infrastructure and Mobility: Spec	ialisation Production and Logistics: Elective Compu	ilsory		
	Biomedical Engineering: Specialisation Art	ificial Organs and Regenerative Medicine: Elective	Compulsory		
	Biomedical Engineering: Specialisation Imp	plants and Endoprostheses: Elective Compulsory			
	Biomedical Engineering: Specialisation Me	dical Technology and Control Theory: Elective Com	pulsory		
	Biomedical Engineering: Specialisation Ma	nagement and Business Administration: Compulsor	ry		
	Product Development, Materials and Produ	uction: Specialisation Product Development: Electiv	e Compulsory		
	Product Development, Materials and Produ	action: Specialisation Production: Compulsory			
	Product Development, Materials and Produ	iction: Specialisation Materials: Elective Compulsor	Ty .		
	Theoretical Mechanical Engineering: Speci	alisation Product Development and Production: Ele	ctive Compulsory		
	Theoretical Mechanical Engineering: Techr	nical Complementary Course: Elective Compulsory			

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

Course L0929: Production Pl	anning 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 Pl	urse 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	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 M0921: Electi	ronic Circuits for Medical Ap	pplications			
Courses					
Title Electronic Circuits for Medical Appli Electronic Circuits for Medical Appli			Typ Lecture Recitation Section (small)	Hrs/wk 2 1	CP 3 2
Electronic Circuits for Medical Appli	ications (L1408)		Practical Course	1	1
Module Responsible	Prof. Matthias Kuhl				
Admission Requirements	None				
	Fundamentals of electrical engineering				
Knowledge					
Educational Objectives	After taking part successfully, students l	have reached the followir	ng learning results		
Professional Competence Knowledge	 Students can explain the basic fur Students are able to explain the basic fur Students can exemplify the common students can describe the special students can explain the function Students are able to discuss the process. 	ouild-up of an action pote nunication between neuro I features of low-noise an Is of prostheses, e. g. an	ential and its propagation alor ons and electronic devices nplifiers for medical applicati artificial hand	ng an axon	
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 pr professional background. Students are able to recognize the Students can document their work whenever it is necessary 	eir specific limitations, sc	that they can ask for assista	ance to the right t	ime.
Autonomy	Students are able to realisticall necessary. Students can break down their wo Students can handle the complex Students are able to act in a response.	ork in appropriate work p	ackages and schedule their vectrical experiments without	work in a realistic needing support.	
Workload in Hours	Independent Study Time 124, Study Tim	ne in Lecture 56			
Credit points	6				
Course achievement	Yes None Subject theore practical work No None Excercises	Description etical and			
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Electrical Engineering: Specialisation Me	edical Technology: Electiv	e Compulsory		
Following Curricula	Biomedical Engineering: Specialisation A	Artificial Organs and Rege	enerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation I	mplants and Endoprosthe	eses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory				
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory				
	Microelectronics and Microsystems: Specialisation Microelectronics Complements: Elective Compulsory				
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory				
	meoretical Mechanical Engineering: Spe	ecialisation Blo- and Medi	car rechnology: Elective Con	іриіѕогу	

Course L0696: Electronic Circ	cuits 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	ation Section (small)			
Hrs/wk	1			
СР	2			
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14			
Lecturer	Prof. Matthias Kuhl			
Language	EN			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

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

Module M1150: Conti	nuum Mechanics				
Courses					
Title		Тур	Hrs/wk	СР	
Continuum Mechanics (L1533)		Lecture	2	3	
Continuum Mechanics Exercise (L1	Continuum Mechanics Exercise (L1534) Recitation Section (small) 2 3				
Module Responsible	Prof. Christian Cyron				
Admission Requirements	None				
Recommended Previous	Basics of linear continuum mechanics as taught, e.g., ir	the module Mechanics II (forces and	l moments, stres	ss, linear strain, free-	
Knowledge	body principle, linear-elastic constitutive laws, strain end	ergy).			
Educational Objectives	After taking part successfully, students have reached the	e following learning results			
Professional Competence					
Knowledge					
	The students can explain the fundamental concepts to calculate the mechanical behavior of materials.				
Skills	The students can set up balance laws and apply basics of deformation theory to specific aspects, both in applied contexts as in research contexts.				
Personal Competence					
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.			wn identify and solve	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	60 min				
scale					
Assignment for the	Materials Science: Specialisation Modeling: Elective Com	pulsory			
Following Curricula	Mechanical Engineering and Management: Specialisation				
	Mechatronics: Technical Complementary Course: Electiv				
	Biomedical Engineering: Specialisation Artificial Organs		Compulsory		
	Biomedical Engineering: Specialisation Implants and Engineering	•			
	Biomedical Engineering: Specialisation Medical Technology		-		
	Biomedical Engineering: Specialisation Management and Product Development, Materials and Production: Core qu		inpuisory		
	Theoretical Mechanical Engineering: Technical Complem	• •			
	Theoretical Mechanical Engineering: Core qualification: I				
	co. carear recentanical Engineering. Core qualification. I	y			

Тур	Lecture
Hrs/wk	
СР	3
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	Fundamentals of tensor calculus
	Transformation invariance
	Tensor algebra
	Tensor analysis
	Kinematics
	Motion of continuum
	Deformation of infinitesimal line, area and volume elements
	Material and spatial description
	Polar decomposition
	Spectral decomposition
	Objectivity
	Strain measures
	Time derivatives
	Partial / material time derivatives
	Objective time rates
	Strain and deformation rates
	Transport theorems
	Balance equations (global and local form)
	Balance of mass
	The stress state
	 Surface traction vectors
	Cauchy's fundamental theorem
	 Stress tensors (Cauchy, 1. and 2. Piola-Kirchhoff, Kirchhoff stress tensor)
	Balance of linear momentum
	Balance of angular momentum
	Balance of energy
	Balance of entropy Claudius Dubom inequality.
	Clausius-Duhem inequality Constitutive laws
	Constitutive laws Constitutive assumptions
	Fluids
	Elastic solids
	Hyperelasticity
	Material symmetry
	Elasto-plastic solids
	• Analysis
	Initial-boundary value problems and their numerical solution
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker
2	
	I-S. Liu: Continuum Mechanics, Springer
	weitere siehe in der Literaturliste des Scripts
	The state of the s

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

Module M1151: Mate	rials Modeling				
Courses					
Title	Typ Hrs/wk CP				
Material Modeling (L1535)	Lecture 2 3				
Material Modeling (L1536)	Recitation Section (small) 2 3				
Module Responsible	Prof. Christian Cyron				
Admission Requirements	None				
Recommended Previous	Basics of linear and nonlinear continuum mechanics as taught, e.g., in the modules Mechanics II and Continuum Mechanics (force				
Knowledge	and moments, stress, linear and nonlinear strain, free-body principle, linear and nonlinear constitutive laws, strain energy)				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	The students can explain the fundamentals of multidimensional consitutive material 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					
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 solv				
	problems in the area of materials modeling and acquire the knowledge required to this end.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points					
Course achievement					
Examination					
Examination duration and					
scale					
Assignment for the	Materials Science: Specialisation Modeling: Elective Compulsory				
Following Curricula					
-	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: Specialisation Materials Science: Elective Compulsory				
	Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory				

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

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

Module M1199: Adva	nced Functional Materials				
Courses					
Title	Тур	p	Hrs/wk	СР	
Advanced Functional Materials (L16	625) Sen	ninar	2	6	
Module Responsible	Prof. Patrick Huber				
Admission Requirements	None				
Recommended Previous	Basic knowledge in Materials Science, e.g. Materials Science I/II				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the following le	earning results			
Professional Competence					
Knowledge	The students will be able to explain the properties of advanced mate	erials along with their applica	ations in techno	logy, in particular	
	metallic, ceramic, polymeric, semiconductor, modern composite mate	erials (biomaterials) and nan	omaterials.		
Skills	The students will be able to select material configurations accord	•			
		materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on			
	modern materials science, which enables them to select optimum materials combinations depending on the technical				
	applications.				
Personal Competence					
Social Competence	The students are able to present solutions to specialists and to devel	op ideas further.			
Autonomy	The students are able to				
	assess their own strengths and weaknesses.				
	assess their own strengths and weaknesses.gather new necessary expertise by their own.				
	g , ,,				
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28				
Credit points	6				
Course achievement	None				
Examination	Presentation				
Examination duration and	30 min				
scale					
Assignment for the	, , , ,				
Following Curricula					
	Biomedical Engineering: Specialisation Artificial Organs and Regenera Biomedical Engineering: Specialisation Implants and Endoprostheses		puisory		
	Biomedical Engineering: Specialisation Implants and Endoprostneses Biomedical Engineering: Specialisation Medical Technology and Conti		nrv		
	Biomedical Engineering: Specialisation Management and Business Ac		•		
	Theoretical Mechanical Engineering: Technical Complementary Cours	·	,		
	Theoretical Mechanical Engineering: Specialisation Materials Science				

Course L1625: Advanced Fur	nctional Materials			
Тур	Seminar			
Hrs/wk	2			
СР	6			
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28			
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Christian Cyron			
Language	DE			
Cycle	WiSe			
Content	1. Porous Solids - Preparation, Characterization and Functionalities			
	2. Fluidics with nanoporous membranes			
	3. Thermoplastic elastomers			
	4. Optimization of polymer properties by nanoparticles			
	5. Fiber composites in automotive			
	6. Modeling of materials based on quantum mechanics			
	7. Biomaterials			
Literature	Aktuelle Publikationen aus der Fachliteratur werden während der Veranstaltung bekanntgegeben.			

Courses				
Title		Tun	Hrs/wk	СР
Introduction to Biochemistry and M	olecular Biology (L0386)	Typ Lecture	2 2	3
	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, student	ts have reached the following learning results		
Professional Competence				
Knowledge	The students can			
	 describe basic biomolecules; 			
	 explain how genetic information 	n is coded in the DNA:		
	explain the connection between			
Skills	The students can			
	recognize the importance of mo	olecular parameters for the course of a disease;		
	 describe selected molecular-dia 	agnostic procedures;		
	explain the relevance of these	procedures for some diseases		
Personal Competence				
	The students can participate in discus	ssions in research and medicine on a technical level.		
		ling of topics from the course, using technical literat		
Workload in Hours	, , , , , , , , , , , , , , , , , , , ,	me in Lecture 28		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale	6	7		
Assignment for the		n program, 7 semester): Specialisation Biomedical E		
Following Curricula		nan program, 7 semester): Specialisation Mecha	inical Engineering, Fo	icus Biomechanics
	Compulsory	Compulsory		
	Data Science: Specialisation Medicine	Medical Technology: Elective Compulsory		
	Engineering Science: Specialisation Bi			
		program, 7 semester): Specialisation Biomedical En		
		ish program, 7 semester): Specialisation Mecha	nicai Engineering, Fo	icus biomechanics
	Compulsory Machanical Engineering: Specialisation	n Riomachanics: Compulsory		
	Mechanical Engineering: Specialisation		o Compulser:	
		n Management and Business Administration: Electiv		
		n Artificial Organs and Regenerative Medicine: Elect		
	3 1	n Medical Technology and Control Theory: Elective (
		n Implants and Endoprostheses: Elective Compulsor	у	
	reconformatnematics: Specialisation III	I. Engineering Science: Elective Compulsory		

Course L0386: Introduction t	ourse 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					
Literature	Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage				
	Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008				

Module M1334: BIO II	: Biomaterials			
Courses				
Title		Тур	Hrs/wk	СР
Biomaterials (L0593)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	Basic knowledge of orthopedic and surgical technique	es is recommended.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	The students can describe the materials of the huma	an body and the materials being use	d in medical engineerir	ng, and their fields of
	use.			
Skills	The students can explain the advantages and disadv	vantages of different kinds of biomat	erials	
Skiiis	The students can explain the davantages and disadv	anages of amerene kinds of biolina	ieriais.	
Personal Competence				
Social Competence	The students are able to discuss issues related to m	aterials being present or being used	d for replacements with	student mates and
	the teachers.			
Autonomy	The students are able to acquire information on their	r own. They can also judge the infor	mation with respect to	its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 2	28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	International Management and Engineering: Speciali	sation II. Process Engineering and B	iotechnology: Elective (Compulsory
Following Curricula	$\label{eq:Materials} Materials Science: Specialisation Nano and Hybrid Nano and Hybrid Materials Nano and Hybrid Nano And Hybrid$	aterials: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Orga	•	tive Compulsory	
	Biomedical Engineering: Specialisation Implants and			
	Biomedical Engineering: Specialisation Medical Tech	• • • • • • • • • • • • • • • • • • • •		
	Biomedical Engineering: Specialisation Management			
	Theoretical Mechanical Engineering: Technical Comp	,	•	
	Theoretical Mechanical Engineering: Specialisation B	io- and Medical Technology: Elective	e Compulsory	

Course L0593: Biomaterials	
Typ Hrs/wk	
CP	
	Independent Study Time 62, Study Time in Lecture 28
	Prof. Michael Morlock
Language	EN
Cycle	WiSe
Content	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
	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.
Literature	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.
	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.
1	

Module M1342: Polyn	oors				
Module M1342: Polyn	iers				
Courses					
Title		Тур	Hrs/wk	СР	
Structure and Properties of Polyme	rs (L0389)	Lecture	2	3	
Processing and design with polyme	rs (L1892)	Lecture	2	3	
Module Responsible	Dr. Hans Wittich				
Admission Requirements	None				
Recommended Previous	Basics: chemistry / physics / material scienc	ce			
Knowledge					
Educational Objectives	After taking part successfully, students have	e reached the following learning results			
Professional Competence					
Knowledge	Students can use the knowledge of plastics	and define the necessary testing and analys	iis.		
	They can explain the complex relationships	structure-property relationship and			
	the interactions of chemical structure of the	e polymers, including to explain neighboring	contexts (e.g. sustaina	bility, environmenta	
	protection).			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
Skills	Students are capable of				
	- using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate evaluate the different materials.				
	- selecting appropriate solutions for mecha	nical recycling problems and sizing example	stiffness, corrosion res	sistance.	
Personal Competence					
Social Competence	Students can				
	- arrive at funded work results in heterogen	ius groups and document them.			
	- provide appropriate feedback and handle feedback on their own performance constructively.				
Autonomy	Students are able to				
	- assess their own strengths and weaknesse	25.			
	- assess their own state of learning in specif	fic 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 in	n Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	Materials Science: Specialisation Engineerin	ng Materials: Elective Compulsory			
Following Curricula	Biomedical Engineering: Specialisation Impl	lants and Endoprostheses: Compulsory			
	Biomedical Engineering: Specialisation Artif	ficial Organs and Regenerative Medicine: Elec	ctive Compulsory		
		agement and Business Administration: Elect			
	3 3 1	lical Technology and Control Theory: Elective	. ,		
		ction: Specialisation Production: Elective Com			
	' '	ction: Specialisation Materials: Elective Comp	,		
		ction: Specialisation Product Development: E			
		ical Complementary Course: Elective Compul Ilisation Materials Science: Elective Compulso	•		

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				
	norph, crystalline, blends				
	- Properties				
	Elasticity, plasticity, viscoelacity				
	- Thermal properties				
	- Electrical properties				
	- Theoretical modelling				
	- Applications				
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag				

Course L1892: Processing an	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	lanufacturing 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: Rege	nerative Medicin	е				
Courses						
Title			Тур	Hrs/wk	СР	
Regenerative Medicine (L0347)			Seminar	2	3	
Lecture Tissue Engineering - Rege	nerative Medicine (L1664)		Seminar	2	3	
Module Responsible	Prof. Ralf Pörtner					
Admission Requirements	None					
Recommended Previous	None					
Knowledge						
Educational Objectives	After taking part succes	ssfully, students have rea	ached the following learning results			
Professional Competence						
Knowledge	After successful comple	etion of the module stud	dents will be able to describe the basic	methods of regenera	tive medicine and t	
	explain the use of the t	issue cells for different m	nethods of tissue engineering. They are a	able to give a basic ov	erview of methods for	
	the cultivation of anima	l and human cells.				
	The students can out	line the actual concept	s of Tissue Engineering and regeneral	tive medicine and ca	an explain the basi	
	udnerlying principles of					
Skills	After successful comple	tion of the module stude	ents are			
	able to use medi	cal databases for acquiri	erung and presentation of relevant up-to	-date data independe	ntly	
	able to present t	heir work results in the fo	orm of presentations			
	 able to carry out 	basic cell culture metho	ds and the corresponding analysis indep	endently		
	 able to analyse a 	and evaluate current rese	earch topics for Tissue Engineering and re	egenerative medicine.		
Personal Competence	,					
Social Competence		ork together as a team w	vith 2-4 students to solve given tasks and	d discuss their results	in the plenary and t	
Social Competence	defend them.	nk together as a team w	nti 2 4 stadents to solve given tusks une	a diseass then results	in the plendry and t	
	Students are able to ref	flect their work orally and	d discuss it with other students and teach	hers.		
Autonomy	,					
	After completion of the	nis module, participants	s will be able to solve a technical pr	oblem in teams of	approx. 2-4 person	
	independently including a presentation of the results.					
Workload in Hours	' '	e 124, Study Time in Lec	cture 56			
Credit points	1	Form	Description			
Course achievement	·	Written elaboration	Ausarbeitung zu Ringvorlesung / prot	tocol for lecture series		
Examination	Presentation					
Examination duration and	1	cussion (30 min)				
scale	· ·					
Assignment for the		: Specialisation Implants	and Endoprostheses: Elective Compulso	ory		
Following Curricula		•	Organs and Regenerative Medicine: Com	•		
_		Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory				
	Biomedical Engineering	omedical 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
Cycle	WiSe
Content	The course deals with the application of biotechnological engineering principles for re-generation of human tissues. The main topics are "tissue engineering" for the generation of "artificial organs" such as cartilage, liver, blood vessel etc., and their applications: Introduction (historical development, examples for medical and technical applications, commercial aspets) Cell specific fundamentals (cell physiology, biochemistry, metabolism, special requirements for cell cultivation "in vitro") Process specific fundamentals (requirements for culture systems, examples for reactor design, mathematical modelling, process and control strategies) Examples for applications for clinical applications, drug testing and material testing The fundamentals will be presented by the lecturers. The "state of the art" of specific applications will be exploited by the students based on selected papers and presented during the course.
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Academic Pr Inc; ISBN-10: 0123693713, ISBN-13: 978-0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-3540777540

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

Module M1333: BIO I:	Implants and Fracture Healing	
Courses		
Title	Typ Hrs/wk CP	
Implants and Fracture Healing (L03	(76) Lecture 2 3	
Module Responsible	Prof. Michael Morlock	
Admission Requirements	None	
Recommended Previous	It is recommended to participate in "Introduction into Anatomie" before attending "Implants and Fracture Healing".	
Knowledge		
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 their existence.	
	The students can name different treatments for the spine and hollow bones under given fracture morphologies.	
Clille		
SKIIIS	The students can determine the forces acting within the human body under quasi-static situations under specific assumptions	S.
Personal Competence		
Social Competence	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.	
Autonomy	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Credit points	3	
Course achievement	None	
Examination	Written exam	
Examination duration and	90 min	
scale		
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomech	nanio
Following Curricula	Compulsory	
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory	
	Engineering Science: Specialisation Biomedical Engineering: Compulsory	
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory	
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomech	nanio
	Compulsory	
	Mechanical Engineering: Specialisation Biomechanics: Compulsory	
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory	
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory	
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory	
	Orientation Studies: Core qualification: Elective Compulsory	
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory	

Course L0376: Implants and	Fracture Healing					
Тур	Lecture					
Hrs/wk						
СР						
	ndependent Study Time 62, Study Time in Lecture 28					
Language	rof. Michael Morlock					
Cycle						
Content	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)					
	5 Fracture Healing					
	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					
Literature	Cochran V.B.: Orthopädische Biomechanik					
Eiterature	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics					
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine					
	Nigg, B.: Biomechanics of the musculo-skeletal system					
	Schiebler T.H., Schmidt W.: Anatomie					
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat					
	. tateer, act reads act rendestine, band a betraggingsapparate					

Module M0630: Robot	tics and Naviga	ntion in Medicine				
Courses						
Title Robotics and Navigation in Medicine (L0335) Robotics and Navigation in Medicine (L0338) Robotics and Navigation in Medicine (L0336)			Typ Lecture Project Seminar Recitation Section (small)	Hrs/wk 2 2 1	CP 3 2	
Module Responsible		nefer				
Admission Requirements	None					
Recommended Previous Knowledge		nath (algebra, analysis/calculu rogramming, e.g., in Java or C ab skills				
Educational Objectives	After taking part succ	cessfully, students have reach	ed the following learning results			
Professional Competence Knowledge Skills	The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typic systems regarding design and limitations. The students are able to design and evaluate navigation systems and robotic systems for medical applications.					
Personal Competence Social Competence Autonomy	The students discuss the results of other groups, provide helpful feedback and can incoorporate feedback into their work. The students can reflect their knowledge and document the results of their work. They can present the results in an appropriat manner.					
Workload in Hours	Independent Study T	ime 110, Study Time in Lectur	e 70			
Credit points	6					
Course achievement	Compulsory Bonus Yes 10 % Yes 10 %	Form Written elaboration Presentation	Description			
Examination	Written exam					
Examination duration and scale Assignment for the	90 minutes		gineering: Elective Compulsory			
Following Curricula	International Manage International Manage Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Product Developmen Product Developmen	ement and Engineering: Specialisation Intelligent Systems aring: Specialisation Artificial Orang: Specialisation Implants and Ing: Specialisation Medical Tecong: Specialisation Management, Materials and Production: Specialisation Management	disation II. Electrical Engineering: Elect disation II. Process Engineering and Bio d Robotics: Elective Compulsory gans and Regenerative Medicine: Elect d Endoprostheses: Elective Compulsor hnology and Control Theory: Elective Co at and Business Administration: Elective decialisation Product Development: Ele pecialisation Production: Elective Compu-	otechnology: Elective ve Compulsory y Compulsory e Compulsory ctive Compulsory oulsory	e Compulsory	
			plementary Course: Elective Compulso Bio- and Medical Technology: Elective			

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

Course L0338: Robotics and	urse 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 M1384: Case	Studies for Regenerative Medi	cine and Tissue Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Case Studies for Regenerative Med	icine and Tissue Engineering (L1963)	Seminar	3	6
Module Responsible	Prof. Ralf Pörtner			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 138, Study Time in	Lecture 42		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	45 min			
scale				
Assignment for the	Biomedical Engineering: Specialisation Artific	ial Organs and Regenerative Medicine: Com	pulsory	
Following Curricula	Biomedical Engineering: Specialisation Impla	·	•	
	Biomedical Engineering: Specialisation Mana	-		
	Biomedical Engineering: Specialisation Medic	al Technology and Control Theory: Elective (Compulsory	

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

Module M0634: Introd						
Courses						
Title				Тур	Hrs/wk	СР
Introduction into Medical Technolog				Lecture	2	3
Introduction into Medical Technolog				Project Seminar	2	2
Introduction into Medical Technolog				Recitation Section (large)	1	1
Module Responsible	†	efer				
Admission Requirements						
Recommended Previous			us)			
Knowledge	1					
	principles of programi	illing, K/Matiab				
Educational Objectives	After taking part succ	essfully, students hav	ve reached the followi	ng learning results		
Professional Competence						
Knowledge	The students can ex	plain principles of m	nedical technology, in	cluding imaging systems, c	omputer aided s	surgery, and medica
	information systems.	They are able to give	an overview of regula	atory affairs and standards in	medical technol	ogy.
Skills	The students are able	to evaluate systems	and medical devices	in the context of clinical appl	ications	
Skills	The students are able	to evaluate systems	and medical devices	in the context of clinical appi	ications.	
Personal Competence						
Social Competence	The students describe	e a problem in medica	al technology as a proj	ect, and define tasks that are	e solved in a join	effort.
Autonomy	The students can refl	ect their knowledge	and document the res	sults of their work. They can	nrecent the reci	ılts in an annronriat
riaconomy	manner.	cet their knowledge	and document the re-	outs of their work. They can	present the rest	nes in un appropriac
Workload in Hours	Independent Study Tir	me 110, Study Time i	in Lecture 70			
Credit points						
Course achievement	Compulsory Bonus Yes 10 %	Form Presentation	Description			
	Yes 10 %	Written elaboration				
Examination		Witten elaboration				
Examination duration and						
scale	90 minutes					
Assignment for the	General Engineering 9	Science (German prod	gram 7 semester). Sn	ecialisation Biomedical Engir	neering: Compuls	nrv
Following Curricula				eering: Elective Compulsory	icering. compais	51 y
		•	_	ng Science: Elective Compuls	ory	
	Data Science: Core qu		•	,	,	
	Electrical Engineering					
	Engineering Science:	Specialisation Biomed	dical Engineering: Con	npulsory		
	General Engineering S	Science (English prog	ram, 7 semester): Spe	ecialisation Biomedical Engine	eering: Compulso	ry
	Computational Scienc	e and Engineering: S	pecialisation II. Mathe	matics & Engineering Science	e: Elective Comp	ulsory
	Biomedical Engineerin	ng: Specialisation Arti	ficial Organs and Reg	enerative Medicine: Elective	Compulsory	
	_			eses: Elective Compulsory		
	_			Control Theory: Elective Com		
1	_			ss Administration: Elective Co	ompulsory	
	Technomathematics:	Specialisation III. Eng	ineering Science: Elec	ctive Compulsory		

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

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

Course L1876: Introduction i	nto 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: Nonlin	near Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Dynamics (L0702)		Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous Knowledge	CalculusLinear AlgebraEngineering Mechanics			
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence			<u> </u>	<u> </u>
	Students are able to reflect existing terms and conc concepts. Students are able to apply existing methods and proce-		·	
Personal Competence	Students are able to apply existing methods and proces	sures of Northhear Dynamics and to	develop novel meth	lous and procedures.
·	Students can reach working results also in groups.			
, , , , , , , , , , , , , , , , , , ,	Students are able to approach given research tasks ind	ividually and to identify and follow	un novel research ta	sks hy themselves
,	Independent Study Time 124, Study Time in Lecture 56		ap nover research to	sks by themselves.
Credit points				
-	None			
Examination				
	2 Hours			
scale				
Assignment for the	Aircraft Systems Engineering: Core qualification: Electiv	ve Compulsory		
Following Curricula	International Management and Engineering: Specialisat	tion II. Mechatronics: Elective Comp	ulsory	
	Mechanical Engineering and Management: Specialisation	on Mechatronics: Elective Compulso	ry	
	Mechatronics: Specialisation System Design: Elective C	ompulsory		
	Mechatronics: Specialisation Intelligent Systems and Ro	obotics: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs	and Regenerative Medicine: Elective	e Compulsory	
	Biomedical Engineering: Specialisation Implants and En			
	Biomedical Engineering: Specialisation Medical Technol	•		
	Biomedical Engineering: Specialisation Management an		Compulsory	
	Product Development, Materials and Production: Core of			
	Theoretical Mechanical Engineering: Technical Complet	· ·	ry	
	Theoretical Mechanical Engineering: Core qualification:	Elective Compulsory		

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

module MO701. Semi	conductor Technology			
Courses				
Title		Тур	Hrs/wk	СР
Semiconductor Technology (L0722)	Lecture	4	4
Semiconductor Technology (L0723		Practical Course	2	2
Module Responsible	Prof. Hoc Khiem Trieu			
Admission Requirements	None			
	Basics in physics, chemistry, material science and semi	onductor devices		
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge				
	Students are able			
	to describe and to explain surrent febrication technique	auga for Ci and CaAa substrates		
	to describe and to explain current fabrication technic	ques for Si affo GaAs substrates	,	
	to discuss in details the relevant fabrication	processes, process flows and	the impact thereof or	n the fabrication
	semiconductor devices and integrated circuits and			
	to present integrated process flows.			
	process management process management			
Skills				
	Students are capable			
	to analyze the impact of process parameters on the	processing results,		
	to coloct and to evaluate processes and			
	to select and to evaluate processes and			
	to develop process flows for the fabrication of semio	onductor devices.		
Personal Competence				
Social Competence				
	Students are able to prepare and perform their lab expe	riments in team work as well as	to present and discus	s the results in fro
	of audience.			
Autonomy	None			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Nanoelectronics ar	d Microsystems Technology: Ele	ctive Compulsorv	
Following Curricula		,		
3	Biomedical Engineering: Specialisation Implants and End	•		
	Biomedical Engineering: Specialisation Medical Technology			
	Biomedical Engineering: Specialisation Management and	Business Administration: Electi	ve Compulsory	
	Microelectronics and Microsystems: Core qualification: E	ective Compulsory		

urse L0722: Semiconducto	or Technology
	Lecture
Hrs/wk	
CP	
	Independent Study Time 64, Study Time in Lecture 56 Prof. Hoc Khiem Trieu
Language	
Cycle	
Content	 Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski , Bridgeman and float zone process) Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping profile, higher order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation damage annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions, kinetics influences on growth rate, process technology and equipment, anodic oxidation, plasma oxidation, thermal oxidation (GaAs) Deposition techniques (theory: nucleation, film growth and structure zone model, film growth process, reaction kinetics temperature dependence and equipment; epitaxy: gas phase, liquid phase, molecular beam epitaxy; CVD techniques APCVD, LPCVD, deposition of metal silicide, PECVD and LECVD; basics of plasma, equipment, PVD techniques: high vacuur evaporation, sputtering) Structuring techniques (subtractive methods, photolithography: resist properties, printing techniques: contact, proximit and projection printing, resolution limit, practical issues and equipment, additive methods: liftoff technique an
	electroplating, improving resolution: excimer laser light source, immersion lithography and phase shift lithography, electrobeam lithography, X-ray lithography, EUV lithography, ion beam lithography, wet chemical etching: isotropic an anisotropic, corner undercutting, compensation masks and etch stop techniques; dry etching: plasma enhanced etching backsputtering, ion milling, chemical dry etching, RIE, sidewall passivation) • Process integration (CMOS process, bipolar process) • Assembly and packaging technology (hierarchy of integration, packages, chip-on-board, chip assembly, electrical contact wire bonding, TAB and flip chip, wafer level package, 3D stacking)
Literature	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: Huma	noid Robotics			
Courses				
Title		Тур	Hrs/wk	СР
Humanoid Robotics (L0663)		Seminar	2	2
Module Responsible	Patrick Göttsch			
Admission Requirements	None			
Recommended Previous				
Knowledge	Introduction to control systems			
	Control theory and design			
	control and design			
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge	Students can explain humanoid robo	ts.		
	· ·	concepts for different tasks in humanoid ro	botics.	
Skills				
SKIIIS	Students acquire knowledge about set	elected aspects of humanoid robotics, based	d on specified literature	
	 Students generalize developed result 	ts and present them to the participants		
	Students practice to prepare and give	e a presentation		
Personal Competence				
Social Competence				
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		solutions in interdisciplinary teams and prese		
	They are able to provide appropriate	feedback and handle constructive criticism	of their own results	
Autonomy				
	•	drawbacks of different forms of presenta-	tion for specific tasks	and select the best
	solution Students familiarize themselves with	n a scientific field, are able of introduce it	and follow presentation	ns of other students
	such that a scientific discussion deve		and follow presentation	is of other students,
	Such and a Scientific discussion deve			
Workload in Hours	Independent Study Time 32, Study Time in	Lecture 28		
Credit points	2			
Course achievement				
Examination	Presentation			
Examination duration and	30 min			
scale	Machabasias Cassisliantias late War of Cast	bears and Bahatian Flating Committee		
Assignment for the	Mechatronics: Specialisation Intelligent Syst			
Following Curricula	Mechatronics: Specialisation System Design Biomedical Engineering: Specialisation Artif	i: Elective Compulsory icial Organs and Regenerative Medicine: Ele	ective Compulsory	
		lants and Endoprostheses: Elective Compuls	, ,	
		ical Technology and Control Theory: Elective	•	
		agement and Business Administration: Elect		
	Theoretical Mechanical Engineering: Techni	cal Complementary Course: Elective Compu	llsory	
	Theoretical Mechanical Engineering: Specia	lisation Robotics and Computer Science: Ele	ctive Compulsory	

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

Module M0838: Linea	r and Nonlinear System Identifika	tion		
Courses				
Title		Тур	Hrs/wk	СР
Linear and Nonlinear System Identi	fication (L0660)	Lecture	2	3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	 Classical control (frequency response, root State space methods Discrete-time systems Linear algebra, singular value decompositi Basic knowledge about stochastic processe 	on		
Educational Objectives	After taking part successfully, students have read	thed the following learning results		
Professional Competence				
Knowledge	 Students can explain the general framew nonlinear model structures They can explain how multilayer perceptro They can explain how an approximate precent they can explain the idea of subspace identification. 	n networks are used to model nonline dictive control scheme can be based o	ear dynamics on neural network model	
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 groups on specific pr	oblems to arrive at joint solutions.		
Autonomy	Students are able to find required information in solve given problems.	sources provided (lecture notes, litera	ature, software documer	tation) and use it to
Workload in Hours	Independent Study Time 62, Study Time in Lectur	re 28		
Credit points	3			
Course achievement	None			
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the	Electrical Engineering: Specialisation Control and	Power Systems Engineering: Elective	Compulsory	
Following Curricula	Mechatronics: Specialisation Intelligent Systems a			
	Mechatronics: Specialisation System Design: Elec			
	Biomedical Engineering: Specialisation Artificial C	3	. ,	
	Biomedical Engineering: Specialisation Implants a	·	•	
	Biomedical Engineering: Specialisation Medical Te Biomedical Engineering: Specialisation Managem			
	Theoretical Mechanical Engineering: Technical Co			
	Theoretical Mechanical Engineering: Core qualific			
	3 3 44	. ,		

Course L0660: Linear and No	onlinear 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

ourcoc				
ourses				
itle ptimal and Robust Control (L0658		Typ Lecture	Hrs/wk 2	CP 3
ptimal and Robust Control (L0659		Recitation Section (small)	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	None			
Knowledge	 Classical control (frequency response, root locus) 			
	State space methods			
	 Linear algebra, singular value decomposition 			
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence	3,7	3 3		
Knowledge				
	 Students can explain the significance of the matrix 	Riccati equation for the solution of	LQ problems.	
	 They can explain the duality between optimal state 	feedback and optimal state estima	tion.	
	They can explain how the H2 and H-infinity norms			
	They can explain how an LQG design problem can	•		
	They can explain how model uncertainty can be re-	•		-
	They can explain how - based on the small gain to	neorem - a robust controller can gu	arantee stability	апа реттогталсе
	an uncertain plant.They understand how analysis and synthesis condi	rions on foodback loops can be rope	acontod ac linear	matrix inaqualitie
	They understand now analysis and synthesis condi	lions of feedback loops can be repri	esenteu as imear	matrix mequantie
Skills	• Students are capable of designing and tuning LOC	controllers for multivariable plant m	adals	
	 Students are capable of designing and tuning LQG They are capable of representing a H2 or H-infinity 			nd of using stand
	software tools for solving it.	design problem in the form of a ge	neranzeu piant, a	nd of dailing stand
	They are capable of translating time and frequency	y domain specifications for control	loops into constr	aints on closed-l
	sensitivity functions, and of carrying out a mixed-s			
	They are capable of constructing an LFT uncertainty		, and of designin	ig a mixed-objec
	robust controller.			,
	 They are capable of formulating analysis and synt 	nesis conditions as linear matrix ine	qualities (LMI), a	nd of using stand
	LMI-solvers for solving them.			
	 They can carry out all of the above using standard 	software tools (Matlab robust contro	ol toolbox).	
Personal Competence				
•	Students can work in small groups on specific problems to	arrive at joint solutions		
	Students can work in small groups on specific problems to Students are able to find required information in sources		oftware decume	station) and use i
Autonomy	solve given problems.	provided (lecture flotes, literature, s	software documer	itation) and use i
	solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale	33			
Assignment for the	Electrical Engineering: Specialisation Control and Power S	ystems Engineering: Elective Comp	ulsory	
Following Curricula	Energy Systems: Core qualification: Elective Compulsory			
	Aircraft Systems Engineering: Core qualification: Elective	' '		
	Mechatronics: Specialisation Intelligent Systems and Robe	, ,		
	Mechatronics: Specialisation System Design: Elective Con Biomedical Engineering: Specialisation Artificial Organs a		Compulsory	
	Biomedical Engineering: Specialisation Implants and Endo	•	compuisory	
	Biomedical Engineering: Specialisation Implants and Endo Biomedical Engineering: Specialisation Medical Technolog		nulsory	
	Biomedical Engineering: Specialisation Management and			
	Product Development, Materials and Production: Specialis			
	Product Development, Materials and Production: Specialis	·		
	Product Development, Materials and Production: Specialis	·	•	
	Theoretical Mechanical Engineering: Technical Compleme	·	•	
	5	,		

Course L0658: Optimal and F	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 F	ourse 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	

Module M0855: Marko	eting (Sales and Services / Innovation	Marketing)		
Courses				
Title		Тур	Hrs/wk	СР
Marketing of Innovations (L2009)		Lecture	4	4
PBL Marketing of Innovations (L086	52)	Project-/problem-based Learning	1	2
Module Responsible	Prof. Christian Lüthje			
Admission Requirements				
Recommended Previous	Module International Business			
Knowledge	Basic understanding of business administration	principles (strategic planning, decisi	on theory, pro	oject management,
	international business)			
	Bachelor-level Marketing Knowledge (Marketing In		egies, Basics o	f Buying Behavior)
	 Unerstanding the differences beweetn B2B and B2 Understanding of the importance of managing inn 			
	Good English proficiency; presentation skills	ovacion in global industrial markets		
	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students will have gained a deep understanding of			
	Specific characteristics in the marketing of innova	tive poroducts and services		
	Approaches for analyzing the current market situation		İ	
	The gathering of information about future customs			
	 Concepts and approaches to integrate lead users Approaches and tools for ensuring customer-orien 			
	Marketing mix elements that take into considera			
	services		3	
	Pricing methods for new products and services			
	The organization of complex sales forces and pers	onal selling		
	Communication concepts and instruments for new	products and services		
Skills	Based on the acquired knowledge students will be able t	0:		
	Design and to evaluate decisions regarding market	ting and innovation strategies		
	Analyze markets by applying market and technology	gy portfolios		
	Conduct forecasts and develop compelling scenar			
	 Translate customer needs into concepts, prototyl customer-oriented product and service development 		rully apply adv	anced methods for
	Use adequate methods to foster efficient diffusion			
	Choose suitable pricing strategies and communication			
	Make strategic sales decisions for products and ser	rvices (i.e. selection of sales channels)		
	Apply methods of sales force management (i.e. cu	stomer value analysis)		
Personal Competence				
· ·	The students will be able to			
	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 contact.	ontext and to man this knowledge on ot	her new compl	ex problem fields
	Consider proposed business actions in the field of	,	ner new compi	ex problem neids.
	Independent Study Time 110, Study Time in Lecture 70			
Credit points Course achievement				
	Subject theoretical and practical work			
Examination duration and		ipation		
scale	, sacrosso, presentation, oral partie	er en		
Assignment for the	Global Technology and Innovation Management & Entrep	preneurship: Core qualification: Compuls	ory	
Following Curricula	International Management and Engineering: Specialisation	on I. Electives Management: Elective Cor	npulsory	
	Mechanical Engineering and Management: Specialisation			
	Biomedical Engineering: Specialisation Artificial Organs a		npulsory	
	Biomedical Engineering: Specialisation Implants and End		COTY	
	Biomedical Engineering: Specialisation Medical Technolo Biomedical Engineering: Specialisation Management and		ьог у	
	Diamedical Engineering, Specialisation Management and	Sasmess / ammiscration. Compaisory		

Course L2009: Marketing of	Innovations	
Тур	Lecture	
Hrs/wk	4	
СР	4	
	Independent Study Time 64, Study Time in Lecture 56	
	Prof. Christian Lüthje	
Language		
Cycle	I. Introduction	
	 Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing) 	
	II. Methods and approaches of strategic marketing planning	
	patterns of industrial development, patent and technology portfolios	
	III. Strategic foresight and scenario analysis	
	objectives and challenges of strategic foresight, scenario analysis, Delphi method	
	IV. User innovations	
	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 Marketing	Course L0862: PBL Marketing of Innovations		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Christian Lüthje		
Language	EN		
Cycle	SoSe		
Content	This PBL course is seggregated into two afternoon sessions. This cours aims at enhancing the students' practical skills in (1) forecasting the future development of markets and (2) making appropriate market-related decisions (particularly segmentation, managing the marketing mix). The students will be prompted to use the knowledge gathered in the lecture of this module and will be invited to (1) Conduct a scenario analysis for an innovative product category and (2) Engage in decision making within a market simulation game.		
Literature			

Module M1143: Applie	ed Design Methodology in Mechatro	nics		
Courses				
Title		Тур	Hrs/wk	СР
Applied Design Methodology in Med	chatronics (L1523)	Lecture	2	2
Applied Design Methodology in Med	chatronics (L1524)	Project-/problem-based Learning	3	4
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mechanical design, electrical design or con	nputer-sciences		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	Science-based working on interdisciplinary product of	design considering targeted application of sp	ecific product	design techniques
Skills	Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.			
Personal Competence				
•	Students will solve and execute technical-scientific	tasks from an industrial context in small	design-teams	s with application of
,	common, creative methodologies.		•	
Autonomy	Students are enabled to optimize the design and dev	velopment process according to the target ar	nd topic of the	e design
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	30 min Presentation for a group design-work			
scale				
Assignment for the	International Management and Engineering: Speciali	sation II. Product Development and Production	on: Elective Co	ompulsory
Following Curricula	International Management and Engineering: Speciali	sation II. Mechatronics: Elective Compulsory		
	Mechanical Engineering and Management: Specialisa	ation Product Development and Production: E	Elective Comp	ulsory
	Mechatronics: Specialisation System Design: Elective	e Compulsory		
	Biomedical Engineering: Specialisation Artificial Orga	ans and Regenerative Medicine: Elective Com	npulsory	
	Biomedical Engineering: Specialisation Implants and	Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical Tech	nology and Control Theory: Elective Compuls	sory	
	Biomedical Engineering: Specialisation Management	and Business Administration: Elective Comp	ulsory	
	Theoretical Mechanical Engineering: Specialisation P	roduct Development and Production: Elective	e Compulsory	
	Theoretical Mechanical Engineering: Technical Comp	olementary Course: Elective Compulsory		

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

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

Courses					
Title			Тур	Hrs/wk	СР
Bioprocess Engineering - Fundame	ntals (L0841)		Lecture	2	3
Bioprocess Engineering- Fundamer	ntals (L0842)		Recitation Section (large)	2	1
Bioprocess Engineering - Fundame	ntal Practical Course (L0843)		Practical Course	2	2
Module Responsible	Prof. Andreas Liese				
Admission Requirements	None				
Recommended Previous	none, module "organic chemistry", modu	le "fundamentals for p	rocess engineering"		
Knowledge					
Educational Objectives	After taking part successfully, students h	ave reached the follow	ving learning results		
Professional Competence					
Knowledge	Students are able to describe the basic of	oncepts of bioprocess	engineering. They are able to	classify different	t types of kinetics
	enzymes and microorganisms, as well	as to differentiate di	fferent types of inhibition. T	he parameters o	of stoichiometry a
	rheology can be named and mass tran	sport processes in bi	oreactors can be explained.	The students are	e capable to expl
	fundamental bioprocess management, st	erilization technology	and downstream processing ir	n detail.	
Skilla	After successful completion of this module	lo students should be	able to		
SKIIIS	After successful completion of this modul	e, students should be	able to		
	 describe different kinetic approach 	es for growth and sub	strate-uptake and to calculate	the corresponding	ng parameters
	 predict qualitatively the influence 	of energy generation	n, regeneration of redox equi	valents and grow	wth inhibition on t
	fermentation process				
	analyze bioprocesses on basis of s	toichiometry and to se	et up / solve metabolic flux equ	uations	
	distinguish between scale-up crite	ria for different biorea	ctors and bioprocesses (anaer	obic, aerobic as	well as microaerob
	to compare them as well as to app	ly them to current bio	technical problem		
	 propose solutions to complicated b 	oiotechnological proble	ems and to deduce the corresp	onding models	
	. to combine more because days accommon				
	to explore new knowledge resource				
	 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 				
	to document and discuss their pro-	Ledures as well as rest	aits in a scientific manner		
B 16 1					
Personal Competence					
Social Competence					
	take position to their own opinions and in	crease their capacity f	for teamwork in engineering a	nd scientific envi	ronments.
Autonomy	After completion of this module participa	ants will be able to sol	ve a technical problem in a te	am independentl	lv bv organizing th
,	workflow and to present their results in a				, , , , , , , ,
	·	<u>'</u>			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84			
Credit points					
Course achievement		Description			
	Yes 5 % Subject theoret	ical and			
	practical work				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	General Engineering Science (German pro	ogram, 7 semester). S	pecialisation Process Engineer	ing: Compulsory	
Following Curricula					
. cc.mig carricula	Bioprocess Engineering: Core qualification				,
	Green Technologies: Energy, Water, Clim		resource Technology: Flective	Compulsory	
	Biomedical Engineering: Specialisation Ar		3,		
	Biomedical Engineering: Specialisation In			,	
	2.5carcar Engineering. Specialisation in				
	Biomedical Engineering: Specialisation M.	edical Technology and	CONTROL I NEORY: FIECTIVE LOW	nijisorv	
	Biomedical Engineering: Specialisation M Biomedical Engineering: Specialisation M				
	Biomedical Engineering: Specialisation M Biomedical Engineering: Specialisation M Technomathematics: Specialisation III. Er	anagement and Busine	ess Administration: Elective Co		

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

Course L0842: Bioprocess En	gineering- 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
Language	DE
Cycle	SoSe
Content	1. Introduction (Prof. Liese, Prof. Zeng)
	2. Enzymatic kinetics (Prof. Liese)
	3. Stoichiometry I + II (Prof. Liese)
	4. Microbial Kinetics I+II (Prof. Zeng)
	5. Rheology (Prof. Liese)
	6. Mass transfer in bioprocess (Prof. Zeng)
	7. Continuous culture (Chemostat) (Prof. Zeng)
	8. Sterilisation (Prof. Zeng)
	9. Downstream processing (Prof. Liese)
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)
Literature	siehe Vorlesung

Course L0843: Bioprocess En	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 M1280: MED	II: Introduction to Physiology
Courses	
Title	Typ Hrs/wk CP
Introduction to Physiology (L0385)	Lecture 2 3
Module Responsible	Dr. Roger Zimmermann
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can
	describe the basics of the energy metabolism;
	describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.
GL III.	
SKIIIS	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, development of forces and vital functions) and relate them to similar technical systems.
Personal Competence	of forces and vital functions) and relate them to similar technical systems.
•	The students can conduct discussions in research and medicine on a technical level.
Social competence	The students can find solutions to problems in the field of physiology, both analytical and metrological.
Autonomy	
	themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	60 minutes
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Following Curricula	
	Compulsory Data Science: Specialization Medicine: Compulsory
	Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Elective 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 Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective 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
	recimonitationaties. Specialisation in. Engineering Science. Elective Compulsory

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

Module M1277: MED I:	: Introduction to Anatomy
Courses	
Title	Typ Hrs/wk CP
Introduction to Anatomy (L0384)	Lecture 2 3
Module Responsible	Prof. Udo Schumacher
Admission Requirements	None
Recommended Previous	None
Knowledge	
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.
Skille	The students can recognize the relationship between given anatomical facts and the development of some common diseases; the
	can explain the relevance of structures and their functions in the context of widespread diseases.
	can explain the relevance of structures and their functions in the context of widespread discuses.
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 acqui
,	the relevant knowledge themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	90 minutes
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
•	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic
	Compulsory
	Data Science: Specialisation Medicine: Compulsory
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Biomedical Engineering: Specialisation Biomedical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory. Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory

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

Module M12/8: MED	l: Introduction to Radiology and Radiation Therapy				
Courses					
Title	Typ Hrs/wk CP				
Introduction to Radiology and Radia	ation Therapy (L0383) Lecture 2 3				
Module Responsible	Prof. Ulrich Carl				
Admission Requirements	None				
Recommended Previous Knowledge	None				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	Therapy				
	The students can distinguish different types of currently used equipment with respect to its use in radiation therapy.				
	The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine).				
	The students can describe the patients' passage from their initial admittance through to follow-up care.				
	Diagnostics				
	The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, a well as sectional imaging techniques (CT, MRT, US).				
	The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for thos techniques.				
	The students can choose the right treatment method depending on the patient's clinical history and needs.				
	The student can explain the influence of technical errors on the imaging techniques.				
	The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.				
Skills	Therapy				
	The students can distinguish curative and palliative situations and motivate why they came to that conclusion.				
	The students can develop adequate therapy concepts and relate it to the radiation biological aspects.				
	The students can use the therapeutic principle (effects vs adverse effects)				
	The students can distinguish different kinds of radiation, can choose the best one depending on the situation (location of th 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. follow-up treatment, sports, social hel groups, self-help groups, social services, psycho-oncology).				
	Diagnostics				
	The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.				
	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of anatomy, pathology and pathophysiology.				
Personal Competence					
Social Competence	The students can assess the special social situation of tumor patients and interact with them in a professional way. The students are aware of the special, often fear-dominated behavior of sick people caused by diagnostic and therapeut 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 topi and acquire the relevant knowledge themselves.				
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28				
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and scale	90 minutes				
Assignment for the Following Curricula					
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory				
	Engineering Science: Specialisation Biomedical Engineering: Compulsory				
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory				
1	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 t	to Radiology and Radiation Therapy
Тур	Lecture
Hrs/wk	
CP	
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ulrich Carl, Prof. Thomas Vestring
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
Literature	"Technik der medizinischen Radiologie" von T. + J. Laubenberg –
	7. Auflage – Deutscher Ärzteverlag – erschienen 1999
	"Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr –
	4. Auflage - Verlag Urban & Fischer – erschienen 02.03.2006
	ISBN: 978-3-437-23960-1
	"Strahlentherapie und Onkologie für MTA-R" von R. Sauer –
	5. Auflage 2003 - Verlag Urban & Schwarzenberg – erschienen 08.12.2009
	ISBN: 978-3-437-47501-6
	"Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus-
	8. Auflage – Georg Thieme Verlag - erschienen 19.09.2012
	ISBN: 978-3-13-567708-8
	• "Der Körper des Menschen " von A. Faller u. M. Schünke -
	16. Auflage 2004 - Georg Thieme Verlag - erschienen 18.07.2012
	ISBN: 978-3-13-329716-5
	"Praxismanual Strahlentherapie" von Stöver / Feyer –
	1. Auflage - Springer-Verlag GmbH – erschienen 02.06.2000

Module M1335: BIO II	: Artificial Joint Replacement				
Courses					
Title		Тур	Hrs/wk	СР	
Artificial Joint Replacement (L1306)		Lecture	2	3	
Module Responsible	Prof. Michael Morlock				
Admission Requirements	None				
Recommended Previous	Basic knowledge of orthopedic and surgical techn	iques is recommended.			
Knowledge					
Educational Objectives	After taking part successfully, students have read	hed the following learning results			
Professional Competence					
Knowledge	The students can name the different kinds of arti	ficial limbs.			
CI:II-	The students can explain the advantages and disadvantages of different kinds of endoprotheses.				
SKIIIS	The students can explain the advantages and dis	advantages of different kinds of endop	rotneses.		
Personal Competence					
Social Competence	The students are able to discuss issues related to	endoprothese with student mates and	I the teachers.		
Autonomy	The students are able to acquire information on t	heir own. They can also judge the infor	mation with respect to	its cradibility	
Autonomy	The students are able to dequire information on t	nen own. They can also judge the infor	mation with respect to	its credibility.	
Workload in Hours	Independent Study Time 62, Study Time in Lectu	re 28			
Credit points	3				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	International Management and Engineering: Spec	ialisation II. Process Engineering and B	liotechnology: Elective	Compulsory	
Following Curricula	Materials Science: Specialisation Nano and Hybrid	d Materials: Elective Compulsory			
	Biomedical Engineering: Specialisation Artificial C	organs and Regenerative Medicine: Elec	ctive Compulsory		
	Biomedical Engineering: Specialisation Implants a	and Endoprostheses: Compulsory			
	Biomedical Engineering: Specialisation Medical To	echnology and Control Theory: Elective	Compulsory		
	Biomedical Engineering: Specialisation Managem	ent and Business Administration: Electi	ive Compulsory		
	Orientation Studies: Core qualification: Elective C	ompulsory			
	Theoretical Mechanical Engineering: Technical Co	emplementary Course: Elective Compul	sory		
	Theoretical Mechanical Engineering: Specialisation	n Bio- and Medical Technology: Electiv	e Compulsorv		

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

Module M0845: Feedl	oack Control in Medical Tech	nology		
Courses				
Title		Тур	Hrs/wk	СР
Feedback Control in Medical Techno	ology (L0664)	Lecture	2	3
Module Responsible	Johannes Kreuzer			
Admission Requirements	None			
Recommended Previous	Basics in Control, Basics in Physiology			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ive reached the following learning results		
Professional Competence				
Knowledge	The lecture will introduce into the fascinating area of medical technology with the engineering point of view. Fundamentals human physiology will be similarly introduced like knowledge in control theory.			w. Fundamentals in
	Internal control loops of the human body will be discussed in the same way like the design of external closed loop system example in for anesthesia control. The handling of PID controllers and modern controller like predictive controller or fuzzy controller or neural networks will illustrated. The operation of simple equivalent circuits will be discussed.			
Skills	Application of modeling, identification, co	ntrol technology in the field of medical technolo	gy.	
Personal Competence Social Competence	Students can develop solutions to specific	problems in small groups and present their res	ults	
Autonomy	· ·	ture and to set it into the context of the lectur their learning process. They can combine kno	•	-
Workload in Hours	Independent Study Time 62, Study Time in	n Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Oral exam			
Examination duration and	20 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Medi	ical Technology: Elective Compulsory		
Following Curricula	Electrical Engineering: Specialisation Cont	rol and Power Systems Engineering: Elective Co	ompulsory	
	Biomedical Engineering: Specialisation Im	plants and Endoprostheses: Elective Compulsor	У	
	Biomedical Engineering: Specialisation Art	tificial Organs and Regenerative Medicine: Elect	ive Compulsory	
		nagement and Business Administration: Electiv		
	Biomedical Engineering: Specialisation Me	edical Technology and Control Theory: Compulso	ory	

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

Module M0832: Adva	nced Topics in Control				
Courses					
Title		Тур	Hrs/wk	СР	
Advanced Topics in Control (L0661))	Lecture	2	3	
Advanced Topics in Control (L0662))	Recitation Section (small)	2	3	
Module Responsible					
Admission Requirements					
Recommended Previous Knowledge	H-infinity optimal control, mixed-sensitivity design, line	ar matrix inequalities			
	After taking part successfully, students have reached t	he following learning results			
Professional Competence					
Knowledge	Students can explain the advantages and shortcomings of the classical gain scheduling approach They can explain the representation of nonlinear systems in the form of quasi-LPV 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 and synthesis problems for LPV systems They are familiar with polytopic and LFT representations of LPV systems and some of the basic synthesis associated with each of these model structures				
	 Students can explain how graph theoretic consystems They can explain the convergence properties of They can explain analysis and synthesis conditions 	first order consensus protocols			
	 Students can explain the state space representation of spatially invariant distributed systems that are discreto an actuator/sensor array They can explain (in outline) the extension of the bounded real lemma to such distributed systems and synthesis conditions for distributed controllers 				
Skills	 Students are capable of constructing LPV models of nonlinear plants and carry out a 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 these tasks 				
	Students are able to design distributed formation controllers for groups of agents with either LTI or LPV dynamics Matlab tools provided				
Personal Competence	Students are able to design distributed controlle	rs for spatially interconnected systems	, using the Matla	b MD-toolbox	
•	Students can work in small groups and arrive at joint re	esults.			
,	Students are able to find required information in source solve given problems.		oftware documer	ntation) and use it to	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	5	<u>-</u>		
Credit points	6				
Course achievement					
Examination					
Examination duration and scale	30 min				
	Electrical Engineering: Specialisation Control and Powe	r Systems Engineering: Elective Compu	ılsory		
•	Aircraft Systems Engineering: Specialisation Avionic Sy	,	,		
	Aircraft Systems Engineering: Specialisation Aircraft Sy	, ,			
	Aircraft Systems Engineering: Core qualification: Electi	ve Compulsory			
	International Management and Engineering: Specialisa	·	ory		
	Mechatronics: Specialisation System Design: Elective C				
	Mechatronics: Specialisation Intelligent Systems and R	, ,			
	Biomedical Engineering: Specialisation Implants and Er Biomedical Engineering: Specialisation Medical Techno		oulsorv		
	Biomedical Engineering: Specialisation Management at	•	•		
	Biomedical Engineering: Specialisation Artificial Organs				
	Theoretical Mechanical Engineering: Technical Comple	mentary Course: Elective Compulsory			

Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Course L0661: Advanced Top	oics 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
	Linear and Nonlinear Model Predictive Control based on LMIs
Literature	Werner, H., Lecture Notes "Advanced Topics in Control"
	Selection of relevant research papers made available as pdf documents via StudIP

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	

_					
Courses					
Title		Тур	Hrs/wk	СР	
Bioelectromagnetics: Principles and		Lecture	3	5 1	
Bioelectromagnetics: Principles and		Recitation Section (small)	2	1	
	Prof. Christian Schuster				
	None				
Recommended Previous Knowledge	Basic principles of physics				
Kilowiedge					
Educational Objectives	After taking part successfully, students h	ave reached the following learning results			
Professional Competence	Arter taking part successiony, students no	ave reached the following learning results			
-	Students can explain the basic principles	, relationships, and methods of bioelectromagne	otics is the quantific	ation and applicati	
Knowicage		isue. They can define and exemplify the most			
		frequency of the fields. They can give an over			
		omagnetic fields in practical applications . The			
	diagnostic utilization of electromagnetic f		, , ,	·	
Skills	Students know how to apply various meth	nods to characterize the behavior of electromag	netic fields in biologic	cal tissue. In order	
	do this they can relate to and make use	e of the elementary solutions of Maxwell's Equ	ations. They are able	e to assess the mo	
	important effects that these models predict for biological tissue, they can order the effects corresponding to wavelength and				
	frequency, respectively, and they can an	alyze them in a quantitative way. They are able	to develop validation	n strategies for the	
	predictions. They are able to evaluate the effects of electromagnetic fields for therapeutic and diagnostic applications and make a				
	appropriate choice.				
Personal Competence	Students are able to work together on s	whice tradeted tacks in small groups. Thou are	able to procent their	regults offertively	
Social Competence	English (e.g. during small group exercises	ubject related tasks in small groups. They are a	able to present their	results effectively	
	English (e.g. during small group exercises	η.			
Autonomy	Students are capable to gather informa	ation from subject related, professional publica	ations and relate tha	it information to t	
·	context of the lecture. They are able to	make a connection between their knowledge ol	btained in this lecture	e with the content	
	other lectures (e.g. theory of electroma	gnetic fields, fundamentals of electrical engine	eering / physics). The	ey can communica	
	problems and effects in the field of bioele	ectromagnetics in English.			
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70			
•					
Course achievement	Compulsory Bonus Form	Description			
Examination	Yes None Presentation Oral exam	_			
	Oral exam 45 min				
scale	45 11111				
Scale					
Assignment for the	Electrical Engineering: Specialisation Micr	rowave Engineering, Optics, and Electromagneti	c Compatibility: Elect	ive Compulsory	
Following Curricula	Electrical Engineering: Specialisation Med	lical Technology: Elective Compulsory			
ronowing curricula	International Management and Engineering	ng: Specialisation II. Electrical Engineering: Elect			
r chowing curricula	!				
. Onothing curricula	· · · · · ·	tificial Organs and Regenerative Medicine: Elect			
. onouning curricula	Biomedical Engineering: Specialisation Ma	anagement and Business Administration: Electiv	e Compulsory		
. onoming curricula	Biomedical Engineering: Specialisation Ma Biomedical Engineering: Specialisation Ma	anagement and Business Administration: Elective (edical Technology and Control Theory: Elective (re Compulsory Compulsory		
. onouning curricula	Biomedical Engineering: Specialisation Ma Biomedical Engineering: Specialisation Ma Biomedical Engineering: Specialisation Im	anagement and Business Administration: Electiv	re Compulsory Compulsory		

Course L0371: Bioelectromagnetics: Principles and Applications		
Тур	Lecture	
Hrs/wk	3	
СР	5	
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42	
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle		
Content	- 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	
	- 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	
Literature	- 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)	
	- S. Grimnes, O. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008)	
	- F. Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnetic Fields", CRC (2006)	
<u> </u>		

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

Specialization Artificial Organs and Regenerative Medicine

Module M0623: Intelli	igent Systems	in Medicine				
Courses						
Title				Тур	Hrs/wk	СР
Intelligent Systems in Medicine (L0	331)			Lecture	2	3
Intelligent Systems in Medicine (L0				Project Seminar	2	2
Intelligent Systems in Medicine (L0	333)			Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schla	efer				
Admission Requirements	None					
Recommended Previous	• principles of m	ath (algebra, analysis/ca	lculus)			
Knowledge	 principles of ri 		iculus)			
		rogramming, Java/C++ a	nd R/Matlah			
	advanced prog					
Educational Objectives	After taking part succ	cessfully, students have r	eached the following	ng learning results		
Professional Competence						
Knowledge				lanning and decision suppo		
				r classification and their res		
				s for representing medical k		
			allenges due to the	e clinical nature of the data	and its acquisitio	n and due to privac
	and safety requireme	ents.				
Skills	The students can giv	e reasons for selecting a	and adapting meth	ods for classification, regre	ssion, and predict	ion. They can assess
	the methods based o	n actual patient data and	l evaluate the impl	emented methods.		
Damanal Commetence						
Personal Competence	The students discuss	the recults of other group	na provida bolnful	foodback and can incoorna	rato foodback into	thair work
Social Competence	The students discuss	the results of other grou	ps, provide neipiui	feedback and can incoorpo	rate reedback into	their work.
Autonomy	The students can ref	lect their knowledge and	document the res	sults of their work. They can	n present the resu	lts in an appropriate
	manner.					
Workload in Hours	Independent Study T	ime 110, Study Time in L	ecture 70			
Credit points	6	-				
Course achievement	Compulsory Bonus	Form	Description			
	Yes 10 %	Written elaboration				
	Yes 10 %	Presentation				
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	Computer Science: S	pecialisation II: Intelligen	ce Engineering: Ele	ective Compulsory		
Following Curricula		g: Specialisation Medical				
	-			hods in Biomedical Imaging:	Compulsory	
		lisation Intelligent Syster			Control la	
	_	•		enerative Medicine: Elective	Compulsory	
	_			eses: Elective Compulsory	anulaan.	
		• .		Control Theory: Elective Con		
	3	5 1		ss Administration: Elective Compulsory	. ,	
				Course: Elective Compulsory ical Technology: Elective Co		
L	mediencai Mechaliic	ai Engineening. Specialis	ממוטוו שוט- מווט ויופטו	icai reciliology. Elective Co	πραισσι γ	

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

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

Module M1241: Selec	ted Topics of Biomedical Engineering	g - Option B (12 LP)		
Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L16	563)	Seminar	2	3
Introduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1669)	Lecture	3	4
Introduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2
Development and Regulatory Appre	oval of Medical Devices (L1588)	Lecture	2	3
Experimental Methods in Biomecha	nics (L0377)	Lecture	2	3
Experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	3
Numerical Methods in Biomechanic	s (L1583)	Seminar	2	3
Seminar Biomedical Engineering (L	1890)	Seminar	2	3
Fluid Mechanics II (L0001)		Lecture	2	4
System Simulation (L1820)		Lecture	2	2
System Simulation (L1821)		Recitation Section (large)	1	2
Ceramics Technology (L0379)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	12			
Assignment for the	Biomedical Engineering: Specialisation Artificial Organ	ns and Regenerative Medicine: Elective	Compulsory	
Following Curricula	Biomedical Engineering: Specialisation Implants and E	Endoprostheses: Elective Compulsory		
-	Biomedical Engineering: Specialisation Medical Techn		nulsory	
	Diomedical Engineering. Specialisation Medical recili			

Course L1663: Nature's Hiera	archical 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

Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	
Examination Form	
Examination duration and	
scale	30 (1)(1)
	Prof. Christian Schuster
Language	
Cycle	
	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well a
Content	Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequence
	/ high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagatio
	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)
	7. Serrado, W. Karrier, Elektromagnetische Verträgnetikete , Springer (2007)

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

Course L1588: Development	Course L1588: Development and Regulatory Approval of Medical Devices		
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	90 Minuten		
scale			
Lecturer	Dr. Roman Nassutt		
Language	DE		
Cycle	WiSe		
Content			
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik - Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html 		

Course L0377: Experimental Methods in Biomechanics	
•	Lecture
Hrs/wk	
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Michael Morlock
Language	DE
Cycle	SoSe
Content	
Literature	Wird in der Veranstaltung bekannt gegeben

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

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

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

ourse L0001: Fluid Mechan			
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 The place level 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		
	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		
Litoroturo			
Literature	1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.		
	2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.		
	3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.		
	4. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg		
	2006.		
	5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994.		
	6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömunger		
	Springer Verlag, Berlin, Heidelberg, New York, 2006.		
	7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GW		
	Fachverlage GmbH, Wiesbaden, 2008.		
	8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007		
	9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner		
	GWV Fachverlage GmbH, Wiesbaden, 2009. 10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.		
	10. Schade, H.; Kunz, E.: Strömungsiehre. Verlag de Gruyter, Berlin, New York, 2007. 11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springe		
	Verlag, Berlin, Heidelberg, 2008.		
	12. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.		
	13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.		
	25. Van Dyne, Ph. An Album of Fluid Motion. The Furubolic Fress, Stafford California, 1002.		

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

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

Course L0379: Ceramics Tec	hnology		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28	
Examination Form	Klausur		
Examination duration and	90 Minuten		
scale			
	Dr. Rolf Janßen		
Language			
Cycle	WiSe		
Content	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	
		3. Powder fabrication	
		4. Powder processing	
	5. Shape-forming processes		
		6. Densification, sintering	
		7. Glass and Cement technology	
		8. Ceramic-metal joining techniques	
Literature	W.D. Kingery, "Introduction to	Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991		
	D.W. Richerson, "Modern Cerar	nic Engineering", Marcel Decker, New York, 1992	
	Skript zur Vorlesung		

Title Title Title Nature's Hierarchical Materials (L163) Seminar Seminar Seminar Seminar Seminar Seminar Seminar Seminar Secretar of Medical Devices (L1588) Seminar Seperimental Methods in Biomechanics (L0377) Lecture Seminar Seperimental Methods in Biomechanics (L1583) Seminar Seperimental Methods in Biomechanics (L1583) Seminar Semina	Module M1230: Selec	ted Topics of Biomedical Engineering	- Option A (6 LP)		
Nature's Hierarchical Materials (L1663) Seminar 2 3 3 4 Introduction to Waveguides, Antennas, and Electromagnetic Compatibility (L1669) Lecture 3 4 4 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Courses				
Introduction to Waveguides, Antennas, and Electromagnetic Compatibility (L1669) Lecture 3 2 2 Development and Regulatory Approval of Medical Devices (L1588) Experimental Methods in Biomechanics (L0377) Lecture 2 3 Experimental Methods for the Characterization of Materials (L1580) Lecture 2 3 Experimental Methods in Biomechanics (L1583) Seminar Biomedical Engineering (L1890) Seminar Biomedical Engineering Specialisation Management and Business Administration: Elective Compulsory	Title		Тур	Hrs/wk	СР
Introduction to Waveguides, Antennas, and Electromagnetic Compatibility (L1877) Recitation Section (small) 2 2 3 Development and Regulatory Approval of Medical Devices (L1589) Lecture 2 3 3 Experimental Methods in Biomechanics (10377) Lecture 2 3 3 Experimental Methods for the Characterization of Materials (L1580) Lecture 2 3 3 Numerical Methods in Biomechanics (L1583) Seminar 2 3 3 Seminar Biomedical Engineering (L1890) Seminar 2 3 3 Seminar Biomedical Engineering (L1890) Seminar 2 3 3 Fluid Mechanics II (L0001) Lecture 2 3 3 Fluid Mechanics II (L0001) Lecture 2 3 3 Fluid Mechanics II (L0001) Lecture 2 3 3 System Simulation (L1820) Lecture 2 3 3 System Simulation (L1820) Lecture 2 3 3 System Simulation (L1820) Lecture 2 3 3 Module Responsible Prof. Michael Morlock Lecture 2 3 3 Module Responsible None Recommended Previous 5 Rowledge 5 Kills After taking part successfully, students have reached the following learning results Professional Competence Knowledge 5 Kills Personal Competence Autonomy Dependence Food Courses Social Competence Autonomy Social Competence Social Competence Social Competence Social Competence Autonomy Social Competence Social	Nature's Hierarchical Materials (L16	663)	Seminar	2	3
Development and Regulatory Approval of Medical Devices (L1588) Lecture 2 3 Experimental Methods in Biomechanics (L0377) Lecture 2 3 Numerical Methods for the Characterization of Materials (L1580) Seminar 2 3 Numerical Methods in Biomechanics (L1583) Seminar 2 3 Seminar Biomedical Engineering (L10001) Lecture 2 3 Seminar 3 3 Seminar 3 3 Seminar 3 3 Seminar 4 3 Seminar 4 3 Seminar 4 3 Seminar 5 3 Seminar 5 3 Seminar 6 3 Seminar 7 3 Seminar 7 3 Seminar 8 3 Seminar 8 3 Seminar 8 3 Seminar 9 3 Seminar	Introduction to Waveguides, Anteni	nas, and Electromagnetic Compatibility (L1669)	Lecture	3	4
Experimental Methods in Biomechanics (L0377)	Introduction to Waveguides, Anteni	nas, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2
Experimental Methods for the Characterization of Materials (L1580) Numerical Methods in Biomechanics (L1583) Seminar 2 3 Seminar 2 3 Seminar 2 2 3 Fluid Mechanics II (L0001) Lecture 2 4 System Simulation (L1820) System Simulation (L1820) System Simulation (L1821) Recitation Section (large) 1 2 Ceramics Technology (L0379) Module Responsible Prof. Michael Morlock Recommended Previous Knowledge Skills Recommended Previous Chowledge Skills Resommended Previous Chowledge Skills Personal Competence Skills Personal Com	Development and Regulatory Appro	oval of Medical Devices (L1588)	Lecture	2	3
Numerical Methods in Biomechanics (11583) Seminar Biomedical Engineering (11890) Seminar Biomedical Engineering (11890) Seminar Biomedical Engineering (11890) Lecture 2 4 System Simulation (11820) System Simulation (11821) Ceramics Technology (10379) Module Responsible Prof. Michael Morlock Admission Requirements Knowledge Educational Objectives Knowledge Skills Personal Competence Social Competence Social Competence Social Competence Credit points Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Experimental Methods in Biomecha	nics (L0377)	Lecture	2	3
Seminar Biomedical Engineering (L1890) Seminar 2 3 Fluid Mechanics II (L0001) Lecture 2 4 System Simulation (L1820) Recitation Section (large) 1 2 System Simulation (L1821) Recitation Section (large) 1 2 Ceramics Technology (L0379) Prof. Michael Morlock Module Responsible Recommended Previous Knowledge Skills Forfessional Competence Rocal 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 Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	3
Fluid Mechanics II (L0001)	Numerical Methods in Biomechanic	s (L1583)	Seminar	2	3
System Simulation (L1820)	Seminar Biomedical Engineering (L	1890)	Seminar	2	3
System Simulation (L1821) Ceramics Technology (L0379) Recitation Section (large) Lecture 2 3 Module Responsible Admission Requirements None Recommended Previous Knowledge Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the Following Curricula Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Fluid Mechanics II (L0001)		Lecture	2	4
Module Responsible Prof. Michael Morlock Admission Requirements None Recommended Previous Knowledge Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	System Simulation (L1820)		Lecture	2	2
Module Responsible Prof. Michael Morlock Admission Requirements None Recommended Previous Knowledge Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	System Simulation (L1821)		Recitation Section (large)	1	2
Admission Requirements Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the Following Curricula Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Ceramics Technology (L0379)		Lecture	2	3
Recommended Previous Knowledge Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Module Responsible	Prof. Michael Morlock			
Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Admission Requirements	None			
Educational Objectives Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Credit points Assignment for the Following Curricula Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Recommended Previous				
Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Knowledge				
Rnowledge Skills Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Educational Objectives	After taking part successfully, students have reached	the following learning results		
Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Professional Competence				
Personal Competence Social Competence Autonomy Workload in Hours Depends on choice of courses Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Knowledge				
Social Competence Autonomy Workload in Hours Depends on choice of courses Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Skills				
Workload in Hours Depends on choice of courses Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Personal Competence				
Workload in Hours Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Social Competence				
Credit points 6 Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Autonomy				
Assignment for the Following Curricula Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Workload in Hours	Depends on choice of courses			
Following Curricula Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Credit points	6			
Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Assignment for the	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory			
Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory	Following Curricula	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory			
	_				
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory					

-	
Course L1663: Nature's Hiera	archical 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

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

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

Course L1588: Development	and Regulatory Approval of Medical Devices		
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	90 Minuten		
scale			
Lecturer	Dr. Roman Nassutt		
Language	DE		
Cycle	WiSe		
Content			
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik - Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html 		

Course L0377: Experimental Methods in Biomechanics			
·			
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	90 min		
scale			
Lecturer	Prof. Michael Morlock		
Language	DE		
Cycle	SoSe		
Content			
Literature	Wird in der Veranstaltung bekannt gegeben		

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

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

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

Tim	Lecture
Тур	2
Hrs/wk	
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Klausur
xamination 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	
Encluture	1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.
	2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.
	3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.
	 Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelber 2006.
	5. 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 Strömunge Springer Verlag, Berlin, Heidelberg, New York, 2006.
	7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GV Fachverlage GmbH, Wiesbaden, 2008.
	8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007
	9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubne
	GWV Fachverlage GmbH, Wiesbaden, 2009.
	10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.
	11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Spring
	Verlag, Berlin, Heidelberg, 2008.
	12. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.

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

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

Course L0379: Ceramics Tecl	hnology				
Тур	Lecture				
Hrs/wk	2				
СР	3				
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28			
Examination Form	Klausur				
Examination duration and	90 Minuten				
scale					
	Dr. Rolf Janßen				
Language					
Cycle	WiSe				
Content	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			
		3. Powder fabrication			
	4. Powder processing				
		5. Shape-forming processes			
		6. Densification, sintering			
	7. Glass and Cement technology				
		8. Ceramic-metal joining techniques			
Literature	W.D. Kingery, "Introduction to	Ceramics", John Wiley & Sons, New York, 1975			
	ASM Engineering Materials Handbook Vol.4 "Ceramics and Glasses", 1991				
	D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992				
	Skript zur Vorlesung				

Courses				
itle		Тур	Hrs/wk	СР
ntelligent Autonomous Agents and	Cognitive Robotics (L0341)	Lecture	2	4
ntelligent Autonomous Agents and	Cognitive Robotics (L0512)	Recitation Section (small)	2	2
Module Responsible	Rainer Marrone			
Admission Requirements	None			
Recommended Previous	Vectors, matrices, Calculus			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ive reached the following learning results		
Professional Competence				
Skills	(goals, utilities, environments). They can describe the main features of environments. The notion of adversarial agent cooperation can be discussed in terms of decision problems and algorithms for solving these problems. For dealing with uncertainty in real world scenarios, students can summarize how Bayesian networks can be employed as a knowledge representation and reasoning formalism in static and dynamic settings. In addition, students can define decision making procedures in simple and sequentic settings, with and with complete access to the state of the environment. In this context, students can describe techniques for solving (partially observable) Markov decision problems, and they can recall techniques for measuring the value of information Students can identify techniques for simultaneous localization and mapping, and can explain planning techniques for achieving desired states. Students can explain coordination problems and decision making in a multi-agent setting in term of different types of equilibria, social choice functions, voting protocol, and mechanism design techniques. Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent application students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesian networks/dynamic Bayesian networks and apply bayesian reasoning for simple queries. Students can also name and apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situations students will apply techniques for finding different equilibr states, e.g., Nash equilibria. For multi-agent decision making students will apply different voting protocols and compare and explait the results.			
Personal Competence				
Social Competence	Students are able to discuss their solution	is to problems with others. They communicate in E	nglish	
Autonomy	Students are able of checking their unders	standing of complex concepts by solving varaints o	of concrete probler	ns
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points				
Course achievement				
Examination				
Examination duration and				
scale	30 minutes			
Assignment for the	Computer Science: Specialisation II: Intelli	gence Engineering: Elective Compulsory		
Following Curricula	·	ng: Specialisation II. Information Technology: Electi	ve Compulsory	
rollowing curricula	Mechatronics: Technical Complementary (• .	re compaisory	
	Mechatronics: Specialisation Intelligent Sy			
		tificial Organs and Regenerative Medicine: Elective	Compulsory	
		plants and Endoprostheses: Elective Compulsory	. Compaisory	
	• • •	plants and Endoprostrieses: Elective Compulsory edical Technology and Control Theory: Elective Con	nnulsory	
		anagement and Business Administration: Elective Con		
	Diomedical Engineering: Specialisation Ma	mayement and business Administration: Elective (zorripuisof y	
	Theoretical Mechanical Engineering, Toch	nical Complementary Course: Elective Compulsory	,	

Course L0341: Intelligent Au	tonomous Agents and Cognitive Robotics
	2
	4
	Independent Study Time 92, Study Time in Lecture 28
	Rainer Marrone
3 3	
Cycle	WISE
	 Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference by enumeration), typical-case complexity, pragmatics: reasoning from effect (that can be perceived by an agent) to cause (that cannot be directly perceived). Probabilistic reasoning over time: Environmental state may change even without the agent performing actions, dynamic Bayesian networks, Markov assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation, special cases: hidden Markov models, Kalman filters, Exact inferences and approximations
	 Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decision networks, value of informatio Complex decisions: sequential decision problems, value iteration, policy iteration, MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks Simultaneous Localization and Mapping Planning Game theory (Golden Balls: Split or Share) Decisions with multiple agents, Nash equilibrium, Bayes-Nash equilibrium Social Choice Voting protocols, preferences, paradoxes, Arrow's Theorem,
	 Mechanism Design Fundamentals, dominant strategy implementation, Revelation Principle, Gibbard-Satterthwaite Impossibility Theorem, Direct mechanisms, incentive compatibility, strategy-proofness, Vickrey-Groves-Clarke mechanisms, expected externality mechanisms, participation constraints, individual rationality, budget balancedness, bilateral trade, Myerson-Satterthwaite Theorem
Literature	 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Norvig, Prentice Hall, 2010, Chapters 2-5, 10-11, 13-17 Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005 Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press, 2009

Course L0512: Intelligent Au	ourse 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 M0775: Ergor	nomics			
Courses				
Title		Тур	Hrs/wk	СР
Ergonomics (L0653)		Lecture	2	3
Module Responsible	Dr. Armin Bossemeyer			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 62, Study Time in Lecture	28		
Credit points	3			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	International Management and Engineering: Speci-	alisation II. Product Development ar	nd Production: Elective Co	ompulsory
Following Curricula	Biomedical Engineering: Specialisation Implants ar	nd Endoprostheses: Elective Compu	Isory	
	Biomedical Engineering: Specialisation Artificial Or	gans and Regenerative Medicine: E	lective Compulsory	
	Biomedical Engineering: Specialisation Manageme	nt and Business Administration: Ele	ctive Compulsory	
	Biomedical Engineering: Specialisation Medical Te	chnology and Control Theory: Electi	ve Compulsory	

Course L0653: Ergonomics	ourse L0653: Ergonomics	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Armin Bossemeyer	
Language	DE	
Cycle	WiSe	
Content		
Literature		

Module M0751: Vibra	tion Theory			
Courses				
Title		Тур	Hrs/wk	СР
Vibration Theory (L0701)		Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous	Calculus			
Knowledge	Linear Algebra			
	Engineering Mechanics			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students are able to denote terms and concepts of Vibra	tion Theory and develop them furt	her.	
Skills	Students are able to denote methods of Vibration Theory	and develop them further.		
Personal Competence				
Social Competence	Students can reach working results also in groups.			
Autonomy	Students are able to approach individually research task	s in Vibration Theory.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 Hours			
scale				
Assignment for the	Energy Systems: Core qualification: Elective Compulsory			
Following Curricula	International Management and Engineering: Specialisati	on II. Mechatronics: Elective Comp	ulsory	
	Mechanical Engineering and Management: Specialisation	Mechatronics: Elective Compulsor	ry	
	Mechatronics: Core qualification: Compulsory			
	Biomedical Engineering: Specialisation Artificial Organs	•	re Compulsory	
	Biomedical Engineering: Specialisation Implants and Engineering			
	Biomedical Engineering: Specialisation Medical Technology	•		
	Biomedical Engineering: Specialisation Management and		Compulsory	
	Product Development, Materials and Production: Core qu			
	Naval Architecture and Ocean Engineering: Core qualific			
	Theoretical Mechanical Engineering: Technical Complem	•	У	
	Theoretical Mechanical Engineering: Core qualification:	siective 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 M0814: Techi	nology Management			
Courses				
Title	ту	vn	Hrs/wk	СР
Technology Management (L0849)		cture	3	3
Technology Management Seminar		oject-/problem-based Learning	2	3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous	Bachelor knowledge in business management			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following le	earning results		
Professional Competence				
Knowledge	Students will gain deep insights into:			
	International R&D-Management			
	Technology Timing Strategies			
	Technology Strategies and Lifecycle Management (I/II)			
	Technology Intelligence and Planning			
	Technology Portfolio Management			
	 Technology Portfolio Methodology 			
	 Technology Acquisition and Exploitation 			
	IP Management			
	Organizing Technology Development			
	 Technology Organization & Management 			
	 Technology Funding & Controlling 			
Skills	The course aims to:			
	Develop an understanding of the importance of Technology M	Management - on a national as	well as interr	national level
	Equip students with an understanding of important eler			
	organizational and process-related aspects)	3,		3 . 1
	Foster a strategic orientation to problem-solving within the i	innovation process as well as	Technology M	lanagement and its
	importance for corporate strategy			
	 Clarify activities of Technology Management (e.g. technology 	sourcing, maintenance and e	xploitation)	
	 Strengthen essential communication skills and a basic und 	lerstanding of managerial, o	rganizational	and financial issue
	concerning Technology-, Innovation- and R&D-management.	Further topics to be discussed	l include:	
	Basic concepts, models and tools, relevant to the management	nt of technology. R&D and in	novation	
	Innovation as a process (steps, activities and results)	ne or teermology, ride and in	.074	
Personal Competence				
Social Competence	Interact within a team			
	Raise awareness for globabl issues			
Autonomy	Cain access to knowledge comme			
	Gain access to knowledge sources Discuss recent research debates in the centext of Technology	, and Innovation Managers		
	 Discuss recent research debates in the context of Technology Develop presentation skills 	and innovation Managemen	-	
	Discussion of international cases in R&D-Management			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
	Written exam			
Examination duration and				
scale				
Assignment for the	Global Innovation Management: Core qualification: Compulsory			
Following Curricula		es Management [,] Flective Con	npulsory	
. Showing Curricula	Mechanical Engineering and Management: Specialisation Manageme		.pui301 y	
	Biomedical Engineering: Specialisation Artificial Organs and Regener		pulsory	
		s: Elective Compulsory		
	Biomedical Engineering: Specialisation Implants and Endoprosthese: Biomedical Engineering: Specialisation Medical Technology and Cont		ory	

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

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

Module M0846: Contr	ol Systems Theory and Design	1		
Courses				
Title Control Systems Theory and Design Control Systems Theory and Design		Typ Lecture Recitation Section (small)	Hrs/wk 2 2	CP 4 2
Module Responsible		Recitation Section (small)	2	2
Admission Requirements				
	Introduction to Control Systems			
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Skills	response to initial states or external of they can explain the system properties estimation, respectively They can explain the significance of a they can explain observer-based state. They can extend all of the above to not they can explain the z-transform and they can explain the z-transform and they can explain the experimental id be solved by solving a normal equation. They can explain how a state space roughly can explain how a state space roughly can assess controllability and of they can design LQG controllers for roughly can carry out a controller design for a given sampling rate.	te feedback and how it can be used to achieve nulti-input multi-output systems it its relationship with the Laplace Transform and transfer function models of discrete-time lentification of ARX models of dynamic systems on model can be constructed from a discrete-time tion models into state space models and vice was beervability and construct minimal realisations	relationship to state tracking and disturt systems s, and how the ident impulse response versa domain, and decide	e feedback and state oance rejection ification problem call which is appropriate atal data
	when solving given problems.	rided sources (lecture notes, software docum	·	nt guides) and use
	They can assess their knowledge in weekly	on-line tests and thereby control their learning	progress.	
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale	Floring Engineering Community	ampulsan.		
_	Electrical Engineering: Core qualification: Co			
Following Curricula	Energy Systems: Core qualification: Elective Aircraft Systems Engineering: Core qualification			
	Computational Science and Engineering: Sp International Management and Engineering: International Management and Engineering: Mechanical Engineering and Management: S Mechatronics: Core qualification: Compulson Biomedical Engineering: Specialisation Artif Biomedical Engineering: Specialisation Impl Biomedical Engineering: Specialisation Medi Biomedical Engineering: Specialisation Management	ecialisation II. Engineering Science: Elective Co : Specialisation II. Electrical Engineering: Electi : Specialisation II. Mechatronics: Elective Comp Specialisation Mechatronics: Elective Compulso	ve Compulsory ve Compulsory ve Compulsory ry	

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

Course L0657: Control Syste	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	

odule M0867: Produ	ction Planning & Control a	nd Digital Enterprise		
ourses				
itle		Тур	Hrs/wk	СР
ne Digital Enterprise (L0932)		Lecture	2	2
roduction Planning and Control (L	0929)	Lecture	2	2
roduction Planning and Control (L	0930)	Recitation Section (small)	1	1
xercise: The Digital Enterprise (L0	933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	Fundamentals of Production and Quality	y Management		
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence	•	•		
Knowledge	Students can explain the contents of th	ne module in detail and take a critical position to them	1.	
-	·	applying models and methods from the module to indi		
Personal Competence				
•	Students can develop joint solutions in mixed teams and present them to others.			
Autonomy	Stadents can develop joint solddons in mixed teams and present them to others.			
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	International Management and Enginee	ering: Specialisation II. Product Development and Prod	luction: Elective Co	ompulsorv
•	3	pecialisation Production and Logistics: Elective Comp		,
3 ·· · · ·	•	Artificial Organs and Regenerative Medicine: Elective	•	
		Implants and Endoprostheses: Elective Compulsory	, , ,	
		Medical Technology and Control Theory: Elective Com	npulsory	
		Management and Business Administration: Compulso		
		roduction: Specialisation Product Development: Electiv		
	•	oduction: Specialisation Production: Compulsory		
	·	roduction: Specialisation Materials: Elective Compulsor	ry	
	·	pecialisation Product Development and Production: Ele	•	
		echnical Complementary Course: Elective Compulsory		

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

Course L0929: Production Pl	anning and Control	
Тур	ecture	
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 Pl	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	

Module M0921: Electi	ronic Circuits for Medical App	lications		
Courses				
Title		Тур	Hrs/wk	СР
Electronic Circuits for Medical Appl	ications (L0696)	Lecture	2	3
Electronic Circuits for Medical Appl	ications (L1056)	Recitation Section (small)	1	2
Electronic Circuits for Medical Appl	ications (L1408)	Practical Course	1	1
Module Responsible	Prof. Matthias Kuhl			
Admission Requirements	None			
Recommended Previous	Fundamentals of electrical engineering			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge				
		cionality of the information transfer by the central r		
	· ·	ld-up of an action potential and its propagation alor	ng an axon	
		nication between neurons and electronic devices	ons	
	Students can describe the special re Students can explain the functions of	eatures of low-noise amplifiers for medical applicati	OHS	
	· ·	ential and limitations of cochlea implants and artifi	cial eves	
	• Students are able to discuss the pot	ential and inflications of coefficia implants and artifi	ciai cycs	
CI:II-				
Skills		pendent voltage behavior of an action potential		
	Students can give scenarios for furt	ner improvement of low-noise and low-power signa	l acquisition.	
	Students can develop the block dia	grams of prosthetic systems		
	Students can define the building blo	cks of electronic systems for an articifial eye.		
Personal Competence				
Social Competence				
		lems in the field of medical electronics in teams	together with e	experts with differen
	professional background.			
	-	specific limitations, so that they can ask for assista		
		in a clear manner and communicate their results	in a way that ot	ners can be involved
	whenever it is necessary			
Autonomy	Students are able to realistically	judge the status of their knowledge and to def	fine actions for	improvements wher
	necessary.	•		•
	Students can break down their work	in appropriate work packages and schedule their v	work in a realistic	: way.
	Students can handle the complex date	ata structures of bioelectrical experiments without	needing support.	
	Students are able to act in a respon	sible manner in all cases and situations of experime	ental work.	
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points				
Course achievement		Description		
	Yes None Subject theoretic	al and		
	practical work			
	No None Excercises			
Examination				
Examination duration and scale	90 min			
Assignment for the	Electrical Engineering: Specialisation Medi	cal Technology: Elective Compulsory		
Following Curricula		ficial Organs and Regenerative Medicine: Elective (Compulsory	
. S.I.S Willig Curricula		plants and Endoprostheses: Elective Compulsory	20.11pai301 y	
		dical Technology and Control Theory: Compulsory		
		nagement and Business Administration: Elective Co	ompulsory	
		lisation Microelectronics Complements: Elective Co		
		ical Complementary Course: Elective Compulsory		
		alisation Bio- and Medical Technology: Elective Con	npulsory	

Course L0696: Electronic Circ	cuits 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/

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

Module M1150: Conti	nuum Mechanics			
Courses				
Title		Тур	Hrs/wk	СР
Continuum Mechanics (L1533)		Lecture	2	3
Continuum Mechanics Exercise (L1	534)	Recitation Section (small)	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous	Basics of linear continuum mechanics as taught, e.g., in the module Mechanics II (forces and moments, stress, linear strain, free-			
Knowledge	body principle, linear-elastic constitutive laws, strain en	ergy).		
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence	Their taking part successiony, students have reached to	e ronowing rearring results		
Knowledge				
	The students can explain the fundamental concepts to	alculate the mechanical behavior of m	naterials.	
61.11				
Skills	The students can set up balance laws and apply basic	s of deformation theory to specific as	pects, both in a	pplied contexts as in
	research contexts.			
Personal Competence				
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 an	d weaknesses. They can independently	y and on their o	wn identify and solve
	problems in the area of continuum mechanics and acqu	ire the knowledge required to this end		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min			
scale				
Assignment for the	Materials Science: Specialisation Modeling: Elective Con	npulsory		
Following Curricula	Mechanical Engineering and Management: Specialisation	n Materials: Elective Compulsory		
	Mechatronics: Technical Complementary Course: Elective			
	Biomedical Engineering: Specialisation Artificial Organs	•	compulsory	
	Biomedical Engineering: Specialisation Implants and En		L	
	Biomedical Engineering: Specialisation Medical Technol			
	Biomedical Engineering: Specialisation Management an		mpuisory	
	Product Development, Materials and Production: Core q Theoretical Mechanical Engineering: Technical Complen			
	Theoretical Mechanical Engineering: Technical Complete Theoretical Mechanical Engineering: Core qualification:			
<u>I</u>	meoreacar mechanicar Engineering. Core qualification:	Licetive Compaisony		

Тур	Lecture
Hrs/wk	2
СР	3
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	Fundamentals of tensor calculus
	Transformation invariance
	Tensor algebra
	Tensor analysis
	• Kinematics
	Motion of continuum
	Deformation of infinitesimal line, area and volume elements
	Material and spatial description
	Polar decomposition
	Spectral decomposition
	Objectivity
	Strain measures
	Time derivatives
	 Partial / material time derivatives
	 Objective time rates
	Strain and deformation rates
	Transport theorems
	Balance equations (global and local form)
	Balance of mass
	• The stress state
	Surface traction vectors
	Cauchy's fundamental theorem
	 Stress tensors (Cauchy, 1. and 2. Piola-Kirchhoff, Kirchhoff stress tensor)
	Balance of linear momentum Balance of angular momentum
	Balance of angular momentum Balance of energy
	Balance of energyBalance of entropy
	Clausius-Duhem inequality
	Constitutive laws
	Constitutive assumptions
	• Fluids
	Elastic solids
	Hyperelasticity
	Material symmetry
	Elasto-plastic solids
	Analysis
	 Initial-boundary value problems and their numerical solution
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker
	I-S. Liu: Continuum Mechanics, Springer
	weitere siehe in der Literaturliste des Scripts

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
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: Mate	rials Modeling			
Courses				
Title		Тур	Hrs/wk	СР
Material Modeling (L1535)		Lecture	2	3
Material Modeling (L1536)		Recitation Section (small)	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous	Basics of linear and nonlinear continuum mechanics as	aught, e.g., in the modules Mechanic	s II and Continuu	m Mechanics (force
Knowledge	and moments, stress, linear and nonlinear strain, free-b	ody principle, linear and nonlinear con	stitutive laws, st	rain energy)
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students can explain the fundamentals of multidime	nsional consitutive material laws		
Skills	The students can implement their own material laws in	finite element codes. In particular, the	e students can a	oply their knowledg
	to various problems of material science and evaluate the	e corresponding material models.		
Personal Competence				
Social Competence	The students are able to develop solutions, to present the	em to specialists and to develop idea	s further.	
Autonomy	The students are able to assess their own strengths and problems in the area of materials modeling and acquire	· · ·	y and on their ov	vn identify and solv
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min			
scale				
Assignment for the	Materials Science: Specialisation Modeling: Elective Com	pulsory		
Following Curricula	Mechanical Engineering and Management: Specialisation	n Materials: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs	and Regenerative Medicine: Elective C	Compulsory	
	Biomedical Engineering: Specialisation Implants and Eng	loprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical Technology	gy and Control Theory: Elective Comp	oulsory	
	Biomedical Engineering: Specialisation Management and	Business Administration: Elective Co	mpulsory	
	Product Development, Materials and Production: Core qu	ualification: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Mate	rials Science: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Simu	lation Technology: Elective Compulso	ry	

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

Course L1536: Material Mode	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		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M1199: Advar	nced Functional Materials	
Courses		
Title	Typ Hrs/wk CP	
Advanced Functional Materials (L16	625) Seminar 2 6	
Module Responsible	Prof. Patrick Huber	
Admission Requirements	None	
Recommended Previous	Basic knowledge in Materials Science, e.g. Materials Science I/II	
Knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	The students will be able to explain the properties of advanced materials along with their applications in technology, in parti-	cular
	metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.	
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design	new
	materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview	
	modern materials science, which enables them to select optimum materials combinations depending on the tech	nical
	applications.	
Personal Competence		
_	The students are able to present solutions to specialists and to develop ideas further.	
Social competence	The stadenes are able to present solutions to specialises and to develop faces farmer.	
Autonomy	The students are able to	
	assess their own strengths and weaknesses.	
	gather new necessary expertise by their own.	
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28	
Credit points		
Course achievement		
Examination		
Examination duration and		
scale		
Assignment for the	Materials Science: Core qualification: Compulsory	
Following Curricula	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 Fur	nctional Materials
Тур	Seminar
Hrs/wk	2
СР	6
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	1. Porous Solids - Preparation, Characterization and Functionalities
	2. Fluidics with nanoporous membranes
	3. Thermoplastic elastomers
	4. Optimization of polymer properties by nanoparticles
	5. Fiber composites in automotive
	6. Modeling of materials based on quantum mechanics
	7. Biomaterials
Literature	Aktuelle Publikationen aus der Fachliteratur werden während der Veranstaltung bekanntgegeben.

_				
Courses				
Title	ale code a Biology (LODOS)	Тур	Hrs/wk	СР
Introduction to Biochemistry and M		Lecture	2	3
<u> </u>	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous	None			
Knowledge	After taking part successfully, students have	reached the following learning results		
Professional Competence	After taking part successiumy, students have	reactied the following learning results		
•	The students can			
Momeage	The students can			
	 describe basic biomolecules; 			
	 explain how genetic information is cod 	ed in the DNA;		
	explain the connection between DNA a	nd proteins;		
Skills	The students can			
	 recognize the importance of molecular 	parameters for the course of a disease:		
	describe selected molecular-diagnostic	•		
	explain the relevance of these procedu			
Personal Competence				
Social Competence	The students can participate in discussions in	research and medicine on a technical lev	/el.	
Autonomy	The students can develop understanding of to	opics from the course, using technical liter	rature, by themselves.	
Workload in Hours	Independent Study Time 62, Study Time in Le	ecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (German progra	m, 7 semester): Specialisation Biomedical	l Engineering: Compulsor	у
Following Curricula	General Engineering Science (German pro	gram, 7 semester): Specialisation Mec	chanical Engineering, Fo	cus Biomechanics
	Compulsory			
	Data Science: Specialisation Medicine: Comp	ulsory		
	Electrical Engineering: Specialisation Medical	Technology: Elective Compulsory		
	Engineering Science: Specialisation Biomedic	al Engineering: Compulsory		
	General Engineering Science (English program	n, 7 semester): Specialisation Biomedical	Engineering: Compulsory	
	General Engineering Science (English pro-	gram, 7 semester): Specialisation Med	hanical Engineering, Fo	cus Biomechanics
	Compulsory			
	Mechanical Engineering: Specialisation Biome	chanics: Compulsory		
	Biomedical Engineering: Specialisation Manag	gement and Business Administration: Elec	tive Compulsory	
	Biomedical Engineering: Specialisation Artific	al Organs and Regenerative Medicine: Ele	ective Compulsory	
	Biomedical Engineering: Specialisation Medic	al Technology and Control Theory: Elective	e Compulsory	
	Biomedical Engineering: Specialisation Impla	nts and Endoprostheses: Elective Compuls	sory	
	Technomathematics: Specialisation III. Engine	eering Science: Elective Compulsory		

Course L0386: Introduction t	co 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	
Literature	Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage
	Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008

Module M1334: BIO II	: Biomaterials			
Courses				
Title		Тур	Hrs/wk	СР
Biomaterials (L0593)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	Basic knowledge of orthopedic and surgical technique	es is recommended.		
Knowledge				
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	n body and the materials being u	sed in medical engineerir	ng, and their fields of
	use.			
Ckille	The students can explain the advantages and disadva	antages of different kinds of biom	atorials	
SKIIIS	The students can explain the advantages and disadva	antages of different kinds of bloth	lateriais.	
Personal Competence				
Social Competence	The students are able to discuss issues related to ma	aterials being present or being us	ed for replacements with	student mates and
	the teachers.			
Autonomy	The students are able to acquire information on their	own. They can also judge the info	ormation with respect to	its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 2	8		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	International Management and Engineering: Specialis	ation II. Process Engineering and	Biotechnology: Elective	Compulsory
Following Curricula	Materials Science: Specialisation Nano and Hybrid Ma	terials: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organ	ns and Regenerative Medicine: El	ective Compulsory	
	Biomedical Engineering: Specialisation Implants and I			
	Biomedical Engineering: Specialisation Medical Techn	• • • • • • • • • • • • • • • • • • • •		
	Biomedical Engineering: Specialisation Management			
	Theoretical Mechanical Engineering: Technical Compl	·	•	
	Theoretical Mechanical Engineering: Specialisation Bi	o- and Medical Technology: Elect	ive Compulsory	

ourse L0593: Biomaterials	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Michael Morlock
Language	EN .
-	WiSe Taxing to be accounted include:
Content	Topics to be covered include: 1. Introduction (Importance, nomenclature, relations)
	Biological materials
	2.1 Basics (components, testing methods)
	2.2 Bone (composition, development, properties, influencing factors)
	2.3 Cartilage (composition, development, structure, properties, influencing factors)
	2.4 Fluids (blood, synovial fluid)
	3 Biological structures
	3.1 Menisci of the knee joint
	3.2 Intervertebral discs
	3.3 Teeth
	3.4 Ligaments
	3.5 Tendons
	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.
Literature	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
	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.

Courses				
Title		Тур	Hrs/wk	СР
Finite Element Methods (L0291)		Lecture	2	3
Finite Element Methods (L0804)		Recitation Section (large)	2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Materials) a	nd Mechanics II (Hydrostatics, Kinematics, Dyna	amics)	
Knowledge	Mathematics I, II, III (in particular differential ed	quations)		
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge overview of the theoretical and methodical bas		ent method and	are able to give
Skills	The students are capable to handle engineering problems by formulating suitable finite elements, assembling the correspondir system matrices, and solving the resulting system of equations.			
Personal Competence Social Competence	Students can work in small groups on specific p	problems to arrive at joint solutions.		
Autonomy	The students are able to independently solv Problems can be identified and the results are		levelop own finit	te element routin
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points				
Course achievement	Compulsory Bonus Form	Description		
	No 20 % Midterm			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Core qualification: Compulso	ry		
Following Curricula	Energy Systems: Core qualification: Elective Co	ompulsory		
	Aircraft Systems Engineering: Specialisation Ai	rcraft Systems: Elective Compulsory		
	Aircraft Systems Engineering: Specialisation Ai	r Transportation Systems: Elective Compulsory		
	Aircraft Systems Engineering: Core qualification	n: Elective Compulsory		
	International Management and Engineering: Sp	pecialisation II. Mechatronics: Elective Compulsi	ory	
	International Management and Engineering: Sp	pecialisation II. Product Development and Produ	iction: Elective Co	ompulsory
	Mechatronics: Core qualification: Compulsory	·		
	Biomedical Engineering: Specialisation Implant	s and Endoprostheses: Compulsory		
	Biomedical Engineering: Specialisation Manage		mpulsory	
	Biomedical Engineering: Specialisation Medical			
	Biomedical Engineering: Specialisation Artificia			
	Product Development, Materials and Production			
	· ·			
	Technomathematics: Specialisation III. Enginee	ring Science: Elective Compulsorv		

Course L0291: Finite Elemen	t 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 Elemen	ourse 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	CP
Structure and Properties of Polymers (L0389)		Lecture	2	3
Processing and design with polyme		Lecture	Ζ	3
Module Responsible				
Admission Requirements	None			
Knowledge	Basics: chemistry / physics / material science			
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence	The taking pare succession, seducites have re	defice the following featining results		
	Students can use the knowledge of plastics and define the necessary testing and analysis.			
	They can explain the complex relationships stru	ucture-property relationship and		
	the interactions of chemical structure of the pe	lymore including to explain polabhorin	a contoxto (o a custaina	hility onvironment
	the interactions of chemical structure of the polymers, including to explain neighboring contexts (e.g. sustainability, environment protection).			
Skills	s Students are capable of			
	- using standardized calculation methods in evaluate the different materials.	a given context to mechanical prope	erties (modulus, strengt	ch) to calculate ar
	- selecting appropriate solutions for mechanica	al recycling problems and sizing example	le stiffness, corrosion res	istance.
Personal Competence				
Social Competence	Students can			
	- arrive at funded work results in heterogenius	groups and document them.		
	- provide appropriate feedback and handle feed		uctivoly	
	- provide appropriate regulack and namine reek	aback on their own performance constr	uctively.	
Autonomy	Students are able to			
	 - assess their own strengths and weaknesses. - assess their own state of learning in specific terms and to define further work steps on this basis. 			
	- assess possible consequences of their profess	ional activity.		
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Materials Science: Specialisation Engineering M	laterials: Elective Compulsory		
Following Curricula	Biomedical Engineering: Specialisation Implant	s and Endoprostheses: Compulsory		
	Biomedical Engineering: Specialisation Artificia	3	' '	
	Biomedical Engineering: Specialisation Manage			
	Biomedical Engineering: Specialisation Medical	• • • • • • • • • • • • • • • • • • • •		
	Product Development, Materials and Production	n: Specialisation Production: Elective Co	ompulsory	
	Product Development, Materials and Production	n: Specialisation Materials: Elective Com	npulsory	
	Product Development, Materials and Production	·		
	Theoretical Mechanical Engineering: Technical	, ,	,	
	Theoretical Mechanical Engineering: Specialisa	tion Materials Science: Elective Compul	sory	

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 an	d 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					
Courses					
Title			Тур	Hrs/wk	CP 3
Regenerative Medicine (L0347) Lecture Tissue Engineering - Reger	nerative Medicine (L166		Seminar Seminar	2	3
Module Responsible					
Admission Requirements					
Recommended Previous					
Knowledge	None				
Educational Objectives	After taking part suc	essfully, students have re	ached the following learning results		
Professional Competence	7 incor carring part suc	essiany, stadents nave re	action the following learning results		
	After successful con	oletion of the module stu	dents will be able to describe the basi	c methods of regenera	tive medicine and
	explain the use of the tissue cells for different methods of tissue engineering. They are able to give a basic overview of methods the cultivation of animal and human cells.				
	Th	ura de la compania de	or of the control of		
			ts of Tissue Engineering and regener	ative medicine and ca	in explain the bas
	durierrying 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 			ntly	
				iitiy	
	·		ods and the corresponding analysis inde	pendently	
	-		earch topics for Tissue Engineering and		
	1		, , ,	,	
Personal Competence					
Social Competence	Students are able to work together as a team with 2-4 students to solve given tasks and discuss their results in the plenary and defend them. Students are able to reflect their work orally and discuss it with other students and teachers.				
Autonomy					
	After completion of	this module narticinant	s will be able to solve a technical	nrohlem in teams of :	annrov 2-4 nerso
	After completion of this module, participants will be able to solve a technical problem in teams of approx. 2-4 pe independently including a presentation of the results.			approx. 2 4 perso	
Workload in Hours	Independent Study 7	ne 124, Study Time in Le	cture 56		
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
=	Yes 20 %	Written elaboration	Ausarbeitung zu Ringvorlesung / pr	otocol for lecture series	
Examination	1				
Examination duration and	Oral presentation +	scussion (30 min)			
scale	Diamentino (E colo	an Garadalian II a tanah a	and Endangables of Electric Control		
Assignment for the	_		s and Endoprostheses: Elective Compul	•	
Following Curricula	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory				
	_		Technology and Control Theory: Electiv	, ,	
	Piorifedical Eligineer	ig. Specialisation Medical	recimology and control friedry: Electiv	e compuisory	

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

Course L1664: Lecture Tissue	e 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 M1333: BIO I:	: Implants and Fracture Healing
Courses	
Title	Typ Hrs/wk CP
Implants and Fracture Healing (L03	376) Lecture 2 3
Module Responsible	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous	It is recommended to participate in "Introduction into Anatomie" before attending "Implants and Fracture Healing".
Knowledge	
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 their existence.
	The students can name different treatments for the spine and hollow bones under given fracture morphologies.
CI:II-	
SKIIIS	The students can determine the forces acting within the human body under quasi-static situations under specific assumptions.
Personal Competence	
Social Competence	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.
Autonomy	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	90 min
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
Following Curricula	Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
	Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Orientation Studies: Core qualification: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0376: Implants and	Fracture Healing
Тур	Lecture
Hrs/wk	2
СР	
	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
	Pelvis (anatomy, biomechanics, fracture treatment)
	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
Literature	Cochran V.B.: Orthopädische Biomechanik
	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine
	Nigg, B.: Biomechanics of the musculo-skeletal system
	Schiebler T.H., Schmidt W.: Anatomie
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat

Courses					
Title			Typ Lecture	Hrs/wk 2	CP 4
Microsystems Technology (L0724) Microsystems Technology (L0725)			Project-/problem-based Learning	2	2
Module Responsible	Prof. Hoc Khiem Trieu				
Admission Requirements	None				
Recommended Previous	Basics in physics, chemistry, mechanics at	nd semiconductor tech	hnology		
Knowledge					
Educational Objectives	After taking part successfully, students ha	ve reached the follow	ing learning results		
Professional Competence					
Knowledge	Students are able				
	to present and to explain current famicrosensors and microactuators, as well			lly methods fo	or the fabrication
	to explain in details operation principl	es of microsensors an	d microactuators and		
	to discuss the potential and limitation	of microsystems in ap	oplication.		
Skills	Students are capable				
	to analyze the feasibility of microsyste	ems.			
	to develop process flows for the fabric	ation of microstructui	res and		
	to apply them.				
Personal Competence Social Competence	Students are able to prepare and perform of audience.	their lab experiments	s in team work as well as to preso	ent and discus:	s the results in fro
Autonomy	None				
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56			
Credit points	6				
Course achievement	Compulsory Bonus Form Yes None Subject theoretic practical work		n führen in Kleingruppen ein La und diskutiert die Theorie sowie o amten Kurs.		
Examination	Oral exam				
Examination duration and	30 min				
scale					
Assignment for the	Electrical Engineering: Specialisation Nand			mpulsory	
Following Curricula	Electrical Engineering: Specialisation Medi				
	International Management and Engineerin Biomedical Engineering: Specialisation Imp				
	Biomedical Engineering: Specialisation Imp	·		sory	
	Biomedical Engineering: Specialisation Ma				
	Biomedical Engineering: Specialisation Art	ificial Organs and Reg	enerative Medicine: Elective Com	npulsory	
	Microelectronics and Microsystems: Core of	qualification: Elective (Compulsory		

_	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-genera lithography, nano-imprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; it techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etch anisotropic etching with KOH/TMAH: theory, corner undercrutting, measures for compensation and etch-stop techniq plasma processes, dry etching: back sputtering, plasma etching, film stress, stiction: theory and counter measure original microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SUB, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermol modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemome mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sen piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular is sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) Magnetic Sensors (galvanomagnetic sensors: splinning current Hall sensor and magneto-transistor; magnetoresis sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, ph-FET, SAW sensor, principle of biosen Clark electrode, enzyme electrode, DNA chip) Micro A
Litoratura	IM Madous Fundamentals of Microfabrication CDC Pross 2002
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	IT M Adama D A Lautan latural ratural MEMC Confirman 2010
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010

Course L0725: Microsystems	ourse 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		

Module M0630: Robot	tics and Naviga	tion in Medicine			
Courses					
Title Robotics and Navigation in Medicine (L0335) Robotics and Navigation in Medicine (L0338)			Typ Lecture Project Seminar	Hrs/wk 2 2	CP 3 2
Robotics and Navigation in Medicin			Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schla	efer			
Admission Requirements	None				
Recommended Previous Knowledge		ath (algebra, analysis/calcu ogramming, e.g., in Java or ab skills			
Educational Objectives	After taking part succ	essfully, students have read	thed the following learning results		
Professional Competence Knowledge	detail. Systems can	be evaluated with respect	ng systems in clinical contexts and illuston to collision detection and safety and r		
Skills	systems regarding design and limitations. The students are able to design and evaluate navigation systems and robotic systems for medical applications.				
·			provide helpful feedback and can incoorpocument the results of their work. They o		
Workload in Hours	Independent Study Ti	me 110, Study Time in Lect	ure 70		
Credit points					
Course achievement	Yes 10 %	Form Written elaboration Presentation	Description		
Examination	Written exam				
Examination duration and	90 minutes				
scale					
Assignment for the	Computer Science: Sp	pecialisation II: Intelligence I	Engineering: Elective Compulsory		
Following Curricula	International Manage International Manage Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Product Development Product Development	ment and Engineering: Speciment and Engineering: Specilisation Intelligent Systems ang: Specialisation Artificial Cong: Specialisation Implants ang: Specialisation Medical Tong: Specialisation Menagems, Materials and Production: Congress of the Materials and Production: Congress of	hnology: Elective Compulsory cialisation II. Electrical Engineering: Electi cialisation II. Process Engineering and Biot and Robotics: Elective Compulsory organs and Regenerative Medicine: Electivated Endoprostheses: Elective Compulsory echnology and Control Theory: Elective Cent and Business Administration: Elective Specialisation Product Development: Elec Specialisation Production: Elective Compulsory Elective Compulsory Specialisation Materials: Elective Compulsory	ve Compulsory compulsory compulsory compulsory tive Compulsory ulsory sory	Compulsory
			on Bio- and Medical Technology: Elective (•	

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

Course L0338: Robotics and	rse 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 M1384: Case	Studies for Regenerative Med	icine and Tissue Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Case Studies for Regenerative Med	licine and Tissue Engineering (L1963)	Seminar	3	6
Module Responsible	Prof. Ralf Pörtner			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 138, Study Time in	Lecture 42		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	45 min			
scale				
Assignment for the	Biomedical Engineering: Specialisation Artifi	icial Organs and Regenerative Medicine: Com	oulsory	·
Following Curricula	Biomedical Engineering: Specialisation Impl	ants and Endoprostheses: Elective Compulsor	у	
		agement and Business Administration: Electiv		
	Biomedical Engineering: Specialisation Medi	ical Technology and Control Theory: Elective C	Compulsory	

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

Module M0634: Introd	duction into Me	edical Technolog	y and Systems		
Courses					
Title			Тур	Hrs/wk	СР
Introduction into Medical Technolog	gy and Systems (L0342)		Lecture	2	3
Introduction into Medical Technolog	gy and Systems (L0343)		Project Seminar	2	2
Introduction into Medical Technolog	gy and Systems (L1876)		Recitation Section (Ia	arge) 1	1
Module Responsible	Prof. Alexander Schla	efer			
Admission Requirements	None				
Recommended Previous	principles of math (al	gebra, analysis/calculus	5)		
Knowledge	principles of stochas	tics			
	principles of program	ıming, R/Matlab			
Educational Objectives	After taking part succ	cessfully, students have	reached the following learning results		
Professional Competence					
•	The students can ex	oplain principles of med	dical technology, including imaging sy	stems, computer aided	surgery, and medica
			n overview of regulatory affairs and star		
Skills	The students are able	e to evaluate systems a	nd medical devices in the context of clir	nical applications.	
Personal Competence					
Social Competence	The students describe	e a problem in medical t	echnology as a project, and define task	s that are solved in a joi	nt effort.
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate				
	manner.				
Workload in Hours	Independent Study T	ime 110, Study Time in	Lecture 70		
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
	Yes 10 %	Presentation			
	Yes 10 %	Written elaboration			
Examination	Written exam				
Examination duration and	90 minutes				
scale					
Assignment for the			am, 7 semester): Specialisation Biomedi		sory
Following Curricula	l '		and Software Engineering: Elective Com		
	l '		atics and Engineering Science: Elective	Compulsory	
	·	ualification: Elective Co	•		
		g: Core qualification: Ele			
			cal Engineering: Compulsory	al Engineerica: Carrie	
			m, 7 semester): Specialisation Biomedio cialisation II. Mathematics & Engineerin		•
	1		•		puisoi y
	_		ial Organs and Regenerative Medicine: nts and Endoprostheses: Elective Comp		
	_		al Technology and Control Theory: Elec		
	_		gement and Business Administration: El		
	_		eering Science: Elective Compulsory		

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

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

Course L1876: Introduction i	nto 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: Nonlin	near Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Dynamics (L0702)		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 fo	ollowing learning results		
Professional Competence				
	Students are able to reflect existing terms and concepts in Nonlinear Dynamics and to develop and research new terms and concepts.			
	Students are able to apply existing methods and procesure	s or Nonlinear Dynamics and to	develop novel meth	loas and procedures.
Personal Competence	Students can reach working results also in groups			
· ·	Students can reach working results also in groups. Students are able to approach given research tasks individ	ually and to identify and follow	un novel recearch ta	sks by thomsolves
-	Independent Study Time 124, Study Time in Lecture 56	ually and to identify and follow	up nover research ta	sks by themselves.
Credit points	, , ,			
Course achievement				
Examination				
Examination duration and				
scale	2 110413			
	Aircraft Systems Engineering: Core qualification: Elective C	ompulsorv		
•			oulsory	
	Mechanical Engineering and Management: Specialisation M	echatronics: Elective Compulso	ory	
	Mechatronics: Specialisation System Design: Elective Comp	oulsory		
	Mechatronics: Specialisation Intelligent Systems and Robot	ics: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs and	l Regenerative Medicine: Electi	ve Compulsory	
	Biomedical Engineering: Specialisation Implants and Endop	rostheses: Elective Compulsory	′	
	Biomedical Engineering: Specialisation Medical Technology	•		
	Biomedical Engineering: Specialisation Management and B		Compulsory	
	Product Development, Materials and Production: Core quali			
	Theoretical Mechanical Engineering: Technical Complemen		ry	
	Theoretical Mechanical Engineering: Core qualification: Elec	ctive Compulsory		

ourse L0702: Nonlinear Dynamics		
Тур	Integrated Lecture	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	of. 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 Technology (L0722		Lecture	4	4
Semiconductor Technology (L0723)	Practical Course	2	2
Module Responsible	Prof. Hoc Khiem Trieu			
Admission Requirements				
	Basics in physics, chemistry, material science and sen	iconductor devices		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	he following learning results		
Professional Competence				
Knowledge				
	Students are able			
	to describe and to explain current fabrication tech	niques for Si and GaAs substrates		
	to describe and to explain current labrication tech	iliques for 31 affu GaAs substrates	,	
	to discuss in details the relevant fabrication	processes, process flows and	the impact thereof o	n the fabrication
	semiconductor devices and integrated circuits and			
	to present integrated process flows.			
	3			
Skills				
	Students are capable			
	to analyze the impact of process parameters on ti	e processing results,		
	to coloct and to evaluate processes and			
	to select and to evaluate processes and			
	to develop process flows for the fabrication of sen	iconductor devices.		
Personal Competence				
Social Competence				
	Students are able to prepare and perform their lab ex	periments in team work as well as	s to present and discus	ss the results in fro
	of audience.		·	
Autonomy	None			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Nanoelectronics	and Microsystems Technology: Fle	ective Compulsory	
Following Curricula	Biomedical Engineering: Specialisation Natioelectronics			
. cc.ming carricula	Biomedical Engineering: Specialisation Implants and E	3	. ,	
	Biomedical Engineering: Specialisation Medical Techno	·	•	
	Biomedical Engineering: Specialisation Management a	•		
	Microelectronics and Microsystems: Core qualification:	Elective Compulsory		

Тур	r Technology
	Lecture
	4
CP	
	Independent Study Time 64, Study Time in Lecture 56 Prof. Hoc Khiem Trieu
Language	
Cycle	
Content	 Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski, Bridgeman and float zone process) Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping profile, higher order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation damage annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions, kinetics influences on growth rate, process technology and equipment, anodic oxidation, plasma oxidation, thermal oxidation of GaAs) Deposition techniques (theory: nucleation, film growth and structure zone model, film growth process, reaction kinetics temperature dependence and equipment; epitaxy: gas phase, liquid phase, molecular beam epitaxy; CVD techniques APCVD, LPCVD, deposition of metal silicide, PECVD and LECVD; basics of plasma, equipment, PVD techniques: high vacuum evaporation, sputtering)
	 Structuring techniques (subtractive methods, photolithography: resist properties, printing techniques: contact, proximit and projection printing, resolution limit, practical issues and equipment, additive methods: liftoff technique an electroplating, improving resolution: excimer laser light source, immersion lithography and phase shift lithography, electrobeam lithography, X-ray lithography, EUV lithography, ion beam lithography, wet chemical etching: isotropic an anisotropic, corner undercutting, compensation masks and etch stop techniques; dry etching: plasma enhanced etching backsputtering, ion milling, chemical dry etching, RIE, sidewall passivation) Process integration (CMOS process, bipolar process) Assembly and packaging technology (hierarchy of integration, packages, chip-on-board, chip assembly, electrical contact wire bonding, TAB and flip chip, wafer level package, 3D stacking)
Literature	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
	U. Hilleringmann: Silizium-Halbleitertechnologie, Teubner Verlag
	U. Hilleringmann: Silizium-Halbleitertechnologie, Teubner Verlag H. Beneking: Halbleitertechnologie - Eine Einführung in die Prozeßtechnik von Silizium und III-V-Verbindungen, Teubner Verlag

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

Module M0835: Huma	noid Robotics			
Courses				
Title		Тур	Hrs/wk	СР
Humanoid Robotics (L0663)		Seminar	2	2
Module Responsible	Patrick Göttsch			
Admission Requirements	None			
Recommended Previous				
Knowledge	Introduction to control systems			
	Control theory and design			
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	 Students can explain humanoid rob 	ots.		
	· ·	ol concepts for different tasks in humanoid rob	ootics.	
	11.3	·		
···				
Skills	Students acquire knowledge about	selected aspects of humanoid robotics, based	on specified literature	
	Students generalize developed resu	ults and present them to the participants		
	 Students practice to prepare and gi 	ve a presentation		
Davisanal Compatones				
Personal Competence Social Competence				
30ciai Competence	Students are capable of developing solutions in interdisciplinary teams and present them			
	 They are able to provide appropriat 	e feedback and handle constructive criticism	of their own results	
Autonomy				
riaconomy	 Students evaluate advantages and 	d drawbacks of different forms of presentat	ion for specific tasks	and select the best
	solution			
		th a scientific field, are able of introduce it a	and follow presentatior	ns of other students,
	such that a scientific discussion dev	relops		
Workload in Hours	Independent Study Time 32, Study Time in	n Lecture 28		
Credit points	2			
Course achievement	None			
Examination	Presentation			
Examination duration and	30 min			
scale				
Assignment for the	Mechatronics: Specialisation Intelligent Sy	stems and Robotics: Elective Compulsory		
Following Curricula	Mechatronics: Specialisation System Design	• • •		
		cificial Organs and Regenerative Medicine: Ele		
		plants and Endoprostheses: Elective Compulso		
		edical Technology and Control Theory: Elective		
		nagement and Business Administration: Elect nical Complementary Course: Elective Compu		
		ialisation Robotics and Computer Science: Elec		
	medical mechanical Engineering. Speci	iansación nobocics ana compater science. Eler	ctive compulsory	

Course L0663: Humanoid Ro	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).		

Module M0838: Linea	r and Nonlinear System Ident	ifikation		
Courses				
Title		Тур	Hrs/wk	СР
Linear and Nonlinear System Identi	ification (L0660)	Lecture	2	3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	Classical control (frequency response State space methods Discrete-time systems Linear algebra, singular value decome Basic knowledge about stochastic presented	nposition		
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence Knowledge Skills Personal Competence Social Competence	Students can explain the general fr nonlinear model structures They can explain how multilayer per They can explain how an approxima They can explain the idea of subspace Students are capable of applying the models for dynamic systems They are capable of implementing a They are capable of applying subspace	ramework of the prediction error method are repetron networks are used to model nonlineate predictive control scheme can be based or ce identification and its relation to Kalman results the prediction error method to the experimal nonlinear predictive control scheme based or ace algorithms to the experimental identification of software tools (including the Matlab System cific problems to arrive at ioint solutions.	ar dynamics In neural network model Isalisation theory In a neural network model In a neural network models for	is linear and nonlinear del r dynamic systems
,		tion in sources provided (lecture notes, litera	ture, software docume	ntation) and use it to
Workload in Hours	Independent Study Time 62, Study Time in	Lecture 28		
Credit points				
Course achievement				
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the	Electrical Engineering: Specialisation Contr	rol and Power Systems Engineering: Elective	Compulsory	
Following Curricula	Biomedical Engineering: Specialisation Imp Biomedical Engineering: Specialisation Med Biomedical Engineering: Specialisation Mar	n: Elective Compulsory ficial Organs and Regenerative Medicine: Ele blants and Endoprostheses: Elective Compulse dical Technology and Control Theory: Compul nagement and Business Administration: Elect lical Complementary Course: Elective Compu	ory sory ive Compulsory	

Course L0660: Linear and No	onlinear 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 Control (L0658)	Lecture	2	3
Optimal and Robust Control (L0659)	Recitation Section (small)	2	3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	Classical control (frequency response, rooState space methods	ot locus)		
	Linear algebra, singular value decomposi	tion		
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence Knowledge	They can explain the duality between opt	he matrix Riccati equation for the solution of imal state feedback and optimal state estim ty norms are used to represent stability and	ation.	traints.
	 They can explain how an LQG design prol They can explain how model uncertainty They can explain how - based on the sm an uncertain plant. 	color of the color	H2 design proble f to robust control uarantee stability	m. ler design and performance f
Skills	 Students are capable of designing and tuning LQG controllers for multivariable plant models. They are capable of representing a H2 or H-infinity design problem in the form of a generalized plant, and of using stand software tools for solving it. They are capable of translating time and frequency domain specifications for control loops into constraints on closed-sensitivity functions, and of carrying out a mixed-sensitivity design. They are capable of constructing an LFT uncertainty model for an uncertain system, and of designing a mixed-object. 			raints on closed-loo
	LMI-solvers for solving them.	and synthesis conditions as linear matrix in standard software tools (Matlab robust contr		nd of using standa
Personal Competence				
Social Competence Autonomy	Students can work in small groups on specific p Students are able to find required information in solve given problems.	· ·	software docume	ntation) and use it
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Course achievement				
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the	Electrical Engineering: Specialisation Control an	d Power Systems Engineering: Elective Comp	oulsory	
Following Curricula	Energy Systems: Core qualification: Elective Cor		,	
	Aircraft Systems Engineering: Core qualification	: Elective Compulsory		
	Mechatronics: Specialisation Intelligent Systems	and Robotics: Elective Compulsory		
	Mechatronics: Specialisation System Design: Ele	ective 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 Con	npulsory	
	Biomedical Engineering: Specialisation Manager	nent and Business Administration: Elective C	ompulsory	
	Product Development, Materials and Production	: Specialisation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Production	: Specialisation Production: Elective Compuls	ory	
	Product Development, Materials and Production	: Specialisation Materials: Elective Compulso	ry	
	Theoretical Mechanical Engineering: Technical C			
	Theoretical Mechanical Engineering: Core qualif	ication: Elective Compulsory		

Course L0658: Optimal and F	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 F	ourse 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	

Module M0855: Marko	eting (Sales and Services / Innovation Marketing)
Courses	
Title	Typ Hrs/wk CP
Marketing of Innovations (L2009)	Lecture 4 4
PBL Marketing of Innovations (L086	Project-/problem-based Learning 1 2
Module Responsible	Prof. Christian Lüthje
Admission Requirements	None
Recommended Previous	Module International Business
Knowledge	Basic understanding of business administration principles (strategic planning, decision theory, project management,
	international business)
	Bachelor-level Marketing Knowledge (Marketing Instruments, Market and Competitor Strategies, Basics of Buying Behavior)
	Unerstanding the differences beweetn B2B and B2C marketing
	Understanding of the importance of managing innovation in global industrial markets
	Good English proficiency; presentation skills
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	
, and medge	statistics in have gained a deep and standing of
	Specific characteristics in the marketing of innovative poroducts and services
	Approaches for analyzing the current market situation and the future market development The gathering of information about future gustomer pends and requirements.
	 The gathering of information about future customer needs and requirements Concepts and approaches to integrate lead users and their needs into product and service development processes
	Approaches and tools for ensuring customer-orientation in the development of new products and innovative services
	Marketing mix elements that take into consideration the specific requirements and challenges of innovative products and
	services
	Pricing methods for new products and services
	The organization of complex sales forces and personal selling
	Communication concepts and instruments for new products and services
Skills	Based on the acquired knowledge students will be able to:
	Design and to evaluate decisions regarding marketing and innovation strategies
	Analyze markets by applying market and technology portfolios
	Conduct forecasts and develop compelling scenarios as a basis for strategic planning
	Translate customer needs into concepts, prototypes and marketable offers and successfully apply advanced methods for
	customer-oriented product and service development
	Use adequate methods to foster efficient diffusion of innovative products and services
	Choose suitable pricing strategies and communication activities for innovations
	Make strategic sales decisions for products and services (i.e. selection of sales channels) Apply with all of sales from a services and services (i.e. selection of sales channels)
	Apply methods of sales force management (i.e. customer value analysis)
Personal Competence	
Social Competence	The students will be able to
	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
ĺ	
	 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.
	• Consider proposed business actions in the neid of marketing and reflect on them.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and	Written elaboration, excercises, presentation, oral participation
scale	
Assignment for the	
Following Curricula	
	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
	Significance Engineering. Specialisation management and business Administration. Computsory

Course L2009: Marketing of	Innovations
Тур	Lecture
Hrs/wk	4
СР	4
	Independent Study Time 64, Study Time in Lecture 56
	Prof. Christian Lüthje
Language	
Cycle	I. Introduction
	 Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing)
	II. Methods and approaches of strategic marketing planning
	patterns of industrial development, patent and technology portfolios
	III. Strategic foresight and scenario analysis
	objectives and challenges of strategic foresight, scenario analysis, Delphi method
	IV. User innovations
	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 Marketing of Innovations		
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Christian Lüthje	
Language	EN	
Cycle	SoSe	
Content	This PBL course is seggregated into two afternoon sessions. This cours aims at enhancing the students' practical skills in (1)	
	forecasting the future development of markets and (2) making appropriate market-related decisions (particularly segmentation, managing the marketing mix). The students will be prompted to use the knowledge gathered in the lecture of this module and will be invited to (1) Conduct a scenario analysis for an innovative product category and (2) Engage in decision making wtihin a market simulation game.	
Literature		

Module M1143: Applie	ed Design Methodology in Mechatro	nics		
Courses				
Title		Тур	Hrs/wk	СР
Applied Design Methodology in Med	chatronics (L1523)	Lecture	2	2
Applied Design Methodology in Med	chatronics (L1524)	Project-/problem-based Learning	3	4
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mechanical design, electrical design or com	puter-sciences		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Science-based working on interdisciplinary product d	esign considering targeted application of sp	ecific product	design techniques
Skills	Creative handling of processes used for scientific pre	paration and formulation of complex produ	ct design prob	lems / Application of
	various product design techniques following theoretic	cal aspects.		
Personal Competence				
Social Competence	Students will solve and execute technical-scientific	tasks from an industrial context in small	design-teams	with application of
	common, creative methodologies.			
Autonomy	Students are enabled to optimize the design and dev	elopment process according to the target a	nd topic of the	design
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	30 min Presentation for a group design-work			
scale				
Assignment for the	International Management and Engineering: Specialis	sation II. Product Development and Producti	on: Elective Co	ompulsory
Following Curricula	International Management and Engineering: Specialis	ation II. Mechatronics: Elective Compulsory		
	Mechanical Engineering and Management: Specialisa	tion Product Development and Production: I	Elective Comp	ulsory
	Mechatronics: Specialisation System Design: Elective	Compulsory		
	Biomedical Engineering: Specialisation Artificial Orga	ns and Regenerative Medicine: Elective Con	npulsory	
	Biomedical Engineering: Specialisation Implants and	Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical Techr	nology and Control Theory: Elective Compuls	sory	
	Biomedical Engineering: Specialisation Management	and Business Administration: Elective Comp	oulsory	
	Theoretical Mechanical Engineering: Specialisation Pr	oduct Development and Production: Electiv	e Compulsory	
	Theoretical Mechanical Engineering: Technical Compl	ementary Course: Elective Compulsory		

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

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

_				
Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering - Fundame		Lecture	2	3
Bioprocess Engineering- Fundamentals (L0842) Bioprocess Engineering - Fundamental Practical Course (L0843)		Recitation Section (large) Practical Course	2	1 2
		Tractical course	2	2
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	none, module "organic chemistry", module	"fundamentals for process engineering"		
Educational Objectives	After taking part successfully, students have	re reached the following learning results		
Professional Competence				
	Students are able to describe the basic concepts of bioprocess engineering. They are able to classify different types of kinetics enzymes and microorganisms, as well as to differentiate different types of inhibition. The parameters of stoichiometry a rheology can be named and mass transport processes in bioreactors can be explained. The students are capable to expl. fundamental bioprocess management, sterilization technology and downstream processing in detail.			
SKIIS	 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 of 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 microae 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. 		wth inhibition on	
Personal Competence Social Competence Autonomy	take position to their own opinions and incr	es should be able to debate technical questions rease their capacity for teamwork in engineering ts will be able to solve a technical problem in a plenum.	and scientific envi	ronments.
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points		 -		
Course achievement	Compulsory Bonus Form Yes 5 % Subject theoretic practical work	Description al and		
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the		gram, 7 semester): Specialisation Process Engine	, ,	
Following Curricula		gram, 7 semester): Specialisation Bioprocess Eng	gineering: Compulso	ory
	Bioprocess Engineering: Core qualification:			
	Green Technologies: Energy, Water, Climat	e: Specialisation Bioresource Technology: Electi	ve Compulsory	
	Biomedical Engineering: Specialisation Arti	ficial Organs and Regenerative Medicine: Comp	ulsory	
	Biomedical Engineering: Specialisation Imp	lants and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Med	lical Technology and Control Theory: Elective Co	ompulsory	
	Biomedical Engineering: Specialisation Mar	nagement and Business Administration: Elective	Compulsory	
	Technomathematics: Specialisation III. Eng	ineering Science: Elective 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	
Language	DE	
Cycle	SoSe	
Content	 Introduction: state-of-the-art and development trends in the biotechnology, introduction to the lecture Enzyme kinetics: Michaelis-Menten, differnt types of enzyme inhibition, linearization, conversion, yield, selectivity (Prof. Liese) Stoichiometry: coefficient of respiration, electron balance, degree of reduction, coefficient of yield, theoretical oxygen demand (Prof. Liese) Microbial growth kinetic: batch- and chemostat culture (Prof. Zeng) Kinetic of subtrate consumption and product formation (Prof. Zeng) Rheology: non-newtonian fluids, viscosity, agitators, energy input (Prof. Liese) Transport process in a bioreactor (Prof. Zeng) Technology of sterilization (Prof. Zeng) Fundamentals of bioprocess management: bioreactors and calculation of batch, fed-batch and continuouse bioprocesses (Prof. Zeng/Prof. Liese) Downstream technology in biotechnology: cell breakdown, zentrifugation, filtration, aqueous two phase systems (Prof. Liese) 	
Literature	K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012 H. Chmiel: Bioprozeßtechnik, Elsevier, 2006 R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010 H.W. Blanch, D. Clark: Biochemical Engineering, Taylor & Francis, 1997 P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013	

Course L0842: Bioprocess En	ourse 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		
Language	DE		
Cycle	SoSe		
Content	1. Introduction (Prof. Liese, Prof. Zeng)		
	2. Enzymatic kinetics (Prof. Liese)		
	3. Stoichiometry I + II (Prof. Liese)		
	4. Microbial Kinetics I+II (Prof. Zeng)		
	5. Rheology (Prof. Liese)		
	6. Mass transfer in bioprocess (Prof. Zeng)		
	7. Continuous culture (Chemostat) (Prof. Zeng)		
	8. Sterilisation (Prof. Zeng)		
	9. Downstream processing (Prof. Liese)		
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)		
Literature	siehe Vorlesung		

Course L0843: Bioprocess En	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 M1277: MED I	: Introduction to Anatomy
Courses	
Title	Typ Hrs/wk CP
Introduction to Anatomy (L0384)	Lecture 2 3
Module Responsible	Prof. Udo Schumacher
Admission Requirements	None
Recommended Previous	None
Knowledge	
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; the
Siano	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 acqui
	the relevant knowledge themselves.
Workland in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	
Examination	
Examination duration and	
scale	30 minutes
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Following Curricula	
	Compulsory
	Data Science: Specialisation Medicine: Compulsory
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation 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 L0384: Introduction t	o Anatomy		
Тур	Lecture		
Hrs/wk	2		
СР	3		
		ndependent Study Time 62, Study Time in Lecture 28	
	Prof. Tobias Lange		
Language			
Cycle			
Content	General Anatomy		
	1 st week:	The Eucaryote Cell	
	2 nd week:	The Tissues	
	3 rd week:	Cell Cycle, Basics in Development	
	4 th week:	Musculoskeletal System	
	5 th week:	Cardiovascular System	
	6 th week:	Respiratory System	
	7 th week:	Genito-urinary System	
	8 th week:	Immune system	
	9 th week:	Digestive System I	
	10 th week:	Digestive System II	
	11 th week:	Endocrine System	
	12 th week:	Nervous System	
	13 th week:	Exam	
1:4	Adolf Follow/Mi-b	J Cabilaka Dar Kärner des Manschen 17 Auflage Thioma Verlag Chuttaget 2016	
Literature	Adolf Faller/Michae	el Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag Stuttgart, 2016	

Module M1278: MED	l: Introduction to Radiology and Radiation Therapy					
Courses						
Title	Typ Hrs/wk CP					
Introduction to Radiology and Radio						
Module Responsible	Prof. Ulrich Carl					
Admission Requirements	None					
Recommended Previous	None					
Knowledge	Monthly and a second like the last and the l					
Professional Competence	After taking part successfully, students have reached the following learning results					
Knowledge	Therapy					
	The students can distinguish different types of currently used equipment with respect to its use in radiation therapy.					
	The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine).					
	The students can describe the patients' passage from their initial admittance through to follow-up care.					
	Diagnostics					
	The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, as well as sectional imaging techniques (CT, MRT, US).					
	The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for those techniques.					
	The students can choose the right treatment method depending on the patient's clinical history and needs.					
	The student can explain the influence of technical errors on the imaging techniques.					
	The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.					
Skills	Therapy					
	The students can distinguish curative and palliative situations and motivate why they came to that conclusion.					
	The students can develop adequate therapy concepts and relate it to the radiation biological aspects.					
	The students can use the therapeutic principle (effects vs adverse effects)					
	The students can distinguish different kinds of radiation, can choose the best one depending on the situation (location of 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. follow-up treatment, sports, social hel groups, self-help groups, social services, psycho-oncology).					
	Diagnostics					
	The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.					
	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of anatomy, pathology and pathophysiology.					
Personal Competence						
Social Competence	The students can assess the special social situation of tumor patients and interact with them in a professional way. The students are aware of the special, often fear-dominated behavior of sick people caused by diagnostic and therapeutic measures and can meet them appropriately.					
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					
Course achievement	None					
	Written exam					
Examination duration and scale	90 minutes					
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics Compulsory					
	Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory					
	Engineering Science: Specialisation Biomedical Engineering: Compulsory					
	General Engineering Science (English program, 7 semester): Specialisation 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 t	o Radiology and Radiation Therapy
Тур	Lecture
Hrs/wk	2
	3
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ulrich Carl, Prof. Thomas Vestring
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
Literature	"Technik der medizinischen Radiologie" von T. + J. Laubenberg –
	7. Auflage – Deutscher Ärzteverlag – erschienen 1999
	• "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr –
	4. Auflage - Verlag Urban & Fischer - erschienen 02.03.2006
	ISBN: 978-3-437-23960-1
	"Strahlentherapie und Onkologie für MTA-R" von R. Sauer –
	5. Auflage 2003 - Verlag Urban & Schwarzenberg - erschienen 08.12.2009
	ISBN: 978-3-437-47501-6
	• "Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus-
	8. Auflage - Georg Thieme Verlag - erschienen 19.09.2012
	ISBN: 978-3-13-567708-8
	• "Der Körper des Menschen " von A. Faller u. M. Schünke -
	16. Auflage 2004 - Georg Thieme Verlag - erschienen 18.07.2012
	ISBN: 978-3-13-329716-5
	"Praxismanual Strahlentherapie" von Stöver / Feyer –
	1. Auflage - Springer-Verlag GmbH – erschienen 02.06.2000

Courses			
Title	Тур	Hrs/wk	СР
Introduction to Physiology (L0385)		2	3
Module Responsible	Dr. Roger Zimmermann		
Admission Requirements			
Recommended Previous	None		
Knowledge			
Educational Objectives			
Professional Competence			
Knowledge	The students can		
	describe the basics of the energy metabolism;		
	describe physiological relations in selected fields of muscle, heart/circulation, neuro- and se	ensory physiol	ogy.
Skille	The students can describe the effects of basic bodily functions (sensory, transmission and proces:	sing of inform	ation developmen
Skins	of forces and vital functions) and relate them to similar technical systems.	sing or inform	ation, acveropine
Personal Competence			
Social Competence			
,	The students can find solutions to problems in the field of physiology, both analytical and metrology	gical.	
Autonomy		as, using tech	nnical literature, b
	themselves.		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Credit points	3		
Course achievement	None		
Examination	Written exam		
Examination duration and	60 minutes		
scale			
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineerin	ng: Compulsor	У
Following Curricula		gineering, Fo	cus Biomechanics
	Compulsory		
	Data Science: Specialisation Medicine: Compulsory		
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory		
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical En	aineerina Fo	cus Riomechanic
	Compulsory	gilicering, 10	eds biomeename.
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering	a: Compulsory	/
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering		
	Mechanical Engineering: Specialisation Biomechanics: Compulsory	-	
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulso	ory	
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compu	lsory	
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Comp	oulsory	
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory		
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory		

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

Module M1335: BIO II	: Artificial Joint Replacement			
Courses				
Title		Тур	Hrs/wk	СР
Artificial Joint Replacement (L1306		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	Basic knowledge of orthopedic and surgical techniq	ues is recommended.		
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	The students can name the different kinds of artific	ial limbs.		
Skills	The students can explain the advantages and disad	vantages of different kinds of endor	protheses	
S.i.iis	The stadents can explain the davantages and also	vaniages of amerene kinds of endop		
Personal Competence				
Social Competence	The students are able to discuss issues related to e	ndoprothese with student mates and	the teachers.	
Autonomy	The students are able to acquire information on the	ir own. They can also judge the info	rmation with respect to	its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture	28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	International Management and Engineering: Specia	lisation II. Process Engineering and E	Biotechnology: Elective	Compulsory
Following Curricula	Materials Science: Specialisation Nano and Hybrid N	laterials: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Org	ans and Regenerative Medicine: Ele	ctive Compulsory	
	Biomedical Engineering: Specialisation Implants and	d Endoprostheses: Compulsory		
	Biomedical Engineering: Specialisation Medical Tecl	nnology and Control Theory: Elective	e Compulsory	
	Biomedical Engineering: Specialisation Managemen	t and Business Administration: Elect	ive Compulsory	
	Orientation Studies: Core qualification: Elective Con	npulsory		
	Theoretical Mechanical Engineering: Technical Com	plementary Course: Elective Compu	Isory	
	Theoretical Mechanical Engineering: Specialisation	Bio- and Medical Technology: Electiv	e Compulsory	

qyT	Lecture	
Hrs/wk		
СР		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content	Inhalt (deutsch)	
	1. EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenker-satzes)	
	2. FUNKTIONSANALYSE (Der menschliche Gang, die menschliche Arbeit, die sportliche Aktivität)	
	3. DAS HÜFTGELENK (Anatomie, Biomechanik, Gelenkersatz Schaftseite und Pfannenseite, Evolution der Implantate)	
	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)	
Literature	Literatur:	
	Kapandji, I: Funktionelle Anatomie der Gelenke (Band 1-4), Enke Verlag, Stuttgart, 1984.	
	Nigg, B., Herzog, W.: Biomechanics of the musculo-skeletal system, John Wiley&Sons, New York 1994	
	Nordin, M., Frankel, V.: Basic Biomechanics of the Musculoskeletal System, Lea&Febiger, Philadelphia, 1989.	
	Czichos, H.: Tribologiehandbuch, Vieweg, Wiesbaden, 2003.	
	Sobotta und Netter für Anatomie der Gelenke	

Module M0845: Feed	back Control in Medical Tech	nology			
Courses					
Title		Тур	Hrs/wk	СР	
Feedback Control in Medical Techn	ology (L0664)	Lecture	2	3	
Module Responsible	Johannes Kreuzer				
Admission Requirements	None				
Recommended Previous	Basics in Control, Basics in Physiology				
Knowledge					
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results			
Professional Competence					
Knowledge	The lecture will introduce into the fascinating area of medical technology with the engineering point of view. Fundamentals in human physiology will be similarly introduced like knowledge in control theory.				
	Internal control loops of the human body will be discussed in the same way like the design of external closed loop system for example in for anesthesia control.				
	The handling of PID controllers and modern controller like predictive controller or fuzzy controller or neural networks will billustrated. The operation of simple equivalent circuits will be discussed.				
Skills	Application of modeling, identification, co	ontrol technology in the field of medical technology	ogy.		
Personal Competence					
Social Competence	Students can develop solutions to specific	c problems in small groups and present their res	sults		
Autonomy	Students are able to find necessary literature and to set it into the context of the lecture. They are able to continuously evaluate their knowledge and to take control of their learning process. They can combine knowledge from different courses to form a consistent whole.				
Workload in Hours	Independent Study Time 62, Study Time i	in Lecture 28			
Credit points	3				
Course achievement	None				
Examination	Oral exam				
Examination duration and	20 min				
scale					
Assignment for the	Electrical Engineering: Specialisation Med	lical Technology: Elective Compulsory			
Following Curricula	Electrical Engineering: Specialisation Con	trol and Power Systems Engineering: Elective Co	ompulsory		
		nplants and Endoprostheses: Elective Compulsor	-		
	Biomedical Engineering: Specialisation Ar	rtificial Organs and Regenerative Medicine: Elect	tive Compulsory		
		anagement and Business Administration: Electiv			
	Biomedical Engineering: Specialisation Me	edical Technology and Control Theory: Compuls	ory		

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

Module M0832: Adva	nced Topics in Control			
Courses				
Title		Тур	Hrs/wk	СР
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				
	H-infinity optimal control, mixed-sensitivity design, line	ar matrix inequalities		
Knowledge	After taking part successfully, students have reached t	he following learning results		
Professional Competence	Arter taking part successionly, students have reached t	ne following learning results		
Knowledge				
	 Students can explain how graph theoretic consystems They can explain the convergence properties of They can explain analysis and synthesis conditions 	first order consensus protocols		
	Students can explain the state space represents to an actuator/sensor array They can explain (in outline) the extension of synthesis conditions for distributed controllers			
Skills	 Students are capable of constructing LPV models of nonlinear plants and carry out a mixed-sensitivity design of 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 these tasks 			
	Students are able to design distributed formati Matlab tools provided	on controllers for groups of agents w	th either LTI or l	.PV dynamics, using
Personal Competence	Students are able to design distributed controlle	rs for spatially interconnected systems	, using the Matla	b MD-toolbox
•	Students can work in small groups and arrive at joint re	esults.		
Autonomy	Students are able to find required information in source solve given problems.	es provided (lecture notes, literature, s	oftware documer	ntation) and use it to
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	5		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and .	30 min			
scale	Floridad Facility of Control Control	- Contains Facility of the Fig. 11 - C		
•	Electrical Engineering: Specialisation Control and Powe	,	usory	
Following Curricula	Aircraft Systems Engineering: Specialisation Avionic Sy Aircraft Systems Engineering: Specialisation Aircraft Sy	, ,		
	Aircraft Systems Engineering: Specialisation Aircraft Systems Engineering: Core qualification: Electi	, ,		
	International Management and Engineering: Specialisa		ory	
	Mechatronics: Specialisation System Design: Elective C	·		
	Mechatronics: Specialisation Intelligent Systems and R	obotics: Elective Compulsory		
	Biomedical Engineering: Specialisation Implants and Er			
	Biomedical Engineering: Specialisation Medical Techno	•	•	
	Biomedical Engineering: Specialisation Management at			
	Biomedical Engineering: Specialisation Artificial Organs Theoretical Mechanical Engineering: Technical Comple		Jonnpulsor y	

Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Course L0661: Advanced Top	oics in Control	
Тур	Lecture	
Hrs/wk	2	
СР		
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	
	Linear and Nonlinear Model Predictive Control based on LMIs	
Literature	Werner, H., Lecture Notes "Advanced Topics in Control"	
	Selection of relevant research papers made available as pdf documents via StudIP	

Course L0662: Advanced Top	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		

Module M0546. Block	ectromagnetics: Principles an	Applications				
Courses						
Title		Ту	р	Hrs/wk	СР	
Bioelectromagnetics: Principles an			cture	3	5	
Bioelectromagnetics: Principles an	1	Applications (L0373) Recitation Section (small) 2 1				
· · · · · · · · · · · · · · · · · · ·	Prof. Christian Schuster					
Admission Requirements						
	Basic principles of physics					
Knowledge						
Educational Objectives	After taking part successfully, students have	ve reached the following le	earning results			
Professional Competence	Arter taking part successfully, students have	ve reactied the following is	earriing results			
•	Students can explain the basic principles, i	relationships and method	s of hinelectromagnetics	i e the quantific	ation and application	
Momeage	of electromagnetic fields in biological tiss them corresponding to wavelength and f techniques for characterization of electro	ue. They can define and requency of the fields. T	exemplify the most imp	ortant physical ph ew over measure	enomena and orde	
	diagnostic utilization of electromagnetic fie	,		an give examples	Tor therapeutic arr	
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 Social Competence	Students are able to work together on sul English (e.g. during small group exercises)	•	all groups. They are able	e to present their	results effectively	
Autonomy	Students are capable to gather informatic context of the lecture. They are able to mother lectures (e.g. theory of electromag problems and effects in the field of bioelections.)	nake a connection betwee netic fields, fundamentals	n their knowledge obtai	ned in this lecture	with the content of	
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70				
Credit points						
Course achievement	Compulsory Bonus Form	Description				
	Yes None Presentation					
Examination	Oral exam					
Examination duration and	45 min					
scale						
Assignment for the	Electrical Engineering: Specialisation Micro	wave Engineering, Optics	. and Electromagnetic Co	ompatibility: Electi	ve Compulsory	
Following Curricula			-	,,. =		
•	International Management and Engineering			Compulsory		
	Biomedical Engineering: Specialisation Arti	-	3 3	. ,		
	Biomedical Engineering: Specialisation Mai	3		. ,		
	Biomedical Engineering: Specialisation Med	•				
	Biomedical Engineering: Specialisation Imp	plants and Endoprostheses	s: Elective Compulsory			
	Theoretical Mechanical Engineering: Specia	alisation Bio- and Medical	Technology: Elective Cor	mpulsory		
	Theoretical Mechanical Engineering: Techn	nical Complementary Cour	se: Elective Compulsory			

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

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

Specialization Management and Business Administration

Module M0623: Intell	igent Systems	in Medicine				
Courses						
Title			Туј	0	Hrs/wk	СР
Intelligent Systems in Medicine (L0331)			Lec	ture	2	3
Intelligent Systems in Medicine (L0				ject Seminar	2	2
Intelligent Systems in Medicine (L0			Rec	itation Section (small)	1	1
Module Responsible		efer				
Admission Requirements	None					
Recommended Previous Knowledge	 principles of st 	rogramming, Java/C++ ar				
Educational Objectives	After taking part succ	essfully, students have re	eached the following le	earning results		
Professional Competence						
	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 disadvantage in clinical contexts. The students can compare different methods for representing medical knowledge. They can evaluate method 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 group	os, provide helpful feed	dback and can incoorpo	rate feedback into	their work.
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.					
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
Credit points	6					
Course achievement	Yes 10 % Yes 10 %	Form Written elaboration Presentation	Description			
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the		pecialisation II: Intelligend				
Following Curricula	Interdisciplinary Math Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri	g: Specialisation Medical Tematics: Specialisation C lisation Intelligent Systen ng: Specialisation Artificia ng: Specialisation Implan ng: Specialisation Medica ng: Specialisation Manag al Engineering: Technical	computational Methods as and Robotics: Elective al Organs and Regener ts and Endoprostheses I Technology and Cont ement and Business Ac	s in Biomedical Imaging: we Compulsory ative Medicine: Elective : Elective Compulsory rol Theory: Elective Con dministration: Elective C	Compulsory npulsory compulsory	
		al Engineering: Specialisa				

Course L0331: Intelligent Sy	stems 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 Sy	ourse 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	

		g - Option A (6 LP)		
Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L1	663)	Seminar	2	3
Introduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1669)	Lecture	3	4
ntroduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2
Development and Regulatory Appr	oval of Medical Devices (L1588)	Lecture	2	3
Experimental Methods in Biomecha	nics (L0377)	Lecture	2	3
Experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	3
Numerical Methods in Biomechanic	s (L1583)	Seminar	2	3
Seminar Biomedical Engineering (L	1890)	Seminar	2	3
Fluid Mechanics II (L0001)		Lecture	2	4
System Simulation (L1820)		Lecture	2	2
System Simulation (L1821)		Recitation Section (large)	1	2
Ceramics Technology (L0379)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	6			
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory			
Assignment for the	3 3 3			
Assignment for the Following Curricula		ology and Control Theory: Elective Com	pulsory	
-				

Course L1663: Nature's Hiera	archical Materials
	Seminar
Hrs/wk	
CP	
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

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	30 min				
scale					
Lecturer					
Language 					
	SoSe				
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequenty 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				
	- 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	
Examination Form	Mündliche Prüfung	
Examination duration and	30 min	
scale		
Lecturer	Prof. Christian Schuster	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1588: Development	and Regulatory Approval of Medical Devices
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	90 Minuten
scale	
Lecturer	Dr. Roman Nassutt
Language	DE
Cycle	WiSe
Content	
Literature	 E. Wintermantel, S-W. Ha, Medizintechnik - Life Science Engineering, Springer Verlag, 5. Aufl. Kurt Becker et al., Schriftenreihe der TMF, MVW Verlag, Berlin, 2001 Medizinproduktegesetz in der aktuellen Fassung (online): http://www.gesetze-im-internet.de/mpg/BJNR196300994.html

Course L0377: Experimental Methods in Biomechanics		
•	Lecture	
Hrs/wk		
CP		
	Independent Study Time 62, Study Time in Lecture 28	
Examination Form		
Examination duration and		
scale		
	Prof. Michael Morlock	
Language	DE	
Cycle	SoSe	
Content		
Literature	Wird in der Veranstaltung bekannt gegeben	

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

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

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

ourse L0001: Fluid Mechan	
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	
	1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.
	2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.
	3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.
	4. 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 Strömunger
	Springer Verlag, Berlin, Heidelberg, New York, 2006.
	7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GW
	Fachverlage GmbH, Wiesbaden, 2008.
	8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007
	9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner
	GWV Fachverlage GmbH, Wiesbaden, 2009.
	10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.
	11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer
	Verlag, Berlin, Heidelberg, 2008.
	12. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.
	13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.

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

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

Course L0379: Ceramics Tecl	hnology			
Тур	Lecture			
Hrs/wk	2			
СР	3			
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28		
Examination Form				
Examination duration and	90 Minuten			
scale				
	Dr. Rolf Janßen			
Language				
Cycle				
Content	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		
		3. Powder fabrication		
		4. Powder processing		
		5. Shape-forming processes		
	6. Densification, sintering			
	7. Glass and Cement technology			
		8. Ceramic-metal joining techniques		
Literature	W.D. Kingery, "Introduction to 0	Ceramics", John Wiley & Sons, New York, 1975		
	ASM Engineering Materials Han	dbook Vol.4 "Ceramics and Glasses", 1991		
	D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992			
	Skript zur Vorlesung			

Module M1241: Selec	ted Topics of Biomedical Engineering	g - Option B (12 LP)			
Courses					
Γitle		Тур	Hrs/wk	СР	
Nature's Hierarchical Materials (L1	563)	Seminar	2	3	
ntroduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1669)	Lecture	3	4	
ntroduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2	
Development and Regulatory Appr	oval of Medical Devices (L1588)	Lecture	2	3	
Experimental Methods in Biomech	nics (L0377)	Lecture	2	3	
experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	3	
lumerical Methods in Biomechanio	s (L1583)	Seminar	2	3	
Seminar Biomedical Engineering (L	1890)	Seminar	2	3	
Fluid Mechanics II (L0001)		Lecture	2	4	
System Simulation (L1820)		Lecture	2	2	
System Simulation (L1821)		Recitation Section (large)	1	2	
Ceramics Technology (L0379)		Lecture	2	3	
Module Responsible	Prof. Michael Morlock				
Admission Requirements	None				
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, students have reached	After taking part successfully, students have reached the following learning results			
Professional Competence					
Knowledge					
Skills					
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Depends on choice of courses				
Credit points					
Assignment for the	Biomedical Engineering: Specialisation Artificial Organ	ns and Regenerative Medicine: Elective	Compulsory		
Following Curricula	Biomedical Engineering: Specialisation Implants and E	Endoprostheses: Elective Compulsory			
Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory					

Course L1663: Nature's Hiera	archical Materials		
	Seminar		
Hrs/wk			
CP			
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 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		

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	30 min		
scale			
Lecturer			
Language			
	SoSe		
Content	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well as Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequency high bandwidth data in e.g. medical, automotive, or avionic applications. Both circuit and field concepts of wave propagation and Electromagnetic Compatibility will be introduced and discussed.		
	Topics:		
	- Fundamental properties and phenomena of electrical circuits		
	- Steady-state sinusoidal analysis of electrical circuits		
	- Fundamental properties and phenomena of electromagnetic fields and waves		
	- Steady-state sinusoidal description of electromagnetic fields and waves		
	- Useful microwave network parameters Transmission lines and basis results from transmission line theory.		
	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	ecitation Section (small)			
Hrs/wk				
СР				
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28			
Examination Form	ündliche Prüfung			
Examination duration and	30 min			
scale				
Lecturer	rof. Christian Schuster			
Language	DE/EN			
Cycle	oSe			
Content	See interlocking course			
Literature	See interlocking course			

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

ourse L0377: Experimental Methods in Biomechanics			
Тур	ecture		
Hrs/wk	2		
СР	}		
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28		
Examination Form	álausur (lausur		
Examination duration and	90 min		
scale			
Lecturer	Prof. Michael Morlock		
Language	DE		
Cycle	5oSe		
Content			
Literature	Wird in der Veranstaltung bekannt gegeben		

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

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

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

Tim	Locture			
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				
	1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.			
	2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.			
	3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.			
	 Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelber 2006. 			
	5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994.			
	6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömunge			
	Springer Verlag, Berlin, Heidelberg, New York, 2006.			
	7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GW			
	Fachverlage GmbH, Wiesbaden, 2008.			
	8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007			
	9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubnei			
	GWV Fachverlage GmbH, Wiesbaden, 2009.			
	10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.			
	11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Spring			
	Verlag, Berlin, Heidelberg, 2008.			
	12. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.			
	13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.			

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

Course L1821: System Simulation				
Тур	lecitation Section (large)			
Hrs/wk				
СР				
Workload in Hours	ndependent Study Time 46, Study Time in Lecture 14			
Examination Form	ündliche Prüfung			
Examination duration and	30 min			
scale				
Lecturer	Or. Stefan Wischhusen			
Language	DE			
Cycle	ViSe			
Content	See interlocking course			
Literature	See interlocking course			

Course L0379: Ceramics Tecl	hnology		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Stu	udy Time in Lecture 28	
Examination Form	Klausur		
Examination duration and	90 Minuten		
scale			
	Dr. Rolf Janßen		
Language			
Cycle		sing with amphasis an advanced structural coronics. The source facus producingthy an newdor	
	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: Inhalt:	Introduction Raw materials	
	Titlate.		
		3. Powder fabrication	
		4. Powder processing	
		5. Shape-forming processes	
	6. Densification, sintering		
	7. Glass and Cement technology		
	8. Ceramic-metal joining techniques		
Literature	W.D. Kingery, "Introduction to C	eramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Hand	dbook Vol.4 "Ceramics and Glasses", 1991	
	D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992		
	Skript zur Vorlesung		

	igent Autonomous Agents and (
Courses				
itle		Тур	Hrs/wk	СР
ntelligent Autonomous Agents and	Cognitive Robotics (L0341)	Lecture	2	4
ntelligent Autonomous Agents and	Cognitive Robotics (L0512)	Recitation Section (small)	2	2
Module Responsible	Rainer Marrone			
Admission Requirements	None			
Recommended Previous	Vectors, matrices, Calculus			
Knowledge				
Educational Objectives	After taking part successfully, students have r	reached the following learning results		
Professional Competence				
Skills	can be discussed in terms of decision proble world scenarios, students can summarize how formalism in static and dynamic settings. In settings, with and with complete access to to solving (partially observable) Markov decision Students can identify techniques for simultadesired states. Students can explain coordinating of equilibria, social choice functions, voting problems can derive decision trees and apply networks/dynamic Bayesian networks and addifferent sampling techniques for simplified abest action or policies for concrete settings. I	cribe the main features of environments. The news and algorithms for solving these problems we Bayesian networks can be employed as a knew addition, students can define decision making the state of the environment. In this context, in problems, and they can recall techniques for neous localization and mapping, and can expiration problems and decision making in a multi-arotocol, and mechanism design techniques. In this context, in problems and decision making in a multi-arotocol, and mechanism design techniques. It is context to basic optimization techniques. For those application scent basic optimization techniques. For those application scent basic optimization techniques. For those application scent basic optimization techniques. For simple queries, agent scenarios. For simple and complex decision multi-agent situations students will apply teresticion making students will apply different vot	s. For dealing with owledge represent procedures in significant students can desur measuring the value arios. For simplifications they can also students can also making students for finding the cations for finding the cations for finding the cations for finding students for finding the cations for finding students for finding the cations for finding students can find the cations for finding the cations for finding students can find the cations find the cations for finding students can find the cations find the cations for finding students can find the cations for finding students can find the cations for finding students can find the cations find the cations for finding students can find the cations for finding students can find the cations find the cations for finding students can find the cations for finding students can find the cations find	n uncertainty in ratation and reason mple and sequenceribe techniques value of informatiniques for achierm of different ty ed agent applicates also create Baye so name and and can compute g different equili
Personal Competence				
Social Competence	Students are able to discuss their solutions to	problems with others. They communicate in E	nglish	
Autonomy	Students are able of checking their understan	ding of complex concepts by solving varaints o	f concrete problen	ns
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 minutes			
scale				
Assignment for the	Computer Science: Specialisation II: Intelligen	ice Engineering: Elective Compulsory		
Following Curricula	International Management and Engineering: S	Specialisation II. Information Technology: Electiv	e Compulsory	
	Mechatronics: Technical Complementary Cour	rse: Elective Compulsory		
	Mechatronics: Specialisation Intelligent System	ms and Robotics: Elective Compulsory		
	Biomedical Engineering: Specialisation Artifici	al Organs and Regenerative Medicine: Elective	Compulsory	
	Biomedical Engineering: Specialisation Implar	nts and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medica	al Technology and Control Theory: Elective Com	pulsory	
		gement and Business Administration: Elective C		
	Theoretical Mechanical Engineering: Technica	Il Complementary Course: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialis	ation Robotics and Computer Science: Floative	Compulsory	

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

Course L0512: Intelligent Au	ourse 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 M0775: Ergor	nomics			
Courses				
Title		Тур	Hrs/wk	СР
Ergonomics (L0653)		Lecture	2	3
Module Responsible	Dr. Armin Bossemeyer			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have re-	ached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 62, Study Time in Lect	ure 28		
Credit points	3			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	International Management and Engineering: Sp	ecialisation II. Product Development and	d Production: Elective Co	ompulsory
Following Curricula	Biomedical Engineering: Specialisation Implants	·	•	
	Biomedical Engineering: Specialisation Artificial			
	Biomedical Engineering: Specialisation Manager			
	Biomedical Engineering: Specialisation Medical	Technology and Control Theory: Elective	e Compulsory	

Course L0653: Ergonomics	ourse L0653: Ergonomics		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Armin Bossemeyer		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Module M0751: Vibra	tion Theory			
Courses				
Title		Тур	Hrs/wk	СР
Vibration Theory (L0701)		Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous	Calculus			
Knowledge	Linear Algebra			
	Engineering Mechanics			
	2 Engineering Meenanies			
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	Students are able to denote terms and concepts of Vibratio	n Theory and develop them fu	ther.	
Skills	Students are able to denote methods of Vibration Theory a	nd develop them further.		
Personal Competence				
Social Competence	Students can reach working results also in groups.			
Autonomy	Students are able to approach individually research tasks in Vibration Theory.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 Hours			
scale				
Assignment for the	Energy Systems: Core qualification: Elective Compulsory			
Following Curricula	International Management and Engineering: Specialisation	II. Mechatronics: Elective Comp	oulsory	
	Mechanical Engineering and Management: Specialisation M	lechatronics: Elective Compulso	ory	
	Mechatronics: Core qualification: Compulsory			
	Biomedical Engineering: Specialisation Artificial Organs and	•		
	Biomedical Engineering: Specialisation Implants and Endop			
	Biomedical Engineering: Specialisation Medical Technology	•		
	Biomedical Engineering: Specialisation Management and B		e Compulsory	
	Product Development, Materials and Production: Core quali			
	Naval Architecture and Ocean Engineering: Core qualificati			
	Theoretical Mechanical Engineering: Technical Complemen Theoretical Mechanical Engineering: Core qualification: Ele-	•	огу	
	medietical mechanical Engineering: Core qualification: Elec	ctive 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.	

Courses				
Title		Тур	Hrs/wk	СР
Finite Element Methods (L0291)		Lecture	2	3
Finite Element Methods (L0804)		Recitation Section (large)	2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Material	s) and Mechanics II (Hydrostatics, Kinematics, Dyn	amics)	
Knowledge	Mathematics I, II, III (in particular differenti	al equations)		
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowle overview of the theoretical and methodical	edge regarding the derivation of the finite elembers of the method.	ent method and	are able to give
Skills	The students are capable to handle engineering problems by formulating suitable finite elements, assembling the correspond system matrices, and solving the resulting system of equations.			
Personal Competence Social Competence	Students can work in small groups on spec	ific problems to arrive at joint solutions.		
Autonomy	The students are able to independently solve challenging computational problems and develop own finite element routing Problems can be identified and the results are critically scrutinized.			
Workload in Hours	Independent Study Time 124, Study Time i	n Lecture 56		
Credit points				
Course achievement		Description		
	No 20 % Midterm			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Core qualification: Comp	ulsory		
Following Curricula	Energy Systems: Core qualification: Electiv	e Compulsory		
	Aircraft Systems Engineering: Specialisatio	n Aircraft Systems: Elective Compulsory		
	Aircraft Systems Engineering: Specialisatio	n Air Transportation Systems: Elective Compulsory	,	
	Aircraft Systems Engineering: Core qualific	ation: Elective Compulsory		
	International Management and Engineering	g: Specialisation II. Mechatronics: Elective Compuls	ory	
		g: Specialisation II. Product Development and Product		ompulsory
	Mechatronics: Core qualification: Compulso			
	Biomedical Engineering: Specialisation Imp			
		nagement and Business Administration: Elective Co	ompulsorv	
		dical Technology and Control Theory: Elective Com		
		ficial Organs and Regenerative Medicine: Elective		
	D.S Calcal Engineering. Specialisation Alti	5. gans and regenerative medicine. Elective	pai.50i y	
	Product Development Materials and Product	ction: Core qualification: Compulsory		
	Product Development, Materials and Produ Technomathematics: Specialisation III. Eng			

Course L0291: Finite Elemen	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 Elemen	ourse 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		

ourses				
tle		Тур	Hrs/wk	СР
chnology Management (L0849) chnology Management Seminar	(10050)	Lecture Project-/problem-based Learning	3	3
	Prof. Cornelius Herstatt	Project-/problem-based Learning	2	3
Module Responsible	None			
Admission Requirements Recommended Previous	Bachelor knowledge in business management			
Knowledge	bachelor knowledge in business management			
Educational Objectives	After taking part successfully, students have reached the following	ng learning results		
Professional Competence	The taking part succession, stade its indicated the following	ing rearring results		
	Students will gain deep insights into:			
J				
	International R&D-Management Task as least Tissian Strategies			
	Technology Timing Strategies	(141)		
	Technology Strategies and Lifecycle Management (Technology Intelligence and Planning	1/11)		
	Technology Intelligence and Planning Technology Portfolio Management			
	 Technology Portfolio Management Technology Portfolio Methodology 			
	Technology Acquisition and Exploitation			
	IP Management			
	Organizing Technology Development			
	Technology Organization & Management			
	 Technology Funding & Controlling 			
Skills	The course aims to:			
	Develop an understanding of the importance of Technology Management - on a national as well as international level			
	Equip students with an understanding of important elements of Technology Management (strategic, operations)			
	organizational and process-related aspects)		. Ta ala a al a a N	4
	Foster a strategic orientation to problem-solving within the innovation process as well as Technology Management and innovation of the company of t			
	importance for corporate strategy • Clarify activities of Technology Management (e.g. technology sourcing, maintenance and exploitation)			
	 Clarify activities of Technology Management (e.g. technology sourcing, maintenance and exploitation) Strengthen essential communication skills and a basic understanding of managerial, organizational and financial issue 			
	concerning Technology-, Innovation- and R&D-manageme			and illiancialiss
	Basic concepts, models and tools, relevant to the manage	ement of technology, R&D and in	novation	
	Innovation as a process (steps, activities and results)			
Personal Competence				
Social Competence	• Interact within a team			
	Interact within a team Raise awareness for globabl issues			
	Naise awareness for globable issues			
Autonomy	Gain access to knowledge sources			
	Discuss recent research debates in the context of Technol	logy and Innovation Managemen	+	
	Develop presentation skills	logy and innovation Management	·	
	Discussion of international cases in R&D-Management			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6	•		
Course achievement	None			
Examination	Written exam			
Examination duration and	90 minutes			
scale Assignment for the	Global Innovation Management: Core qualification: Compulsory			
Following Curricula	International Management and Engineering: Specialisation I. Elec	ctives Management: Flective Con	nnulsory	
i onowing curricula	Mechanical Engineering and Management: Specialisation Management		iipuisui y	
	Biomedical Engineering and Management. Specialisation Management		npulsory	
	Biomedical Engineering: Specialisation Artificial Organs and Rego		.p. 41501 y	
	Biomedical Engineering: Specialisation Implants and Endoprosition		orv	
	Biomedical Engineering: Specialisation Management and Busines		. ,	

Course L0849: Technology M	lanagement
Тур	Lecture
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 M	lanagement Seminar
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Beside the written exam at the end of the module, students have to give one presentation (RE) on a research paper and two presentations as part of a group discussion (GD) in the seminar in order to pass. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.
Literature	see lecture Technology Management.

Courses						
Title			Ty	ур	Hrs/wk	СР
Microsystems Technology (L0724)				ecture	2	4
Microsystems Technology (L0725)			Pr	roject-/problem-based Learning	2	2
Module Responsible						
Admission Requirements						
Recommended Previous	1, 3, 11, 1	mistry, mechanics and s	emiconductor techno	logy		
Knowledge	1					
Educational Objectives		essfully, students have r	eached the following	learning results		
Professional Competence						
Knowledge	Students are able					
	· ·	•		microstructures and especial fin more complex systems	illy methods fo	or the fabrication o
	to explain in deta	ils operation principles o	f microsensors and m	nicroactuators and		
	to discuss the pot	tential and limitation of r	nicrosystems in appli	cation.		
Skills	Students are capable					
	to analyze the feat	asibility of microsystems	,			
	 to develop proces 	ss flows for the fabricatio	on of microstructures	and		
	to apply them					
	to apply them.					
Personal Competence Social Competence		orepare and perform the	ir lab experiments in	team work as well as to preso	ent and discuss	s the results in fror
Autonomy	None					
Moddeed in 12	Independent Chiral T	mo 124 Churt Tirre ' '	actura E6			
Workload in Hours	, ,	me 124, Study Time in L	ecture 50			
Course ashievement		Form	Description			
Course achievement	Yes None	Subject theoretical practical work	andStudierenden fü	ühren in Kleingruppen ein La diskutiert die Theorie sowie o ten Kurs.	•	
Examination	Oral exam					
Examination duration and	30 min					
scale						
Assignment for the	Electrical Engineering	: Specialisation Nanoelec	ctronics and Microsys	tems Technology: Elective Co	mpulsory	
Following Curricula	Electrical Engineering	: Specialisation Medical	Technology: Elective	Compulsory		
	International Manager	ment and Engineering: S	pecialisation II. Mecha	atronics: Elective Compulsory		
		ng: Specialisation Implan				
	LBC	ng. Specialisation Medica	I Technology and Cor	ntrol Theory: Elective Compuls	sorv	
	Biomedical Engineerin	ng: Specialisation Manag	ement and Business	Administration: Elective Comperative Medicine: Elective Com	ulsory	

Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-general lithography, nano-imprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; (techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etch anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop technique plasma processes, dry etching: back sputtering, plasma etching, film stress, stiction: they and counter measurolipal man processes, etchning and alternative Techniques (sacrificial etching, film stress, stiction: they and counter measurolipal microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SUB, rapid prototyping) Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermory modulating sensors: thermor resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemone mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sen piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular resensor: operating principle and fabrication process; sensor sensor and magneto-transistor; magnetoresis sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) Chemical and Bio Sensors (thermal gas sensors: spinning current Hall sensor and magneto-transistor; magnetoresis sensors: galvanomagnetic sensor, principle of process, conductor organic semiconductor gas sensor, process, accelerometer) Chemical a
Literature	M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton:Introductory MEMS, Springer, 2010

Course L0725: Microsystems	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	

Module M0846: Contr	ol Systems Theory and Desig	jn		
Courses				
Title Control Systems Theory and Desigr Control Systems Theory and Desigr		Typ Lecture Recitation Section (small)	Hrs/wk 2 2	CP 4 2
Module Responsible	Ì	Recitation Section (Smail)	2	2
Admission Requirements				
	Introduction to Control Systems			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence Knowledge				
Skills	response to initial states or externa They can explain the system prope estimation, respectively They can explain the significance of they can explain observer-based storm are they can explain observer-based storm are they can explain the z-transform are they can explain state space mode. They can explain the experimental be solved by solving a normal equal. They can explain how a state space. Students can transform transfer fund. They can assess controllability and. They can design LQG controllers for they can carry out a controller desfor a given sampling rate. They can identify transfer function of	ate feedback and how it can be used to achieve multi-input multi-output systems and its relationship with the Laplace Transform as and transfer function models of discrete-time identification of ARX models of dynamic systems tion a model can be constructed from a discrete-time action models into state space models and vice wobservability and construct minimal realisations.	relationship to state tracking and disturt systems s, and how the ident impulse response versa domain, and decide	e feedback and state oance rejection ification problem ca
•	· ·	cific problems to arrive at joint solutions. ovided sources (lecture notes, software docum	entation, experimer	nt guides) and use
	when solving given problems.			
	They can assess their knowledge in weekly	y on-line tests and thereby control their learning	progress.	
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
Scale Assignment for the	Electrical Engineering: Core qualification:	Compulsory		
_	Electrical Engineering: Core qualification: (Energy Systems: Core qualification: Elective			
	Aircraft Systems Engineering: Core qualific Computational Science and Engineering: S International Management and Engineerin International Management and Engineerin Mechanical Engineering and Management: Mechatronics: Core qualification: Compuls: Biomedical Engineering: Specialisation Art Biomedical Engineering: Specialisation Imp Biomedical Engineering: Specialisation Me Biomedical Engineering: Specialisation Ma	cation: Elective Compulsory Specialisation II. Engineering Science: Elective Co g: Specialisation II. Electrical Engineering: Electi g: Specialisation II. Mechatronics: Elective Comp s: Specialisation Mechatronics: Elective Compulsor	ve Compulsory ve Compulsory ve Compulsory	

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

Course L0657: Control Syste	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: Produ	ction Planning & Control a	nd Digital Enterprise		
Courses				
Γitle		Тур	Hrs/wk	СР
The Digital Enterprise (L0932)		Lecture	2	2
roduction Planning and Control (L	0929)	Lecture	2	2
Production Planning and Control (L	0930)	Recitation Section (small)	1	1
xercise: The Digital Enterprise (L0	933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	Fundamentals of Production and Quality	y Management		
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Students can explain the contents of the	e module in detail and take a critical position to them	ı.	
Skills	Students are capable of choosing and a	applying models and methods from the module to indu	ustrial problems.	
Personal 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 Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 Minuten			
scale				
Assignment for the	International Management and Enginee	ring: Specialisation II. Product Development and Prod	uction: Elective Co	ompulsory
Following Curricula	Logistics, Infrastructure and Mobility: Sp	pecialisation Production and Logistics: Elective Compu	ulsory	
-	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 Com	npulsory	
	Biomedical Engineering: Specialisation	Management and Business Administration: Compulso	ry	
	Product Development, Materials and Pro	oduction: Specialisation Product Development: Electiv	e Compulsory	
	Product Development, Materials and Pro	oduction: Specialisation Production: Compulsory		
	·	oduction: Specialisation Materials: Elective Compulsor	ry	
	Theoretical Mechanical Engineering: Sp	ecialisation Product Development and Production: Ele	ctive Compulsory	
	Theoretical Mechanical Engineering: Te	chnical Complementary Course: Elective Compulsory	. ,	

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

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

Course L0930: 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	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 M0921: Elect	ronic Circuits for Medical	Applications		
Courses				
Title Electronic Circuits for Medical Appl Electronic Circuits for Medical Appl		Typ Lecture Recitation Section (small)	Hrs/wk 2 1	CP 3 2
Electronic Circuits for Medical Appl	lications (L1408)	Practical Course	1	1
Module Responsible	Prof. Matthias Kuhl			
Admission Requirements	None			
Recommended Previous	Fundamentals of electrical engineering	ng		
Knowledge				
Educational Objectives	After taking part successfully, studen	nts have reached the following learning results		
Professional Competence Knowledge	Students can explain the basic Students are able to explain the	c functionality of the information transfer by the central the build-up of an action potential and its propagation a communication between neurons and electronic devices	along an axon	
	Students can describe the spe Students can explain the funct	ecial features of low-noise amplifiers for medical applic tions of prostheses, e. g. an artificial hand he potential and limitations of cochlea implants and an	cations	
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				
Autonomy	 Students are able to realistically judge the status of their knowledge and to define actions for improvements when necessary. Students can break down their work in appropriate work packages and schedule their work in a realistic way. Students can handle the complex data structures of bioelectrical experiments without needing support. Students are able to act in a responsible manner in all cases and situations of experimental work. 			
Workload in Hours	Independent Study Time 124, Study	Time in Lecture 56		
Credit points	6			
Course achievement	Yes None Subject the practical work	Description Perfection Coretical and C		
Evanination	No None Excercises Written exam			
Examination Examination duration and				
scale				
Assignment for the		Medical Technology: Elective Compulsory		
Following Curricula		on Artificial Organs and Regenerative Medicine: Electiv	ve Compulsorv	
		on Implants and Endoprostheses: Elective Compulsory		
		on Medical Technology and Control Theory: Compulsor		
		on Management and Business Administration: Elective	•	
	Ì	Constitution Missouries Constitution of Electric		
	Microelectronics and Microsystems: 5	Specialisation Microelectronics Complements: Elective	Compulsory	
	· ·	Specialisation Microelectronics Complements: Elective Technical Complementary Course: Elective Compulsor		

Course L0696: Electronic Circ	cuits 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: Electronic Circ	cuits for Medical Applications
Тур	Practical Course
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Matthias Kuhl
Language	EN
Cycle	WiSe
Content	 Market for medical instruments Membrane potential, action potential, sodium-potassium pump Information transfer by the central nervous system Interface tissue - electrode Amplifiers for medical applications, analog-digital converters Examples for electronic implants Artificial eye, cochlea implant
Literature	Kim E. Barret, Susan M. Barman, Scott Boitano and Heddwen L. Brooks Ganong's Review of Medical Physiology, 24nd Edition, McGraw Hill Lange, 2010 Tier- und Humanphysiologie: Eine Einführung von Werner A. Müller (Author), Stephan Frings (Author), 657 p., 4. editions, Springer, 2009 Robert F. Schmidt (Editor), Hans-Georg Schaible (Editor) Neuro- und Sinnesphysiologie (Springer-Lehrbuch) (Paper back), 488 p., Springer, 2006, 5. Edition, currently online only Russell K. Hobbie, Bradley J. Roth, Intermediate Physics for Medicine and Biology, Springer, 4th ed., 616 p., 2007 Vorlesungen der Universität Heidelberg zur Tier- und Humanphysiologie: http://www.sinnesphysiologie.de/gruvo03/gruvoin.htm Internet: http://butler.cc.tut.fi/~malmivuo/bem/bembook/

Module M1150: Conti	nuum Mechanics			
Courses				
Title		Тур	Hrs/wk	СР
Continuum Mechanics (L1533)		Lecture	2	3
Continuum Mechanics Exercise (L1	534)	Recitation Section (small)	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous	Basics of linear continuum mechanics as taught, e.g., in	the module Mechanics II (forces and	l moments, stres	ss, linear strain, free-
Knowledge	body principle, linear-elastic constitutive laws, strain ene	rgy).		
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge				
	The students can explain the fundamental concepts to ca	lculate the mechanical behavior of n	naterials.	
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				
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 in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min			
scale				
Assignment for the	Materials Science: Specialisation Modeling: Elective Comp	oulsory		
Following Curricula	Mechanical Engineering and Management: Specialisation	Materials: Elective Compulsory		
	Mechatronics: Technical Complementary Course: Elective	Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs a	nd Regenerative Medicine: Elective C	Compulsory	
	Biomedical Engineering: Specialisation Implants and End			
	Biomedical Engineering: Specialisation Medical Technology		-	
	Biomedical Engineering: Specialisation Management and		mpulsory	
	Product Development, Materials and Production: Core que			
	Theoretical Mechanical Engineering: Technical Compleme			
	Theoretical Mechanical Engineering: Core qualification: E	lective Compulsory		

Course L1533: Continuum Me	echanics	
Тур	Lecture	
	2	
·	3	
	Independent Study Time 62, Study Time in Lecture 28 Prof. Christian Cyron	
	Prof. Christian Cyron	
	DE Wise	
Cycle	WISE	
Content	Fundamentals of tensor calculus	
	Transformation invariance	
	Tensor algebra	
	Tensor analysis	
	Kinematics	
	Motion of continuum	
	 Deformation of infinitesimal line, area and volume elements 	
	Material and spatial description	
	Polar decomposition	
	Spectral decomposition	
	Objectivity	
	Strain measures	
	Time derivatives	
	 Partial / material time derivatives 	
	Objective time rates	
	Strain and deformation rates	
	Transport theorems	
	Balance equations (global and local form)	
	Balance of mass	
	The stress state	
	Surface traction vectors	
	Cauchy's fundamental theorem	
	 Stress tensors (Cauchy, 1. and 2. Piola-Kirchhoff, Kirchhoff stress tensor) 	
	Balance of linear momentum	
	Balance of angular momentum	
	Balance of energy Palance of entrany	
	Balance of entropy Claudius Duham inequality	
	Clausius-Duhem inequality Constitutive laws	
	Constitutive laws Constitutive assumptions	
	Fluids	
	Elastic solids	
	Hyperelasticity	
	Material symmetry	
	Elasto-plastic solids	
	• Analysis	
	Initial-boundary value problems and their numerical solution	
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker	
	I-S. Liu: Continuum Mechanics, Springer	
	weitere siehe in der Literaturliste des Scripts	

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	
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: Mate	rials Modeling
Courses	
Title	Typ Hrs/wk CP
Material Modeling (L1535)	Lecture 2 3
Material Modeling (L1536)	Recitation Section (small) 2 3
Module Responsible	Prof. Christian Cyron
Admission Requirements	None
Recommended Previous	Basics of linear and nonlinear continuum mechanics as taught, e.g., in the modules Mechanics II and Continuum Mechanics (force
Knowledge	and moments, stress, linear and nonlinear strain, free-body principle, linear and nonlinear constitutive laws, strain energy)
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can explain the fundamentals of multidimensional consitutive material 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	
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 solv
	problems in the area of materials modeling and acquire the knowledge required to this end.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
Examination	
Examination duration and	
scale	
Assignment for the	Materials Science: Specialisation Modeling: Elective Compulsory
Following Curricula	
-	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: Specialisation Materials Science: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

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

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

Module M1199: Advar	nced Functional Materials
Courses	
Title	Typ Hrs/wk CP
Advanced Functional Materials (L16	Seminar 2 6
Module Responsible	Prof. Patrick Huber
Admission Requirements	None
Recommended Previous	Basic knowledge in Materials Science, e.g. Materials Science I/II
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students will be able to explain the properties of advanced materials along with their applications in technology, in particul
	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 no
	materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview
	modern materials science, which enables them to select optimum materials combinations depending on the technic
	applications.
Personal Competence	
·	The students are able to present solutions to specialists and to develop ideas further.
Social competence	The state his the table to present solutions to specialists and to develop facus farther.
Autonomy	The students are able to
	assess their own strengths and weaknesses.
	gather new necessary expertise by their own.
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Credit points	
Course achievement	
Examination	
Examination duration and	
scale	
Assignment for the	Materials Science: Core qualification: Compulsory
Following Curricula	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 Fur	Course L1625: Advanced Functional Materials		
Тур	Seminar		
Hrs/wk	2		
СР	6		
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28		
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Christian Cyron		
Language	DE		
Cycle	WiSe		
Content	1. Porous Solids - Preparation, Characterization and Functionalities		
	2. Fluidics with nanoporous membranes		
	3. Thermoplastic elastomers		
	4. Optimization of polymer properties by nanoparticles		
	5. Fiber composites in automotive		
	6. Modeling of materials based on quantum mechanics		
	7. Biomaterials		
Literature	Aktuelle Publikationen aus der Fachliteratur werden während der Veranstaltung bekanntgegeben.		

	I: Introduction to Biochemis			
Courses				
Title		Тур	Hrs/wk CP	
Introduction to Biochemistry and M	olecular Biology (L0386)	Lecture	2 3	
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
	After taking part successfully, students h	have reached the following learning results		
Professional Competence				
Knowledge	The students can			
	 describe basic biomolecules; 			
	 explain how genetic information is 	s coded in the DNA;		
	 explain the connection between D 	DNA and proteins;		
Skille	The students can			
SKIIIS	The students can			
	 recognize the importance of mole 	cular parameters for the course of a disease;		
	 describe selected molecular-diagr 	nostic procedures;		
	explain the relevance of these pro	ocedures for some diseases		
Personal Competence				
	The students can participate in discussion	ons in research and medicine on a technical leve	el.	
Autonomy	The students can develop understanding	g of topics from the course, using technical liter	ature, by themselves.	
Workload in Hours	Independent Study Time 62, Study Time	in Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 minutes			
scale				
Assignment for the	General Engineering Science (German p	rogram, 7 semester): Specialisation Biomedical	Engineering: Compulsory	
Following Curricula	General Engineering Science (German	n program, 7 semester): Specialisation Mech	hanical Engineering, Focus Biomech	nanics
	Compulsory			
	Data Science: Specialisation Medicine: C	Compulsory		
	Electrical Engineering: Specialisation Me	dical Technology: Elective Compulsory		
	Engineering Science: Specialisation Bion	nedical Engineering: Compulsory		
	General Engineering Science (English pro	ogram, 7 semester): Specialisation Biomedical I	Engineering: Compulsory	
	General Engineering Science (English	program, 7 semester): Specialisation Mech	nanical Engineering, Focus Biomech	ianics
	Compulsory			
	Mechanical Engineering: Specialisation E			
		Management and Business Administration: Elect		
		Artificial Organs and Regenerative Medicine: Ele	• •	
		Medical Technology and Control Theory: Elective		
		mplants and Endoprostheses: Elective Compulsor	or y	
	reciniomathematics: Specialisation III. E	ngineering Science: Elective Compulsory		

Course I 0386: Introduction t	to Biochemistry and Molecular Biology
	Lecture Lecture
Hrs/wk	
CP	
	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Hans-Jürgen Kreienkamp
Language	DE
Cycle	WiSe
Content	
Literature	Müller-Esterl, Biochemie, Spektrum Verlag, 2010; 2. Auflage
	Löffler, Basiswissen Biochemie, 7. Auflage, Springer, 2008

Module M1334: BIO II	: Biomaterials			
Courses				
Title		Тур	Hrs/wk	СР
Biomaterials (L0593)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	Basic knowledge of orthopedic and surgical techniqu	es is recommended.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	The students can describe the materials of the huma	an body and the materials being use	d in medical engineerir	ng, and their fields of
	use.			
Skille	The students can explain the advantages and disadv	vantages of different kinds of hioma	-orials	
Skills	The students can explain the advantages and disadv	rantages of anterent kinds of biolital	eriais.	
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	r own. They can also judge the infor	mation with respect to	its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 2	28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	International Management and Engineering: Speciali	sation II. Process Engineering and B	iotechnology: Elective (Compulsory
Following Curricula	$\label{eq:Materials} \textbf{Materials Science: Specialisation Nano and Hybrid M}$	• •		
	Biomedical Engineering: Specialisation Artificial Orga	•	tive Compulsory	
	Biomedical Engineering: Specialisation Implants and			
	Biomedical Engineering: Specialisation Medical Tech	• • • • • • • • • • • • • • • • • • • •		
	Biomedical Engineering: Specialisation Management			
	Theoretical Mechanical Engineering: Technical Comp	,	•	
	Theoretical Mechanical Engineering: Specialisation B	io- and Medical Technology: Elective	e Compulsory	

ourse L0593: Biomaterials	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Michael Morlock
Language	EN
-	WiSe Tapies to be sourced include:
Content	Topics to be covered include: 1. Introduction (Importance, nomenclature, relations)
	Biological materials
	2.1 Basics (components, testing methods)
	2.2 Bone (composition, development, properties, influencing factors)
	2.3 Cartilage (composition, development, structure, properties, influencing factors)
	2.4 Fluids (blood, synovial fluid)
	3 Biological structures
	3.1 Menisci of the knee joint
	3.2 Intervertebral discs
	3.3 Teeth
	3.4 Ligaments
	3.5 Tendons
	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 ar used for replacements in-vivo). Acquisition of basics for theses work in the area of biomechanics.
Literature	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
	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.

Module M1342: Polyn				
Courses				
Title		Тур	Hrs/wk	СР
Structure and Properties of Polyme	rs (L0389)	Lecture	2	3
Processing and design with polyme	rs (L1892)	Lecture	2	3
Module Responsible	Dr. Hans Wittich			
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / material scien	nce		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students can use the knowledge of plastic	s and define the necessary testing and analy	/sis.	
	They can explain the complex relationship	s structure-property relationship and		
		ne polymers, including to explain neighboring	g contexts (e.g. sustaina	bility, environment
	protection).			
Skills	Students are capable of			
	- using standardized calculation method	s in a given context to mechanical prope	arties (modulus streng	th) to calculate a
	evaluate the different materials.	s in a given context to mechanical prope	critics (modulus, streng	til) to calculate al
	- selecting appropriate solutions for mech	anical recycling problems and sizing example	e stiffness, corrosion res	sistance.
Personal Competence				
Social Competence				
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
	- arrive at funded work results in heteroge	nius groups and document them.		
	- provide appropriate feedback and handle feedback on their own performance constructively.			
Autonomy	Students are able to			
	- assess their own strengths and weakness	5,95		
	- assess their own strengths and weaknesses.			
	- assess their own state of learning in spec	cific terms and to define further work steps o	n this basis.	
	- assess possible consequences of their pr	ofessional activity.		
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Materials Science: Specialisation Engineer			
Following Curricula	Biomedical Engineering: Specialisation Imp	plants and Endoprostheses: Compulsory ificial Organs and Regenerative Medicine: Ele	active Compulsory	
	3 3 1	nagement and Business Administration: Elec	' '	
		dical Technology and Control Theory: Electiv		
	• • •	uction: Specialisation Production: Elective Co		
		action: Specialisation Materials: Elective Com		
	·	action: Specialisation Product Development:		
	·	nical Complementary Course: Elective Compu		
	Theoretical Mechanical Engineering: Speci	alisation Materials Science: Elective Compuls	sorv	

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	
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 an	d 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

C					
Courses					
Title			Тур	Hrs/wk	СР
Regenerative Medicine (L0347) Lecture Tissue Engineering - Reger	nerative Medicine (I 166)	Seminar Seminar	2	3 3
Module Responsible		7	Schillar		3
Admission Requirements					
Recommended Previous					
Knowledge	None				
Educational Objectives	After taking part suc	essfully students have re	eached the following learning results		
Professional Competence	Arter taking part suc	essiany, students have re	active the following learning results		
	After successful completion of the module students will be able to describe the basic methods of regenerative medicine an explain the use of the tissue cells for different methods of tissue engineering. They are able to give a basic overview of methoc the cultivation of animal and human cells.				
	The students can outline the actual concepts of Tissue Engineering and regenerative medicine and can explain the building principles of the discussed topics.				n explain the ba
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	defend them.		with 2-4 students to solve given tasks ar		in the plenary and
Autonomy	*	this module, participanting a presentation of the r	cs will be able to solve a technical presults.	problem in teams of a	approx. 2-4 perso
Workload in Hours	Independent Study 1	me 124, Study Time in Le	ecture 56		
Credit points					
Course achievement		Form	Description		
	Yes 20 %	Written elaboration	Ausarbeitung zu Ringvorlesung / pro	otocol for lecture series	
Examination	Presentation				
Examination duration and	Oral presentation +	liscussion (30 min)			
scale					
Assignment for the	Biomedical Engineer	ng: Specialisation Implant	s and Endoprostheses: Elective Compuls	sory	
Following Curricula	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Compulsory				
	Biomedical Engineer	ng: Specialisation Manage	ement and Business Administration: Elect	tive Compulsory	
	Biomedical Engineer	ng: Specialisation Medical	Technology and Control Theory: Elective	e 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
Cycle	WiSe
Content	The course deals with the application of biotechnological engineering principles for re-generation of human tissues. The main topics are "tissue engineering" for the generation of "artificial organs" such as cartilage, liver, blood vessel etc., and their applications: Introduction (historical development, examples for medical and technical applications, commercial aspets) Cell specific fundamentals (cell physiology, biochemistry, metabolism, special requirements for cell cultivation "in vitro") Process specific fundamentals (requirements for culture systems, examples for reactor design, mathematical modelling, process and control strategies) Examples for applications for clinical applications, drug testing and material testing The fundamentals will be presented by the lecturers.
	The "state of the art" of specific applications will be exploited by the students based on selected papers and presented during the course.
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum ; Academic Pr Inc; ISBN-10: 0123693713 , ISBN-13: 978- 0123693716
	Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-3540777540

Course L1664: Lecture Tissue	e 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 M1333: BIO I:	Implants and Fracture Healing
Courses	
Title	Typ Hrs/wk CP
Implants and Fracture Healing (L03	376) Lecture 2 3
Module Responsible	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous	It is recommended to participate in "Introduction into Anatomie" before attending "Implants and Fracture Healing".
Knowledge	
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 their existence.
	The students can name different treatments for the spine and hollow bones under given fracture morphologies.
Ckilla	The students can determine the forces acting within the human body under guasi-static situations under specific assumptions.
SKIIIS	The students can determine the forces acting within the number body under quasi-static situations under specific assumptions.
Personal Competence	
Social Competence	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.
Autonomy	The students can in groups, salue basis numerical modeling tasks for the calculation of internal forces
Autonomy	The students can, in groups, solve basic numerical modeling tasks for the calculation of internal forces.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	90 min
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
Following Curricula	Compulsory
	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechan
	Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Orientation Studies: Core qualification: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory
	recurromatiematics. Specialisation III. Engineering Science: Elective Compulsory

Course L0376: Implants and	Fracture Healing
Тур	Lecture
Hrs/wk	
СР	
	Independent Study Time 62, Study Time in Lecture 28
Language	Prof. Michael Morlock DE
Cycle	
Content	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)
	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
Literature	Cochran V.B.: Orthopädische Biomechanik
Eiterature	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine
	Nigg, B.: Biomechanics of the musculo-skeletal system
	Schiebler T.H., Schmidt W.: Anatomie
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat
	. tateer, act reads act rendestine, band a betraggingsapparate

Module M0630: Robot	tics and Naviga	tion in Medicine			
Courses					
Title Robotics and Navigation in Medicin Robotics and Navigation in Medicin	e (L0338)		Typ Lecture Project Seminar	Hrs/wk 2 2	CP 3 2
Robotics and Navigation in Medicin	e (L0336)		Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schla	efer			
Admission Requirements	None				
Recommended Previous Knowledge	 principles of math (algebra, analysis/calculus) principles of programming, e.g., in Java or C++ solid R or Matlab skills 				
Educational Objectives	After taking part succ	essfully, students have reac	hed the following learning results		
	detail. Systems can systems regarding de	be evaluated with respect sign and limitations.	ng systems in clinical contexts and illus to collision detection and safety and r igation systems and robotic systems for r	egulations. Student	s can assess typical
,	The students discuss the results of other groups, provide helpful feedback and can incoorporate feedback into their work. 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 Lectu	ure 70		
Credit points	6				
Course achievement	Compulsory Bonus Yes 10 % Yes 10 %	Form Written elaboration Presentation	Description		
Examination	Written exam				
Examination duration and	90 minutes				
scale					
Assignment for the	Computer Science: Sp	pecialisation II: Intelligence E	Engineering: Elective Compulsory		
Following Curricula	International Manage International Manage Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Product Development Product Development Product Development Theoretical Mechanic	ment and Engineering: Speciment and Engineering: Specilisation Intelligent Systems and Engis Specialisation Artificial Ong: Specialisation Implants and Engis Specialisation Medical Teng: Specialisation Medical Teng: Specialisation Management, Materials and Production: 5, Materials and Production: 5, Materials and Production: 6, Materials and Production: 6, Materials and Production: 6, Materials and Production: 6 al Engineering: Technical Co	hnology: Elective Compulsory ialisation II. Electrical Engineering: Electiv ialisation II. Process Engineering and Biot and Robotics: Elective Compulsory irgans and Regenerative Medicine: Electiv and Endoprostheses: Elective Compulsory echnology and Control Theory: Elective Co ent and Business Administration: Elective Especialisation Product Development: Elective Especialisation Production: Elective Compulsory process and Materials: Elective Compulsory implementary Course: Elective Compulsory in Bio- and Medical Technology: Elective Compulsory in Bio- and Medical Technology: Elective Compulsory	echnology: Elective re Compulsory compulsory Compulsory tive Compulsory elsory sory	Compulsory

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

Course L0338: Robotics and	urse 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 M1384: Case	Studies for Regenerative Med	icine and Tissue Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Case Studies for Regenerative Med	icine and Tissue Engineering (L1963)	Seminar	3	6
Module Responsible	Prof. Ralf Pörtner			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 138, Study Time in	Lecture 42		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	45 min			
scale				
Assignment for the	Biomedical Engineering: Specialisation Artifi	cial Organs and Regenerative Medicine: Com	pulsory	
Following Curricula	Biomedical Engineering: Specialisation Impla	' '	,	
		agement and Business Administration: Electiv		
	Biomedical Engineering: Specialisation Medi	cal Technology and Control Theory: Elective	Compulsory	

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

Module M0634: Introd	duction into M	edical Technology	and System	าร		
Courses						
Title				Тур	Hrs/wk	СР
Introduction into Medical Technolog	gy and Systems (L0342)		Lecture	2	3
Introduction into Medical Technolog	gy and Systems (L0343)		Project Seminar	2	2
Introduction into Medical Technolog	gy and Systems (L1876)		Recitation Section (large)	1	1
Module Responsible	Prof. Alexander Schl	aefer				
Admission Requirements	None					
Recommended Previous	principles of math (a	ilgebra, analysis/calculus)				
Knowledge	principles of stocha	stics				
	principles of prograr	nming, R/Matlab				
Educational Objectives	After taking part suc	cessfully, students have r	eached the followi	ng learning results		
Professional Competence	31			<u> </u>		
Knowledge	The students can e	xplain principles of medi	cal technology, in	ncluding imaging systems,	computer aided s	urgery, and medical
	information systems	. They are able to give an	overview of regula	atory affairs and standards i	n medical technolo	ogy.
G1.111						
Skills	The students are ab	le to evaluate systems and	d medical devices	in the context of clinical app	lications.	
Personal Competence						
Social Competence	The students describ	pe a problem in medical te	chnology as a proj	ject, and define tasks that a	re solved in a joint	effort.
A 1						
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.					
	manner.					
Workload in Hours	Independent Study	Γime 110, Study Time in L	ecture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes 10 %	Presentation				
=	Yes 10 %	Written elaboration				
Examination	Written exam					
Examination duration and scale	90 minutes					
Assignment for the	Conoral Engineering	Science (Corman program	n 7 comostor): En	ecialisation Biomedical Engi	nooring: Compuls	on.
Following Curricula				eering: Elective Compulsory	neering. Compuise	лу
r onowing curricula	·			ng Science: Elective Compul	sorv	
	-	qualification: Elective Com		.g	,	
		g: Core qualification: Elec				
	Engineering Science	: Specialisation Biomedica	l Engineering: Con	mpulsory		
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory					
	Computational Scier	nce and Engineering: Spec	ialisation II. Mathe	matics & Engineering Science	e: Elective Compu	ılsory
	Biomedical Engineer	ing: Specialisation Artificia	al Organs and Reg	enerative Medicine: Elective	Compulsory	
	•		•	eses: Elective Compulsory		
	_			Control Theory: Elective Con		
	_			ss Administration: Elective C	compulsory	
	Technomathematics	: Specialisation III. Engine	ering Science: Elec	ctive Compulsory		

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

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

Course L1876: Introduction i	nto 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: Nonlin	near Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Dynamics (L0702)		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 fo	ollowing learning results		
Professional Competence				
	Students are able to reflect existing terms and concepts concepts.	·	·	
	Students are able to apply existing methods and procesure	s of Nonlinear Dynamics and to	develop novel meth	loas and procedures.
Personal Competence	Students can reach working results also in groups			
· ·	Students can reach working results also in groups. Students are able to approach given research tasks individe	vally and to identify and follow	un novel recearch ta	sks by thomsolves
-	Independent Study Time 124, Study Time in Lecture 56	daily and to identify and follow	up nover research ta	sks by themselves.
Credit points	, , ,			
Course achievement				
Examination				
Examination duration and				
scale	2 110413			
	Aircraft Systems Engineering: Core qualification: Elective C	ompulsorv		
•			oulsory	
	Mechanical Engineering and Management: Specialisation M	echatronics: Elective Compulso	ory	
	Mechatronics: Specialisation System Design: Elective Comp	oulsory		
	Mechatronics: Specialisation Intelligent Systems and Robot	ics: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs and	Regenerative Medicine: Electi	ve Compulsory	
	Biomedical Engineering: Specialisation Implants and Endop	rostheses: Elective Compulsory	1	
	Biomedical Engineering: Specialisation Medical Technology	•		
	Biomedical Engineering: Specialisation Management and Br		Compulsory	
	Product Development, Materials and Production: Core quali			
	Theoretical Mechanical Engineering: Technical Complemen	•	ry	
	Theoretical Mechanical Engineering: Core qualification: Elec	ctive Compulsory		

Course L0702: Nonlinear Dyr	ourse 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	CP
Semiconductor Technology (L0722 Semiconductor Technology (L0723		Lecture Practical Course	4 2	4 2
Module Responsible		Fractical Course	2	2
Admission Requirements				
Recommended Previous		aductor devices		
Knowledge	basics in physics, chemistry, material science and semico	iddetor devices		
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence	,			
Knowledge				
	Students are able			
	Students are able			
	to describe and to explain current fabrication techniq	ues for Si and GaAs substrates	,	
	to discuss in details the relevant fabrication price.	ocesses, process flows and t	the impact thereof o	n the fabrication
	semiconductor devices and integrated circuits and		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
	to present integrated process flows.			
Skills				
Skills				
	Students are capable			
	to analyze the impact of process parameters on the p	rocessing results,		
	to select and to evaluate processes and			
	to select und to evaluate processes and			
	to develop process flows for the fabrication of semico	nductor devices.		
Personal Competence				
Social Competence				
	Students are able to prepare and perform their lab experi	ments in team work as well as	to present and discus	s the results in fro
	of audience.			
4.4	N			
Autonomy				
Credit points	Independent Study Time 96, Study Time in Lecture 84			
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the	1			
Following Curricula	3 3 1	•		
	Biomedical Engineering: Specialisation Implants and Endo Biomedical Engineering: Specialisation Medical Technolog	•	•	
	Biomedical Engineering: Specialisation Management and	•		
	Microelectronics and Microsystems: Core qualification: Ele			

Hrs/wk 4 CP 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, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski , Bridgeman and float z Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: react influences on growth rate, process technology and equipment, anodic oxidation, plasma oxidation, thermal	profile, highe
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, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski , Bridgeman and float z Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions.)	profile, highe
Workload in Hours Lecturer Prof. Hoc Khiem Trieu DE/EN Cycle SoSe Content Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski , Bridgeman and float z Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactive contents and oxide charges.	profile, highe
Language DE/EN Cycle SoSe Content Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski , Bridgeman and float z Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions.	profile, highe
Cycle SoSe Content Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski , Bridgeman and float z Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions.)	profile, highe
Content Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski, Bridgeman and float z Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: react	profile, highe
 Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski, Bridgeman and float z Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions.) 	profile, highe
 GaAs) Deposition techniques (theory: nucleation, film growth and structure zone model, film growth process, reatemperature dependence and equipment; epitaxy: gas phase, liquid phase, molecular beam epitaxy; CV APCVD, LPCVD, deposition of metal silicide, PECVD and LECVD; basics of plasma, equipment, PVD techniques evaporation, sputtering) Structuring techniques (subtractive methods, photolithography: resist properties, printing techniques: cont 	al oxidation of action kinetics /D techniques s: high vacuur
and projection printing, resolution limit, practical issues and equipment, additive methods: liftoff the electroplating, improving resolution: excimer laser light source, immersion lithography and phase shift lithography beam lithography, X-ray lithography, EUV lithography, ion beam lithography, wet chemical etching: anisotropic, corner undercutting, compensation masks and etch stop techniques; dry etching: plasma enhabacksputtering, ion milling, chemical dry etching, RIE, sidewall passivation) • Process integration (CMOS process, bipolar process) • Assembly and packaging technology (hierarchy of integration, packages, chip-on-board, chip assembly, elections, TAB and flip chip, wafer level package, 3D stacking)	technique an raphy, electro isotropic an anced etching
Literature 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, Teubn	ner Verlag
K. Schade: Mikroelektroniktechnologie, Verlag Technik Berlin	
K. Schade: Mikroelektroniktechnologie, Verlag Technik Berlin S. Campbell: The Science and Engineering of Microelectronic Fabrication, Oxford University Press	

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: Huma	noid Robotics			
Courses				
Title		Тур	Hrs/wk	СР
Humanoid Robotics (L0663)		Seminar	2	2
Module Responsible	Patrick Göttsch			
Admission Requirements	None			
Recommended Previous				
Knowledge	Introduction to control systems			
	Control theory and design			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	 Students can explain humanoid robots. 			
	Students learn to apply basic control concepts for	or different tasks in humanoid r	obotics.	
Skills				
	Students acquire knowledge about selected asp		ed on specified literature	
	 Students generalize developed results and present them to the participants Students practice to prepare and give a presentation 			
	• Students practice to prepare and give a present	ation		
Personal Competence				
Social Competence	Students are capable of developing solutions in	interdisciplinary teams and pre-	sent them	
	They are able to provide appropriate feedback a			
Autonomy	 Students evaluate advantages and drawbacks 	of different forms of present	ation for specific tasks a	and select the best
	solution			
	 Students familiarize themselves with a scientification 	c field, are able of introduce it	and follow presentation	s of other students,
	such that a scientific discussion develops			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Credit points	2			
Course achievement	None			
Examination	Presentation			
Examination duration and	30 min			
scale				
Assignment for the	Mechatronics: Specialisation Intelligent Systems and R	, ,		
Following Curricula	Mechatronics: Specialisation System Design: Elective C		la ativa Camanula and	
	Biomedical Engineering: Specialisation Artificial Organs Biomedical Engineering: Specialisation Implants and Er	•		
	Biomedical Engineering: Specialisation Implants and El Biomedical Engineering: Specialisation Medical Techno	·	•	
	Biomedical Engineering: Specialisation Management at			
	Theoretical Mechanical Engineering: Technical Comple			
	Theoretical Mechanical Engineering: Specialisation Rob		•	
	3 3 1	•	. ,	

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

Module M0838: Linea	r and Nonlinear System Iden	tifikation		
Courses				
Title Linear and Nonlinear System Identii	fication (L0660)	Typ Lecture	Hrs/wk	CP 3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	 Classical control (frequency response) State space methods Discrete-time systems Linear algebra, singular value decoil Basic knowledge about stochastic p 	mposition		
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
·	nonlinear model structures They can explain how multilayer pe They can explain how an approxima They can explain the idea of subspa Students are capable of applying models for dynamic systems They are capable of implementing a They are capable of applying subsp They can do the above using standa	framework of the prediction error method an inceptron networks are used to model nonline ate predictive control scheme can be based of ace identification and its relation to Kalman reactive prediction error method to the experimental annollinear predictive control scheme based of ace algorithms to the experimental identifical and software tools (including the Matlab System ecific problems to arrive at joint solutions.	ar dynamics In neural network model Italiaation theory Italiaation of Italiaation of Italiaation a neural network model Italiaation of linear models for Italiaation Toolbo	linear and nonlinea del dynamic systems x)
	solve given problems.			
	Independent Study Time 62, Study Time in	1 Lecture 28		
Credit points				
Course achievement				
Examination				
Examination duration and scale	30 min			
Assignment for the	Electrical Engineering: Specialisation Cont	rol and Power Systems Engineering: Elective	Compulsory	
Following Curricula	Biomedical Engineering: Specialisation Im Biomedical Engineering: Specialisation Me Biomedical Engineering: Specialisation Ma	gn: Elective Compulsory ificial Organs and Regenerative Medicine: Ele plants and Endoprostheses: Elective Compuls dical Technology and Control Theory: Compu nagement and Business Administration: Elect nical Complementary Course: Elective Compu	ory Isory iive Compulsory	

Course L0660: Linear and No	ourse 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 Control (L0658 Optimal and Robust Control (L0659		Lecture Recitation Section (small)	2	3
Module Responsible		.teeteaton seetion (s.maii)		
Admission Requirements				
Recommended Previous				
Knowledge	Classical control (frequency respons	se, root locus)		
	State space methods			
	Linear algebra, singular value decor	nposition		
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	Chudanta and avalain the significance		£10	
		e of the matrix Riccati equation for the solution of		
		en optimal state feedback and optimal state estimen. -infinity norms are used to represent stability and		ctrainte
		n problem can be formulated as special case of a		
		tainty can be represented in a way that lends itse		
	They can explain how - based on the control of	ne small gain theorem - a robust controller can g	juarantee stability	and performance
	an uncertain plant.			
	They understand how analysis and s	synthesis conditions on feedback loops can be rep	presented as linear	r matrix inequalitie
Skills				
Skins		nd tuning LQG controllers for multivariable plant	models.	
		H2 or H-infinity design problem in the form of a g	eneralized plant, a	and of using stand
	software tools for solving it.			
		e and frequency domain specifications for contr	ol loops into const	traints on closed-l
	sensitivity functions, and of carrying			
 They are capable of constructing an LFT uncertainty model for an uncertain system, and of design robust controller. 			ng a mixed-object	
		alysis and synthesis conditions as linear matrix in	nequalities (LMI) a	and of using stand
	 They are capable of formulating analysis and synthesis conditions as linear matrix inequalities (LMI), and LMI-solvers for solving them. 			and or asing stand
	They can carry out all of the above using standard software tools (Matlab robust control toolbox).			
Personal Competence	Students can work in small groups on spec	rific problems to arrive at joint solutions		
	e Students can work in small groups on specific problems to arrive at joint solutions. Y Students are able to find required information in sources provided (lecture notes, literature, software documentation) and use it			
Autonomy	solve given problems.	tion in sources provided (lecture notes, literature	, software docume	entation) and use i
	solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points	, , , , , , , , , , , , , , , , , , , ,			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Flactrical Engineering: Specialisation Cont.	rol and Power Systems Engineering: Elective Com	nulsony	
Following Curricula			puisory	
•	Aircraft Systems Engineering: Core qualific	' '		
	Mechatronics: Specialisation Intelligent Sys	stems and Robotics: Elective Compulsory		
	Mechatronics: Specialisation System Desig	n: Elective Compulsory		
	Biomedical Engineering: Specialisation Arti	ificial Organs and Regenerative Medicine: Elective	e Compulsory	
	Biomedical Engineering: Specialisation Imp	plants and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Med	dical Technology and Control Theory: Elective Co	mpulsory	
	Biomedical Engineering: Specialisation Mai	nagement and Business Administration: Elective (Compulsory	
	Product Development, Materials and Produ	action: Specialisation Product Development: Electi	ive Compulsory	
	Product Development, Materials and Produ	action: Specialisation Production: Elective Compul	sory	
	Product Development, Materials and Produ Product Development, Materials and Produ	·	sory	

Course L0658: Optimal 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 F	rse 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		

Module M0855: Marko	eting (Sales and Services / Innovation Mark	eting)		
Courses				
Title		Тур	Hrs/wk	СР
Marketing of Innovations (L2009)		Lecture	4	4
PBL Marketing of Innovations (L086	52)	Project-/problem-based Learning	1	2
Module Responsible	Prof. Christian Lüthje			
Admission Requirements	None			
Recommended Previous	Module International Business			
Knowledge	Basic understanding of business administration prince	inles (strategic planning decision	on theory proj	ect management
	international business)	ipies (strategie pianining, accisio	on encory, proj	tee management,
	Bachelor-level Marketing Knowledge (Marketing Instrument)	ents, Market and Competitor Strate	egies, Basics of	Buying Behavior)
	Unerstanding the differences beweetn B2B and B2C mar	keting		
	Understanding of the importance of managing innovation	n in global industrial markets		
	Good English proficiency; presentation skills			
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence	The calling part succession, seadenes have reached the follow	g rearming results		
Knowledge	Students will have gained a deep understanding of			
	Specific characteristics in the marketing of innovative po			
	Approaches for analyzing the current market situation at The gathering of information about future systems, page			
	 The gathering of information about future customer need Concepts and approaches to integrate lead users and the 		dovolonment n	rococcoc
	Approaches and tools for ensuring customer-orientation			
	Marketing mix elements that take into consideration the second con			
	services		3	·
	Pricing methods for new products and services			
	The organization of complex sales forces and personal sets.	elling		
	Communication concepts and instruments for new produ	icts and services		
Skills	Based on the acquired knowledge students will be able to:			
	Design and to evaluate decisions regarding marketing as	nd innovation strategies		
	Analyze markets by applying market and technology por	tfolios		
	Conduct forecasts and develop compelling scenarios as	a basis for strategic planning		
	Translate customer needs into concepts, prototypes an	d marketable offers and successf	ully apply adva	nced methods for
	customer-oriented product and service development			
	Use adequate methods to foster efficient diffusion of inn			
	 Choose suitable pricing strategies and communication activities for innovations Make strategic sales decisions for products and services (i.e. selection of sales channels) 			
	Apply methods of sales force management (i.e. custome)			
	7, Apply methods of sales force management (i.e. editorie	value allalysis/		
Personal Competence				
Social Competence	The students will be able to			
	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 oth	ner new complex	x problem fields
	Consider proposed business actions in the field of market			
	Independent Study Time 110, Study Time in Lecture 70			
Credit points Course achievement				
	Subject theoretical and practical work			
Examination duration and				
scale	production, craft participation			
Assignment for the	Global Technology and Innovation Management & Entrepreneu	rship: Core qualification: Compulso	ory	
Following Curricula	International Management and Engineering: Specialisation I. Ele	ectives Management: Elective Con	npulsory	
	Mechanical Engineering and Management: Specialisation Mana	gement: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs and Re	generative Medicine: Elective Com	pulsory	
	Biomedical Engineering: Specialisation Implants and Endoprost			
	Biomedical Engineering: Specialisation Medical Technology and		ory	
	Biomedical Engineering: Specialisation Management and Busin	ess Administration: Compulsory		

Course L2009: Marketing of	Innovations	
_	Lecture	
Hrs/wk	4	
СР	4	
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56	
Lecturer		
Language		
Cycle Content	SoSe I. Introduction	
	 Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing) 	
	II. Methods and approaches of strategic marketing planning	
	patterns of industrial development, patent and technology portfolios	
	III. Strategic foresight and scenario analysis	
	objectives and challenges of strategic foresight, scenario analysis, Delphi method	
	IV. User innovations	
	Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis	
	/. 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 Marketing of Innovations		
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Christian Lüthje	
Language	EN	
Cycle	SoSe	
Content	This PBL course is seggregated into two afternoon sessions. This cours aims at enhancing the students' practical skills in (1)	
	forecasting the future development of markets and (2) making appropriate market-related decisions (particularly segmentation,	
	managing the marketing mix). The students will be prompted to use the knowledge gathered in the lecture of this module and will	
	be invited to (1) Conduct a scenario analysis for an innovative product category and (2) Engage in decision making wtihin a	
	market simulation game.	
Literature		

Module M1143: Applie	ed Design Methodology in Mechat	ronics		
Courses				
Title		Тур	Hrs/wk	СР
Applied Design Methodology in Med	chatronics (L1523)	Lecture	2	2
Applied Design Methodology in Med	chatronics (L1524)	Project-/problem-based Learning	3	4
Module Responsible	Prof. Thorsten Kern			
Admission Requirements	None			
Recommended Previous	Basics of mechanical design, electrical design or	computer-sciences		
Knowledge				
Educational Objectives	After taking part successfully, students have read	thed the following learning results		
Professional Competence				
Knowledge	Science-based working on interdisciplinary produ	ct design considering targeted application of sp	ecific product	design techniques
Skills	Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.			
Personal Competence				
Social Competence	Students will solve and execute technical-scien	tific tasks from an industrial context in small	design-teams	with application of
	common, creative methodologies.			
Autonomy	Students are enabled to optimize the design and	development process according to the target ar	nd topic of the	design
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	30 min Presentation for a group design-work			
scale				
Assignment for the	International Management and Engineering: Spec	cialisation II. Product Development and Production	on: Elective Co	ompulsory
Following Curricula	International Management and Engineering: Spec	cialisation II. Mechatronics: Elective Compulsory		
	Mechanical Engineering and Management: Specia	alisation Product Development and Production: E	Elective Comp	ulsory
	Mechatronics: Specialisation System Design: Elec	tive Compulsory		
	Biomedical Engineering: Specialisation Artificial C	Organs and Regenerative Medicine: Elective Com	npulsory	
	Biomedical Engineering: Specialisation Implants	and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical To	echnology and Control Theory: Elective Compuls	sory	
	Biomedical Engineering: Specialisation Managem	ent and Business Administration: Elective Comp	ulsory	
	Theoretical Mechanical Engineering: Specialisation	·	e Compulsory	
	Theoretical Mechanical Engineering: Technical Co	emplementary Course: Elective Compulsory		

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

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

	ocess Engineering - Fundament	ais		
Courses				
Title		Тур	Hrs/wk	СР
Bioprocess Engineering - Fundame		Lecture	2	3
Bioprocess Engineering- Fundamer		Recitation Section (large)	2	1
Bioprocess Engineering - Fundame		Practical Course	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	none, module "organic chemistry", module "fu	indamentals for process engineering		
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	Students are able to describe the basic conce	pts of bioprocess engineering. They are able t	o classify different	types of kinetics for
	enzymes and microorganisms, as well as to	o differentiate different types of inhibition.	The parameters o	of stoichiometry an
	rheology can be named and mass transport	processes in bioreactors can be explained.	The students are	e capable to expla
	fundamental bioprocess management, steriliz	ation technology and downstream processing	in detail.	
Skills	After successful completion of this module, sto	udents should be able to		
	• doscribo different kinetic approaches fo	or growth and substrate untake and to calculate	a tha carrachandir	a parameters
		or growth and substrate-uptake and to calculat energy generation, regeneration of redox equ		
	fermentation process	energy generation, regeneration of redux equ	ilvalents and grow	war minibiaon on a
	'	iometry and to set up / solve metabolic flux ed	uations	
		or different bioreactors and bioprocesses (anac	•	well as microaerobi
	to compare them as well as to apply the		, , , , , , , , , , , , , , , , , , , ,	
	' '''	chnological problems and to deduce the corres	ponding models	
			. 3	
	to explore new knowledge resources ar			
	i i	te industrial use and to formulate solutions.		
	to document and discuss their procedul	res as well as results in a scientific manner		
B				
Personal Competence	After a secondation of their mandale continues			
Social Competence	After completion of this module participants s take position to their own opinions and increase			
Autonomy	After completion of this module participants v	vill be able to solve a technical problem in a t	eam independentl	v bv organizing the
ŕ	workflow and to present their results in a pler		·	, , ,
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Credit points				
Course achievement	Compulsory Bonus Form	Description		
	Yes 5 % Subject theoretical	and		
	practical work			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German program	n, 7 semester): Specialisation Process Enginee	ering: Compulsory	
Following Curricula	General Engineering Science (German program	m, 7 semester): Specialisation Bioprocess Engi	neering: Compulso	ory
-	Bioprocess Engineering: Core qualification: Co			
	Green Technologies: Energy, Water, Climate:	Specialisation Bioresource Technology: Electiv	e Compulsory	
	Biomedical Engineering: Specialisation Artifici	al Organs and Regenerative Medicine: Compul	sory	
	Biomedical Engineering: Specialisation Implan	ts and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medica	l Technology and Control Theory: Elective Cor	npulsory	
	Biomedical Engineering: Specialisation Manag	ement and Business Administration: Elective C	Compulsory	
	Technomathematics: Specialisation III. Engine	ering Science: Elective Compulsory		
	Process Engineering: Core qualification: Comp	ulsory		

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

Course L0842: Bioprocess En	gineering- 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
Language	DE
Cycle	SoSe
Content	1. Introduction (Prof. Liese, Prof. Zeng)
	2. Enzymatic kinetics (Prof. Liese)
	3. Stoichiometry I + II (Prof. Liese)
	4. Microbial Kinetics I+II (Prof. Zeng)
	5. Rheology (Prof. Liese)
	6. Mass transfer in bioprocess (Prof. Zeng)
	7. Continuous culture (Chemostat) (Prof. Zeng)
	8. Sterilisation (Prof. Zeng)
	9. Downstream processing (Prof. Liese)
	10. Repetition (Reserve) (Prof. Liese, Prof. Zeng)
Literature	siehe Vorlesung

Course L0843: 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 M1277: MED I	I: Introduction to Anatomy
Courses	
Title	Typ Hrs/wk CP
Introduction to Anatomy (L0384)	Lecture 2 3
Module Responsible	Prof. Udo Schumacher
Admission Requirements	None
Recommended Previous	None
Knowledge	
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.
Skille	The students can recognize the relationship between given anatomical facts and the development of some common diseases; the
Skills	can explain the relevance of structures and their functions in the context of widespread diseases.
	can explain the reservated of structures and their falletions in the context of masspired 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 acquir
	the relevant knowledge themselves.
Credit points	
Examination duration and	90 minutes
scale	
Assignment for the	
Following Curricula	
	Compulsory Data Salarana Salarina Madiaina Compulsora
	Data Science: Specialisation Medicine: Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Compulsory
	General Engineering Science (English program, 7 semester): Specialisation 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 L0384: Introduction t	to Anatomy	
	Lecture	
Hrs/wk	2	
СР		
Workload in Hours		Time 62, Study Time in Lecture 28
	Prof. Tobias Lange	
Language		
Cycle	General Anatomy	
Content	1 st week:	The Eucaryote Cell
	2 nd week: 3 rd week:	The Tissues Cell Cycle, Basics in Development
	4 th week:	Musculoskeletal System
	5 th week: 6 th week:	Cardiovascular System Respiratory System
	7 th week:	Genito-urinary System
	8 th week:	Immune system
	9 th week:	Digestive System I
	10 th week:	Digestive System II
	11 th week:	Endocrine System
	12 th week:	Nervous System
	13 th week:	Exam
Literature	Adolf Faller/Michae	l Schünke, Der Körper des Menschen, 17. Auflage, Thieme Verlag Stuttgart, 2016

Module M12/8: MED	l: Introduction to Radiology and Radiation Therapy
Courses	
Title	Typ Hrs/wk CP
Introduction to Radiology and Radio	ation Therapy (L0383) Lecture 2 3
Module Responsible	Prof. Ulrich Carl
Admission Requirements	
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Therapy
	The students can distinguish different types of currently used equipment with respect to its use in radiation therapy.
	The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine).
	The students can describe the patients' passage from their initial admittance through to follow-up care.
	Diagnostics
	The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, a well as sectional imaging techniques (CT, MRT, US).
	The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for thos techniques.
	The students can choose the right treatment method depending on the patient's clinical history and needs.
	The student can explain the influence of technical errors on the imaging techniques.
	The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.
Skills	Therapy
	The students can distinguish curative and palliative situations and motivate why they came to that conclusion.
	The students can develop adequate therapy concepts and relate it to the radiation biological aspects.
	The students can use the therapeutic principle (effects vs adverse effects)
	The students can distinguish different kinds of radiation, can choose the best one depending on the situation (location of the tumor) and choose the energy needed in that situation (irradiation planning).
	The student can assess what an individual psychosocial service should look like (e.g. follow-up treatment, sports, social he groups, self-help groups, social services, psycho-oncology).
	Diagnostics
	The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.
	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge of anatomy, pathology and pathophysiology.
Personal Competence	
Social Competence	The students can assess the special social situation of tumor patients and interact with them in a professional way. The students are aware of the special, often fear-dominated behavior of sick people caused by diagnostic and therapeut 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 top and acquire the relevant knowledge themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	
Course achievement	None
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: 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 t	to Radiology and Radiation Therapy
Тур	Lecture
Hrs/wk	
СР	
	Independent Study Time 62, Study Time in Lecture 28
Language	Prof. Ulrich Carl, Prof. Thomas Vestring DF
Cycle	
Content	The students will be given an understanding of the technological possibilities in the field of medical imaging, interventional radiology and radiation therapy/radiation oncology. It is assumed, that students in the beginning of the course have heard the word "X-ray" at best. It will be distinguished between the two arms of diagnostic (Prof. Dr. med. Thomas Vestring) and therapeutic (Prof. Dr. med. Ulrich Carl) use of X-rays. Both arms depend on special big units, which determine a predefined sequence in their respective departments
Literature	"Technik der medizinischen Radiologie" von T. + J. Laubenberg –
	7. Auflage – Deutscher Ärzteverlag – erschienen 1999
	• "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr –
	4. Auflage - Verlag Urban & Fischer – erschienen 02.03.2006
	ISBN: 978-3-437-23960-1
	"Strahlentherapie und Onkologie für MTA-R" von R. Sauer –
	5. Auflage 2003 - Verlag Urban & Schwarzenberg – erschienen 08.12.2009
	ISBN: 978-3-437-47501-6
	"Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus-
	8. Auflage - Georg Thieme Verlag - erschienen 19.09.2012
	ISBN: 978-3-13-567708-8
	• "Der Körper des Menschen " von A. Faller u. M. Schünke -
	16. Auflage 2004 - Georg Thieme Verlag - erschienen 18.07.2012
	ISBN: 978-3-13-329716-5
	"Praxismanual Strahlentherapie" von Stöver / Feyer –
	1. Auflage - Springer-Verlag GmbH – erschienen 02.06.2000

Module M1280: MED	II: Introduction to Physiology
Courses	
Title	Typ Hrs/wk CP
Introduction to Physiology (L0385)	Lecture 2 3
Module Responsible	Dr. Roger Zimmermann
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can
	describe the basics of the energy metabolism;
	 describe the basics of the energy inections, describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.
Skills	The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, development
	of forces and vital functions) and relate them to similar technical systems.
Personal Competence	
Social Competence	
	The students can find solutions to problems in the field of physiology, both analytical and metrological.
Autonomy	The students can derive answers to questions arising in the course and other physiological areas, using technical literature, b
	themselves.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and	60 minutes
scale	
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics
	Compulsory
	Data Science: Specialisation Medicine: Compulsory
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
	Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics
	Compulsory Control Engineering Science (English program, 7 competer), Specialisation Biomedical Engineering, Compulsory
	General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective Compulsory
	Mechanical Engineering: Specialisation Biomechanics: Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory
	Biomedical Engineering: Specialisation Medical Technology and Control Theory. Elective Compulsory
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory
	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

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

: Artificial Joint Replacement			
	Тур	Hrs/wk	СР
	Lecture	2	3
Prof. Michael Morlock			
None			
Basic knowledge of orthopedic and surgical tech	nniques is recommended.		
After taking part successfully, students have rea	ached the following learning results		
The students can name the different kinds of art	tificial limbs.		
The students can explain the adventages and di	and vantages of different kinds of and an	rathacac	
The students can explain the advantages and di	sadvantages of different kinds of endopi	rotrieses.	
The students are able to discuss issues related t	to endoprothese with student mates and	the teachers.	
The students are able to acquire information on	their own. They can also judge the infor	mation with respect to	its credibility.
		-	
	ure 28		
90 min			
		iotechnology: Elective	Compulsory
	· ·		
	•	ctive Compulsory	
		Compulsory	
	•		
		ve compuisory	
'	' '	sorv	
		•	
	After taking part successfully, students have real The students can name the different kinds of and The students can explain the advantages and did The students are able to discuss issues related to The students are able to acquire information on Independent Study Time 62, Study Time in Lect 3 None Written exam 90 min International Management and Engineering: Specialisation Nano and Hybromatical Engineering: Specialisation Artificial Biomedical Engineering: Specialisation Implants Biomedical Engineering: Specialisation Medical Biomedical Engineering: Specialisation Manager Orientation Studies: Core qualification: Elective Theoretical Mechanical Engineering: Technical Core	Typ Lecture Prof. Michael Morlock None Basic knowledge of orthopedic and surgical techniques is recommended. After taking part successfully, students have reached the following learning results The students can name the different kinds of artificial limbs. The students can explain the advantages and disadvantages of different kinds of endopoint are able to discuss issues related to endoprothese with student mates and the students are able to acquire information on their own. They can also judge the information lindependent Study Time 62, Study Time in Lecture 28 None Written exam omin International Management and Engineering: Specialisation II. Process Engineering and B Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Biomedical Engineering: Specialisation Management and Business Administration: Elective Orientation Studies: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compul	Prof. Michael Morlock None Basic knowledge of orthopedic and surgical techniques is recommended. After taking part successfully, students have reached the following learning results The students can name the different kinds of artificial limbs. The students can explain the advantages and disadvantages of different kinds of endoprotheses. The students are able to discuss issues related to endoprothese with student mates and the teachers. The students are able to acquire information on their own. They can also judge the information with respect to Independent Study Time 62, Study Time in Lecture 28 3 None Written exam 90 min International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Materials Science: Specialisation Nano and Hybrid Materials: 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

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

Module M0845: Feedl	oack Control in Medical Tech	nology		
Courses				
Title		Тур	Hrs/wk	СР
Feedback Control in Medical Techno	ology (L0664)	Lecture	2	3
Module Responsible	Johannes Kreuzer			
Admission Requirements	None			
Recommended Previous	Basics in Control, Basics in Physiology			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	The lecture will introduce into the fascinating area of medical technology with the engineering point of view. Fundamentals in human physiology will be similarly introduced like knowledge in control theory.			
	Internal control loops of the human body example in for anesthesia control.	y will be discussed in the same way like the	design of external cl	osed loop system fo
	The handling of PID controllers and mod illustrated. The operation of simple equiva	dern controller like predictive controller or fuz elent circuits will be discussed.	zzy controller or neu	ral networks will be
Skills	Application of modeling, identification, cor	ntrol technology in the field of medical technolo	gy.	
Personal Competence Social Competence	Students can develop solutions to specific	problems in small groups and present their res	ults	
Autonomy		ture and to set it into the context of the lectur their learning process. They can combine kno	•	•
Workload in Hours	Independent Study Time 62, Study Time in	n Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Oral exam			
Examination duration and	20 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Medi	ical Technology: Elective Compulsory		
Following Curricula	Electrical Engineering: Specialisation Cont	rol and Power Systems Engineering: Elective Co	mpulsory	
		plants and Endoprostheses: Elective Compulsor	•	
		rificial Organs and Regenerative Medicine: Elect		
		nagement and Business Administration: Electiv		
	Biomedical Engineering: Specialisation Me	dical Technology and Control Theory: Compulso	ory	

urse 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	Always viewed from the engineer's point of view, the lecture is structured as follows:			
	 Introduction to the topic Fundamentals of physiological modelling Introduction to Breathing and Ventilation Physiology and Pathology in Cardiology Introduction to the Regulation of Blood Glucose kidney function and renal replacement therapy Representation of the control technology on the concrete ventilator Excursion to a medical technology company Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools. 			
Literature	 Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. Oczenski, W. (2017). Atmen: Atemhilfen; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG. 			

	nced Topics in Control			
Courses				
Title		Тур	Hrs/wk	СР
Advanced Topics in Control (L0661) Advanced Topics in Control (L0662)		Lecture Recitation Section (small)	2	3
Module Responsible		Recitation Section (Smail)	2	3
Admission Requirements				
-	H-infinity optimal control, mixed-sensitivity design	n linear matrix inequalities		
Knowledge		i, incar matrix inequalities		
	After taking part successfully, students have reac	hed the following learning results		
Professional Competence		3 3		
Knowledge	 Students can explain the advantages and shortcomings of the classical gain scheduling approach They can explain the representation of nonlinear systems in the form of quasi-LPV 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 and synthesis problems for LPV systems They are familiar with polytopic and LFT representations of LPV systems and some of the basic synthesis techniq associated with each of these model structures 			
	Students can explain how graph theoret systems They can explain the convergence properti They can explain analysis and synthesis co	es of first order consensus protocols		
	 Students 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 such distributed systems and the asso synthesis conditions for distributed controllers 			
Skills	 Students are capable of constructing LPV models of nonlinear plants and carry out a mixed-sensitivity design of g 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 these tasks Students are able to design distributed formation controllers for groups of agents with either LTI or LPV dynamics, us Matlab tools provided 			
Personal Competence Social Competence Autonomy	Students can work in small groups and arrive at joint results.			
i				
	1. 1 1 1. 61 1. = 1	F.C		
Workload in Hours		ure 56		
Credit points	6	ure 56		
Credit points Course achievement	6 None	ure 56		
Credit points Course achievement Examination	6 None Oral exam	ure 56		
Credit points Course achievement Examination Examination and	6 None Oral exam 30 min	ure 56		
Credit points Course achievement Examination Examination duration and scale	6 None Oral exam 30 min		ulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Oral exam 30 min Electrical Engineering: Specialisation Control and	Power Systems Engineering: Elective Comp	ulsory	
Credit points Course achievement Examination Examination duration and scale	6 None Oral exam 30 min Electrical Engineering: Specialisation Control and	Power Systems Engineering: Elective Comp nic Systems: Elective Compulsory	ulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Oral exam 30 min Electrical Engineering: Specialisation Control and Aircraft Systems Engineering: Specialisation Avior	Power Systems Engineering: Elective Comp nic Systems: Elective Compulsory aft Systems: Elective Compulsory	ulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Oral exam 30 min Electrical Engineering: Specialisation Control and Aircraft Systems Engineering: Specialisation Avior	Power Systems Engineering: Elective Comp nic Systems: Elective Compulsory aft Systems: Elective Compulsory Elective Compulsory	·	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Oral exam 30 min Electrical Engineering: Specialisation Control and Aircraft Systems Engineering: Specialisation Avior Aircraft Systems Engineering: Specialisation Aircr Aircraft Systems Engineering: Core qualification:	Power Systems Engineering: Elective Comp nic Systems: Elective Compulsory aft Systems: Elective Compulsory Elective Compulsory ialisation II. Mechatronics: Elective Compuls	·	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Oral exam 30 min Electrical Engineering: Specialisation Control and Aircraft Systems Engineering: Specialisation Avior Aircraft Systems Engineering: Specialisation Aircr Aircraft Systems Engineering: Core qualification: International Management and Engineering: Specialisation	Power Systems Engineering: Elective Comp nic Systems: Elective Compulsory aft Systems: Elective Compulsory Elective Compulsory ialisation II. Mechatronics: Elective Compuls tive Compulsory	·	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Oral exam 30 min Electrical Engineering: Specialisation Control and Aircraft Systems Engineering: Specialisation Avior Aircraft Systems Engineering: Specialisation Aircraft Systems Engineering: Core qualification: International Management and Engineering: Specialisation System Design: Electric Aircraft Systems Engineering: Specialisation Systems Design: Electric Aircraft Systems Engineering: Specialisation Systems Engineering: Specialisation Aircraft Systems Engineering: Core qualification: International Management and Engineering: Specialisation Systems Engineering: Specialisation System	Power Systems Engineering: Elective Comp nic Systems: Elective Compulsory aft Systems: Elective Compulsory Elective Compulsory ialisation II. Mechatronics: Elective Compuls tive Compulsory and Robotics: Elective Compulsory	·	
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Oral exam 30 min Electrical Engineering: Specialisation Control and Aircraft Systems Engineering: Specialisation Avior Aircraft Systems Engineering: Specialisation Aircr Aircraft Systems Engineering: Core qualification: International Management and Engineering: Specialisation System Design: Elect Mechatronics: Specialisation Intelligent Systems a Biomedical Engineering: Specialisation Implants a Biomedical Engineering: Specialisation Medical Terminations and Specialisation M	Power Systems Engineering: Elective Comp nic Systems: Elective Compulsory aft Systems: Elective Compulsory Elective Compulsory ialisation II. Mechatronics: Elective Compuls tive Compulsory and Robotics: Elective Compulsory and Endoprostheses: Elective Compulsory echnology and Control Theory: Elective Com	ory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Oral exam 30 min Electrical Engineering: Specialisation Control and Aircraft Systems Engineering: Specialisation Avior Aircraft Systems Engineering: Specialisation Aircr Aircraft Systems Engineering: Specialisation Aircr Aircraft Systems Engineering: Core qualification: International Management and Engineering: Specialisation System Design: Elect Mechatronics: Specialisation Intelligent Systems a Biomedical Engineering: Specialisation Implants a Biomedical Engineering: Specialisation Medical Te Biomedical Engineering: Specialisation Management	Power Systems Engineering: Elective Comp nic Systems: Elective Compulsory aft Systems: Elective Compulsory Elective Compulsory ialisation II. Mechatronics: Elective Compuls tive Compulsory and Robotics: Elective Compulsory and Endoprostheses: Elective Compulsory echnology and Control Theory: Elective Com ent and Business Administration: Elective Com	pulsory pmpulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Oral exam 30 min Electrical Engineering: Specialisation Control and Aircraft Systems Engineering: Specialisation Avior Aircraft Systems Engineering: Specialisation Aircr Aircraft Systems Engineering: Core qualification: International Management and Engineering: Specialisation System Design: Elect Mechatronics: Specialisation Intelligent Systems a Biomedical Engineering: Specialisation Implants a Biomedical Engineering: Specialisation Medical Terminations and Specialisation M	Power Systems Engineering: Elective Comp nic Systems: Elective Compulsory aft Systems: Elective Compulsory Elective Compulsory ialisation II. Mechatronics: Elective Compuls tive Compulsory and Robotics: Elective Compulsory and Endoprostheses: Elective Compulsory echnology and Control Theory: Elective Com ent and Business Administration: Elective Corgans and Regenerative Medicine: Elective	pulsory pmpulsory	

Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Course L0661: Advanced Top	pics in Control	
Тур	Lecture	
Hrs/wk		
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	
	Linear and Nonlinear Model Predictive Control based on LMIs	
Literature	Werner, H., Lecture Notes "Advanced Topics in Control"	
	Selection of relevant research papers made available as pdf documents via StudIP	

Course L0662: Advanced Top	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		

Module MU548: Bloek	ectromagnetics: Principles ar	id Applications			
Courses					
Title		Тур	Hrs/wk	СР	
Bioelectromagnetics: Principles and	d Applications (L0371)	Lecture	3	5	
Bioelectromagnetics: Principles and	and Applications (L0373) Recitation Section (small) 2				
Module Responsible	Prof. Christian Schuster				
Admission Requirements	None				
	Basic principles of physics				
Knowledge					
Educational Objections	After helice were every filler at all at the	and the fellowing leaves a south			
Professional Competence	After taking part successfully, students ha	ve reached the following learning results			
•	Students can explain the basic principles	relationships, and methods of bioelectroma	anetics i e the quantifi	cation and application	
Knowieage	· · · ·	sue. They can define and exemplify the mo			
	*	requency of the fields. They can give an			
	, ,	magnetic fields in practical applications .			
	diagnostic utilization of electromagnetic fi	•	, , ,		
Skills	Students know how to apply various meth	ods to characterize the behavior of electron	nagnetic fields in biologi	cal tissue. In order	
	do this they can relate to and make use	of the elementary solutions of Maxwell's \ensuremath{I}	Equations. They are abl	e to assess the mo	
	important effects that these models pred	dict for biological tissue, they can order t	ne effects correspondin	g to wavelength a	
		llyze them in a quantitative way. They are a			
	j' ,	effects of electromagnetic fields for therape	eutic and diagnostic app	lications and make	
	appropriate choice.				
Personal Competence					
•	Students are able to work together on su	bject related tasks in small groups. They a	re able to present their	r results effectively	
Social competence	English (e.g. during small group exercises)		re uble to present then	results effectively	
Autonomy	Students are capable to gather informat	ion from subject related, professional pub	lications and relate th	at information to th	
	context of the lecture. They are able to n	nake a connection between their knowledge	e obtained in this lectur	re with the content	
	other lectures (e.g. theory of electromag	netic fields, fundamentals of electrical en	gineering / physics). Th	ey can communica	
	problems and effects in the field of bioelec	tromagnetics in English.			
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70			
Credit points		Ecclare 70			
Course achievement	Compulsory Bonus Form	Description			
	Yes None Presentation				
Examination					
Examination duration and .	45 min				
scale					
Assignment for the	Electrical Engineering: Specialisation Micro	owave Engineering, Optics, and Electromagn	netic Compatibility: Elec	tive Compulsory	
Following Curricula	Electrical Engineering: Specialisation Medi	cal Technology: Elective Compulsory			
	International Management and Engineerin	g: Specialisation II. Electrical Engineering: E	lective Compulsory		
	Biomedical Engineering: Specialisation Art	ificial Organs and Regenerative Medicine: E	lective Compulsory		
	Biomedical Engineering: Specialisation Ma	nagement and Business Administration: Ele	ctive Compulsory		
	Biomedical Engineering: Specialisation Me	dical Technology and Control Theory: Electi	ve Compulsory		
		plants and Endoprostheses: Elective Compu			
		alisation Bio- and Medical Technology: Elect			
	Theoretical Mechanical Engineering: Techi	nical Complementary Course: Elective Comp	ulsory		

Course L0371: Bioelectromag	gnetics: 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		
Content	- 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	
	- 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	
Literature	- 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)	
	- S. Grimnes, O. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008)	
	- F. Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnetic Fields", CRC (2006)	

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

Specialization Medical Technology and Control Theory

Module M0623: Intelli	igent Systems	in Medicine				
Courses						
Title			-	Гур	Hrs/wk	СР
Intelligent Systems in Medicine (L0	331)			Lecture	2	3
Intelligent Systems in Medicine (L0			F	Project Seminar	2	2
Intelligent Systems in Medicine (L0	333)		F	Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schla	efer				
Admission Requirements	None					
Recommended Previous	principles of m	ath (algebra, analysis/cal	culus)			
Knowledge	 principles of st 		,			
		ogramming, Java/C++ ar	nd R/Matlab			
	 advanced prog 	ramming skills				
Educational Objectives	After taking part succ	essfully, students have re	eached the following	g learning results		
Professional Competence						
Knowledge	The students are able	e to analyze and solve cl	inical treatment pla	nning and decision suppo	ort problems using	methods for search
	optimization, and pla	nning. They are able to e	xplain methods for o	classification and their res	pective advantage	s and disadvantages
	in clinical contexts. T	he students can compare	different methods	for representing medical	knowledge. They ca	an evaluate methods
			allenges due to the	clinical nature of the data	a and its acquisition	n and due to privacy
	and safety requireme	nts.				
Skills	The students can giv	e reasons for selecting a	nd adapting method	ds for classification, regre	ession, and predicti	on. 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 group	os, provide helpful fe	eedback and can incoorpo	rate feedback into	their work.
Autonomy	The students can ref	act their knowledge and	document the resu	Its of their work. They ca	n present the resu	Its in an appropriate
Autonomy	manner.	ect their knowledge and	document the resu	its of their work. They ca	ii present the resu	its iii aii appropriate
Workload in Hours		me 110, Study Time in Le	ecture 70			
Credit points	6	F	Donald diam			
Course achievement	Compulsory Bonus Yes 10 %	Form Written elaboration	Description			
	Yes 10 %	Presentation				
Examination	Written exam					
Examination duration and	90 minutes					
scale						
Assignment for the	Computer Science: Sp	pecialisation II: Intelligend	e Engineering: Elect	tive Compulsory		
Following Curricula	Electrical Engineering	: Specialisation Medical 1	echnology: Elective	Compulsory		
	Interdisciplinary Math	ematics: Specialisation C	omputational Metho	ds in Biomedical Imaging	: Compulsory	
	Mechatronics: Specia	lisation Intelligent Systen	ns and Robotics: Elec	ctive Compulsory		
	Biomedical Engineeri	ng: Specialisation Artificia	l Organs and Regen	erative Medicine: Elective	Compulsory	
	Biomedical Engineeri	ng: Specialisation Implant	s and Endoprosthes	ses: Elective Compulsory		
	_			ontrol Theory: Elective Cor		
	_	• .		Administration: Elective (
		-		urse: Elective Compulsory		
	i neoretical Mechanic	aı Engineering: Specialisa	ition Bio- and Medica	al Technology: Elective Co	ompulsory	

Course L0331: Intelligent Sy	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 Sy	ourse L0334: Intelligent Systems in Medicine		
Тур	Project Seminar		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Alexander Schlaefer		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

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

Module M1230: Selec	ted Topics of Biomedical Engineering	g - Option A (6 LP)		
Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L16	563)	Seminar	2	3
Introduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1669)	Lecture	3	4
Introduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2
Development and Regulatory Appre	oval of Medical Devices (L1588)	Lecture	2	3
Experimental Methods in Biomecha	nics (L0377)	Lecture	2	3
Experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	3
Numerical Methods in Biomechanic	s (L1583)	Seminar	2	3
Seminar Biomedical Engineering (L	1890)	Seminar	2	3
Fluid Mechanics II (L0001)		Lecture	2	4
System Simulation (L1820)		Lecture	2	2
System Simulation (L1821)		Recitation Section (large)	1	2
Ceramics Technology (L0379)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Biomedical Engineering: Specialisation Implants and E	Endoprostheses: Elective Compulsory		
Following Curricula	Biomedical Engineering: Specialisation Medical Techn	ology and Control Theory: Elective Com	pulsory	
-	Biomedical Engineering: Specialisation Management a	•		
	5 5			

Course L1663: Nature's Hiera	archical 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

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	30 min
scale	
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
	This course is intended as an introduction to the topics of wave propagation, guiding, sending, and receiving as well of Electromagnetic Compatibility (EMC). It will be useful for engineers that face the technical challenge of transmitting high frequen 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 - Numerical techniques and CAD tools for waveguide and antenna design - Fundamentals of Electromagnetic Compatibility - Coupling mechanisms and countermeasures - Shielding, grounding, filtering - Standards and regulations - EMC measurement techniques
Literature	- Zinke, Brunswig, "Hochfrequenztechnik 1", Springer (1999)
	- J. Detlefsen, U. Siart, "Grundlagen der Hochfrequenztechnik", Oldenbourg (2012)
	- D. M. Pozar, "Microwave Engineering", Wiley (2011)
	- Y. Huang, K. Boyle, "Antenna: From Theory to Practice", Wiley (2008)
	- H. Ott, "Electromagnetic Compatibility Engineering", Wiley (2009)
	- A. Schwab, W. Kürner, "Elektromagnetische Verträglichkeit", Springer (2007)

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

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

Course L0377: Experimental Methods in Biomechanics				
Тур	Lecture			
Hrs/wk	2			
СР				
Workload in Hours	dependent Study Time 62, Study Time in Lecture 28			
Examination Form	ausur			
Examination duration and	90 min			
scale				
Lecturer	Prof. Michael Morlock			
Language	DE			
Cycle	SoSe			
Content				
Literature	Wird in der Veranstaltung bekannt gegeben			

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

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

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

ourse L0001: Fluid Mechan					
Тур					
Hrs/wk	2				
СР	4				
Workload in Hours	ndependent Study Time 92, Study Time in Lecture 28				
Examination Form	Clausur				
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 The same threat the Collin Research for the same for the sam				
	Flow around particles - Solids Process Engineering Counting of processing and both transfers. The most Process Engineering				
	Coupling of momentum and heat transfer - Thermal Process Engineering Deadlaws Ricardona Facility and 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 Mind and Mary Turbines - Resourch - France				
	Wind- and Wave-Turbines - Renewable Energy				
	Introduction into Computational Fluid Dynamics				
Literature					
	1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.				
	2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.				
	3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.				
	4. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelber 2006.				
	5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994.				
	6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömung Springer Verlag, Berlin, Heidelberg, New York, 2006.				
	7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GV Fachverlage GmbH, Wiesbaden, 2008.				
	8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007				
	9. Oertl, H.: Strömungsmechanik: Munichen, Fearson Studium, 2007 9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubne				
	GWV Fachverlage GmbH, Wiesbaden, 2009.				
	10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.				
	11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Spring				
	Verlag, Berlin, Heidelberg, 2008.				
	12. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.				
	13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.				

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

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

Course L0379: Ceramics Tecl	hnology					
Тур	Lecture					
Hrs/wk	2					
СР	3					
Workload in Hours	Independent Study Time 62, St	udy Time in Lecture 28				
Examination Form	Klausur					
Examination duration and	90 Minuten					
scale						
	Dr. Rolf Janßen					
Language						
Cycle	WiSe					
Content	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				
		3. Powder fabrication				
		4. Powder processing				
	5. Shape-forming processes					
	6. Densification, sintering					
	7. Glass and Cement technology					
	8. Ceramic-metal joining techniques					
Literature	W.D. Kingery, "Introduction to	Ceramics", John Wiley & Sons, New York, 1975				
	ASM Engineering Materials Har	ndbook Vol.4 "Ceramics and Glasses", 1991				
	D.W. Richerson, "Modern Cerar	D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992				
	Skript zur Vorlesung	Skript zur Vorlesung				

Module M1241: Selec	ted Topics of Biomedical Engineering	j - Option B (12 LP)		
Courses				
Title		Тур	Hrs/wk	СР
Nature's Hierarchical Materials (L16	563)	Seminar	2	3
Introduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1669)	Lecture	3	4
Introduction to Waveguides, Anten	nas, and Electromagnetic Compatibility (L1877)	Recitation Section (small)	2	2
Development and Regulatory Appre	oval of Medical Devices (L1588)	Lecture	2	3
Experimental Methods in Biomecha	nics (L0377)	Lecture	2	3
Experimental Methods for the Char	acterization of Materials (L1580)	Lecture	2	3
Numerical Methods in Biomechanic	s (L1583)	Seminar	2	3
Seminar Biomedical Engineering (L	1890)	Seminar	2	3
Fluid Mechanics II (L0001)		Lecture	2	4
System Simulation (L1820)		Lecture	2	2
System Simulation (L1821)		Recitation Section (large)	1	2
Ceramics Technology (L0379)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	12			
Assignment for the	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory			
Following Curricula	Biomedical Engineering: Specialisation Implants and E	Endoprostheses: Elective Compulsory		
Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory				
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory			

Course L1663: Nature's Hiera	archical Materials			
	Seminar			
Hrs/wk				
CP				
Workload in Hours	ndependent 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			

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

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

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

Course L0377: Experimental Methods in Biomechanics				
·				
Тур	Lecture			
Hrs/wk				
СР				
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28			
Examination Form	lausur			
Examination duration and	90 min			
scale				
Lecturer	Prof. Michael Morlock			
Language)E			
Cycle	ioSe			
Content				
Literature	Wird in der Veranstaltung bekannt gegeben			

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

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

Course L1890: Seminar Biomedical Engineering			
Тур	eminar		
Hrs/wk			
СР			
Workload in Hours	ndependent Study Time 62, Study Time in Lecture 28		
Examination Form	eferat		
Examination duration and	schriftliche ausarbeitung und Vortrag (20 min)		
scale			
Lecturer	Prof. Michael Morlock		
Language	DE		
Cycle	ViSe		
Content			
Literature	Zeine Teine		

urse L0001: Fluid Mechan				
Тур	Lecture			
Hrs/wk	2			
CP	4			
Workload in Hours				
Examination Form	Klausur			
Examination duration and				
scale				
Lecturer	Prof. Michael Schlüter			
Language	DE			
Cycle	WiSe			
Content				
	Differential equations for momentum-, heat and mass transfer Type play for simplifications of the Navier Stakes Equations			
	 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			
	Priow threw porous structures - neterogeneous catalysis Pumps and turbines - Energy- and Environmental Process Engineering			
	Wind- and Wave-Turbines - Renewable Energy			
	Introduction into Computational Fluid Dynamics			
Literature				
	1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.			
	2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.			
	3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.			
	4. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelbei			
	2006.			
	5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994.			
	6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömung			
	Springer Verlag, Berlin, Heidelberg, New York, 2006.			
	7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GN			
	Fachverlage GmbH, Wiesbaden, 2008.			
	8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007			
	9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubne			
	GWV Fachverlage GmbH, Wiesbaden, 2009.			
	10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.			
	11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Spring			
	Verlag, Berlin, Heidelberg, 2008.			
	12. Schlichting, H.: Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.			
	13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.			

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

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

Course L0379: Ceramics Tecl	hnology		
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	90 Minuten		
scale			
	Dr. Rolf Janßen		
Language			
Cycle		using with amphasis an advanced structural saramies. The source facus prodominatly an newdor	
Contain	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	
		3. Powder fabrication	
		4. Powder processing	
		5. Shape-forming processes	
		6. Densification, sintering	
		7. Glass and Cement technology	
	8. Ceramic-metal joining techniques		
Literature	W.D. Kingery, "Introduction to 0	Ceramics", John Wiley & Sons, New York, 1975	
	ASM Engineering Materials Han	dbook Vol.4 "Ceramics and Glasses", 1991	
	D.W. Richerson, "Modern Ceramic Engineering", Marcel Decker, New York, 1992		
	Skript zur Vorlesung		

Courses				
Title		Тур	Hrs/wk	СР
Intelligent Autonomous Agents and	_	Lecture	2	4
Intelligent Autonomous Agents and		Recitation Section (small)	2	2
Module Responsible				
Admission Requirements				
	Vectors, matrices, Calculus			
Knowledge				
	After taking part successfully, students have re	eached the following learning results		
Professional Competence Knowledge	Students can explain the agent abstraction, de	efine intelligence in terms of rational beha	vior and give details	s about agent des
Knowicage	(goals, utilities, environments). They can descr			
	can be discussed in terms of decision problem			
	world scenarios, students can summarize how			
	formalism in static and dynamic settings. In a			
	settings, with and with complete access to th	ne state of the environment. In this conte	xt, students can des	scribe techniques
	solving (partially observable) Markov decision	problems, and they can recall techniques	for measuring the	value of informati
	Students can identify techniques for simultan	eous localization and mapping, and can e	xplain planning tech	nniques for achiev
	desired states. Students can explain coordinate	ion problems and decision making in a mul	ti-agent setting in te	erm of different ty
	of equilibria, social choice functions, voting protocol, and mechanism design techniques.			
Skills	Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent applic			
S.i.iis	students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesia networks/dynamic Bayesian networks and apply bayesian reasoning for simple queries. Students can also name and apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situations students will apply techniques for finding different equilibrium.			
	states,e.g., Nash equilibria. For multi-agent dec	cision making students will apply different v	voting protocols and	compare and exp
	the results.			
Personal Competence				
Social Competence	Students are able to discuss their solutions to p	problems with others. They communicate in	n English	
Autonomy	Students are able of checking their understand	ling of complex concepts by solving varaint	s of concrete probler	ms
	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points				
Course achievement				
	Written exam			
Examination duration and	90 minutes			
scale	Constant Street Constallation II Latellian	- Factor to Flority Consider		
Assignment for the	Computer Science: Specialisation II: Intelligenc		stiva Compulsory	
Following Curricula	International Management and Engineering: Sp Mechatronics: Technical Complementary Cours	••	ctive Compulsory	
	Mechatronics: Specialisation Intelligent System	, ,		
	Biomedical Engineering: Specialisation Artificia		ve Compulsorv	
	Biomedical Engineering: Specialisation Implant			
	Biomedical Engineering: Specialisation Medical	·		
	Biomedical Engineering: Specialisation Manage			
	Theoretical Mechanical Engineering: Technical			
		complementary course. Elective compaison	n y	

_	tonomous Agents and Cognitive Robotics Lecture
	2
	4
_	Independent Study Time 92, Study Time in Lecture 28
	Rainer Marrone
Language	
Cycle	WISE
Content	 Definition of agents, rational behavior, goals, utilities, environment types Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, produce rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference by enumeration), typical-cas complexity, pragmatics: reasoning from effect (that can be perceived by an agent) to cause (that cannot be directly perceived). Probabilistic reasoning over time: Environmental state may change even without the agent performing actions, dynamic Bayesian networks, Marko assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation special cases: hidden Markov models, Kalman filters, Exact inferences and approximations Decision making under uncertainty: Simple decisions: sequential decision problems, value iteration, policy iteration, MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks Simultaneous Localization and Mapping Planning Game theory (Golden Balls: Split or Share) Decisions with multiple agents, Nash equilibrium, Bayes-Nash equilibrium Social Choice Voting protocols, preferences, paradoxes, Arrow's Theorem, Mechanism Design Fundamentals, dominant strategy implementation, Revelation Principle, Gibbard-Satterthwaite Impossibility Theorem Direct mechanisms, incentive compatibility, str
	mechanisms, participation constraints, individual rationality, budget balancedness, bilateral trade, Myerson-Satterthwai Theorem
Literature	 Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Norvig, Prentice Hall, 2010, Chapters 2-5, 1 11, 13-17 Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005
	 Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham, Kevin Leyton-Brown, Cambridg University Press, 2009

Course L0512: Intelligent Au	ırse 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 M0775: Ergon	omics			
Courses				
Title		Тур	Hrs/wk	СР
Ergonomics (L0653)		Lecture	2	3
Module Responsible	Dr. Armin Bossemeyer			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 62, Study Time in Le	cture 28		
Credit points	3			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	International Management and Engineering: S	pecialisation II. Product Development and	d Production: Elective C	ompulsory
Following Curricula	Biomedical Engineering: Specialisation Implar	its and Endoprostheses: Elective Compuls	sory	
	Biomedical Engineering: Specialisation Artifici	al Organs and Regenerative Medicine: Ele	ective Compulsory	
	Biomedical Engineering: Specialisation Manag	ement and Business Administration: Elec	tive Compulsory	
	Biomedical Engineering: Specialisation Medical	al Technology and Control Theory: Electiv	e Compulsory	

Course L0653: Ergonomics	rse L0653: Ergonomics		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Armin Bossemeyer		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Module M0751: Vibra	tion Theory				
Courses					
Title		Тур	Hrs/wk	СР	
Vibration Theory (L0701)		Integrated Lecture	4	6	
Module Responsible	Prof. Norbert Hoffmann				
Admission Requirements	None				
Recommended Previous	Calculus				
Knowledge	Linear Algebra				
	Engineering Mechanics				
-	After taking part successfully, students have reached t	he following learning results			
Professional Competence					
•	Students are able to denote terms and concepts of Vib	·	her.		
Skills	Students are able to denote methods of Vibration Theo	ry and develop them further.			
Personal Competence					
Social Competence	Students can reach working results also in groups.				
Autonomy	Students are able to approach individually research tasks in Vibration Theory.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	5			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	2 Hours				
scale					
Assignment for the	Energy Systems: Core qualification: Elective Compulso	ry			
Following Curricula	International Management and Engineering: Specialisa	tion II. Mechatronics: Elective Compu	ulsory		
	Mechanical Engineering and Management: Specialisation	on Mechatronics: Elective Compulsor	У		
	Mechatronics: Core qualification: Compulsory				
	Biomedical Engineering: Specialisation Artificial Organs	•	e Compulsory		
	Biomedical Engineering: Specialisation Implants and Er				
	Biomedical Engineering: Specialisation Medical Techno	•			
	Biomedical Engineering: Specialisation Management as		Compuisory		
	Product Development, Materials and Production: Core				
	Naval Architecture and Ocean Engineering: Core qualif				
	Theoretical Mechanical Engineering: Technical Comple Theoretical Mechanical Engineering: Core qualification:	·	у		
	medietical Mechanical Engineering. Core qualification:	Liective Compuisory			

Course L0701: Vibration The	ory
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.

ourses					
itle		Тур	Hrs/wk	СР	
echnology Management (L0849)	1,0050)	Lecture	3	3	
echnology Management Seminar		Project-/problem-based Learning	2	3	
	Prof. Cornelius Herstatt				
Admission Requirements	None Rechalar knowledge in hyginess management				
Recommended Previous Knowledge	Bachelor knowledge in business management				
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence	Arter taking part successfully, students have reached	the following learning results			
•	Students will gain deep insights into:				
, and medge	Stadents IIII gain deep insignes into				
	International R&D-Management				
	Technology Timing Strategies				
	 Technology Strategies and Lifecycle Mar 	agement (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	The course aims to:				
	Develop an understanding of the importance of	Technology Management - on a national a	s well as inter	national level	
	• Equip students with an understanding of important elements of Technology Management (strategic, o				
	organizational and process-related aspects) • Foster a strategic orientation to problem-solving within the innovation process as well as Technology Management and				
	importance for corporate strategy				
	Clarify activities of Technology Management (e.g. technology sourcing, maintenance and exploitation)				
	Strengthen essential communication skills and a basic understanding of managerial, organizational and financial issue.				
	concerning Technology-, Innovation- and R&D-r				
	Basic concepts, models and tools, relevant to ti	ne management of technology R&D and in	novation		
	 Innovation as a process (steps, activities and re 		novation		
Personal Competence					
Social Competence					
	Interact within a team				
	 Raise awareness for globabl issues 				
Autonomy					
	Gain access to knowledge sources				
	Discuss recent research debates in the context	of Technology and Innovation Managemen	t		
	Develop presentation skills				
	Discussion of international cases in R&D-Manage				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0			
Credit points Course achievement	None				
Examination	Written exam				
Examination duration and					
scale	90 minutes				
Assignment for the	Global Innovation Management: Core qualification: Co	mnulsory			
•	•	, ,	mpulcor.		
Following Curricula	International Management and Engineering: Specialisa	•	npuisory		
	Mechanical Engineering and Management: Specialisat		anulas :		
	Biomedical Engineering: Specialisation Artificial Organ		іриіѕогу		
	Biomedical Engineering: Specialisation Implants and E		an.		
	Biomedical Engineering: Specialisation Medical Techn	ology and Control Theory: Elective Compuls	ioi y		

Course L0849: Technology M	anagement
Тур	Lecture
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 M	lanagement Seminar
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Beside the written exam at the end of the module, students have to give one presentation (RE) on a research paper and two presentations as part of a group discussion (GD) in the seminar in order to pass. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.
Literature	see lecture Technology Management.

ourses						
itle			Typ Lectu	ro.	Hrs/wk	CP 4
icrosystems Technology (L0724) icrosystems Technology (L0725)				re ct-/problem-based Learning	2	2
Module Responsible	Prof. Hoc Khiem Trieu	I	·	-		
Admission Requirements	None					
Recommended Previous	Basics in physics, che	emistry, mechanics and s	emiconductor technology	/		
Knowledge						
Educational Objectives	After taking part succ	cessfully, students have r	eached the following lea	rning results		
Professional Competence						
Knowledge	Students are able					
	· ·	to explain current fabric croactuators, as well as t		crostructures and especia more complex systems	Illy methods fo	r the fabrication
	to explain in deta	ails operation principles o	f microsensors and micro	pactuators and		
	to discuss the po	tential and limitation of r	nicrosystems in applicati	on.		
Skills	Students are capable					
	to analyze the feasibility of microsystems,					
	to develop process flows for the fabrication of microstructures and					
	• to apply them.					
Personal Competence Social Competence	Students are able to	prepare and perform the	ir lab experiments in tea	m work as well as to preso	ent and discuss	the results in fro
	of audience.					
Autonomy	None					
Autonomy						
Workload in Hours	Independent Study Ti	ime 124, Study Time in L	ecture 56			
Workload in Hours Credit points	Independent Study Ti					
Workload in Hours	Independent Study Ti	ime 124, Study Time in L Form Subject theoretical practical work	Description andStudierenden führe	en in Kleingruppen ein La kutiert die Theorie sowie o Kurs.		
Workload in Hours Credit points	Independent Study Ti 6 Compulsory Bonus Yes None	Form Subject theoretical	Description andStudierenden führe präsentiert und dis	kutiert die Theorie sowie		
Workload in Hours Credit points Course achievement	Independent Study Ti 6 Compulsory Bonus Yes None Oral exam	Form Subject theoretical	Description andStudierenden führe präsentiert und dis	kutiert die Theorie sowie		
Workload in Hours Credit points Course achievement Examination Examination and	Independent Study Ti 6 Compulsory Bonus Yes None Oral exam 30 min	Form Subject theoretical practical work	Description andStudierenden führe präsentiert und dis vor dem gesamten	kutiert die Theorie sowie (Kurs.	die Ergebniise i	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Ti 6 Compulsory Bonus Yes None Oral exam 30 min Electrical Engineering	Form Subject theoretical practical work g: Specialisation Nanoele	Description andStudierenden führe präsentiert und dis vor dem gesamten	kutiert die Theorie sowie of Kurs. State of the Theorie sowie of the Th	die Ergebniise i	
Workload in Hours Credit points Course achievement Examination Examination and	Independent Study Ti 6 Compulsory Bonus Yes None Oral exam 30 min Electrical Engineering Electrical Engineering	Form Subject theoretical practical work g: Specialisation Nanoele	Description andStudierenden führe präsentiert und dis vor dem gesamten ctronics and Microsystem Technology: Elective Con	kutiert die Theorie sowie of Kurs. State of the State of	die Ergebniise i	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Ti 6 Compulsory Bonus Yes None Oral exam 30 min Electrical Engineering Electrical Engineering International Manage	Form Subject theoretical practical work g: Specialisation Nanoele g: Specialisation Medical ment and Engineering: S	Description andStudierenden führe präsentiert und dis vor dem gesamten ctronics and Microsystem Technology: Elective Con pecialisation II. Mechatro	kutiert die Theorie sowie of Kurs. Ins Technology: Elective Compulsory Insignification Compulsory Insignification Compulsory Insignification Compulsory	die Ergebniise i	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Ti 6 Compulsory Bonus Yes None Oral exam 30 min Electrical Engineering Electrical Engineering International Manage Biomedical Engineering	Form Subject theoretical practical work g: Specialisation Nanoele g: Specialisation Medical ment and Engineering: S	Description andStudierenden führe präsentiert und dis vor dem gesamten ctronics and Microsystem Technology: Elective Con pecialisation II. Mechatro ts and Endoprostheses: I	kutiert die Theorie sowie of Kurs. Ins Technology: Elective Compulsory Insignification Compulsory Insignification Compulsory Insignification Compulsory	die Ergebniise i	
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Ti 6 Compulsory Bonus Yes None Oral exam 30 min Electrical Engineering Electrical Engineering International Manage Biomedical Engineering Biomedical Engineering	Form Subject theoretical practical work g: Specialisation Nanoeleg: Specialisation Medical ment and Engineering: Sng: Specialisation Implanng: Specialisation Medical specialisation Me	Description andStudierenden führe präsentiert und dis vor dem gesamten ctronics and Microsystem Technology: Elective Con pecialisation II. Mechatro ts and Endoprostheses: I	kutiert die Theorie sowie of Kurs. Is Technology: Elective Conpulsory onics: Elective Compulsory	mpulsory	

Course L0724: Microsystems	Technology
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	 Introduction (historical view, scientific and economic relevance, scaling laws) Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVI 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, 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) 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; screelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensors: operating principle and fabrication process; screelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensors: operating principle and fabrication process; screelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensors: operating principle and fabrication proce
	 MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration) Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tu relationship) System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding
Literature	TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID) M. Madou: Fundamentals of Microfabrication, CRC Press, 2002
	N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009
	T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010 G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008

Course L0725: Microsystems	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		

Module M0846: Contr	rol Systems Theory and Design			
Courses				
Title		Тур	Hrs/wk	СР
Control Systems Theory and Design	n (L0656)	Lecture	2	4
Control Systems Theory and Design	n (L0657)	Recitation Section (small)	2	2
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous	Introduction to Control Systems			
Knowledge				
	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students can explain how linear dynamic system	ns are represented as state space m	odels; they can	interpret the system
	response to initial states or external excitation as	trajectories in state space		
	They can explain the system properties controlla	bility and observability, and their rela	ationship to state	feedback and state
	estimation, respectively			
	They can explain the significance of a minimal real			
	They can explain observer-based state feedback a		cking and disturb	ance rejection
	They can extend all of the above to multi-input me They can explain the 7 transform and its relations			
	 They can explain the z-transform and its relations They can explain state space models and transfer 		tems	
	They can explain the experimental identification of	•		fication problem can
	be solved by solving a normal equation			
	They can explain how a state space model can be	constructed from a discrete-time imp	oulse response	
Skills				
Skills	Students can transform transfer function models i	nto state space models and vice vers	a	
	They can assess controllability and observability a	and construct minimal realisations		
	They can design LQG controllers for multivariable	•		
	They can carry out a controller design both in co	ntinuous-time and discrete-time dom	ain, and decide v	which is appropriate
	for a given sampling rate	sta anaga madala of dunamia sustama	from ovnorimon	tal data
	They can identify transfer function models and state They can carry out all these tasks using standal			
	Simulink)	a software tools (Matlab Control for	nbox, System la	chancation looibox,
Personal Competence				
Social Competence	Students can work in small groups on specific problems	to arrive at joint solutions.		
Autonomy	Students can obtain information from provided courses	(lastura notas software dasument	ation oversimon	t guidas) and usa it
Autonomy	Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use when solving given problems.			t guides) and use it
	They can assess their knowledge in weekly on-line tests	and thereby control their learning pro	ogress.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Electrical Engineering: Core qualification: Compulsory			
Following Curricula	Energy Systems: Core qualification: Elective Compulsory			
	Aircraft Systems Engineering: Core qualification: Elective			
	Computational Science and Engineering: Specialisation I		-	
	International Management and Engineering: Specialisation			
	International Management and Engineering: Specialisation	·	ory	
	Mechanical Engineering and Management: Specialisation Mechatronics: Core qualification: Compulsory	i Mechatronics: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs a	and Regenerative Medicine: Flective (Compulsory	
	Biomedical Engineering: Specialisation Implants and End		p a 1501 y	
	Biomedical Engineering: Specialisation Medical Technolo			
	Biomedical Engineering: Specialisation Management and		mpulsory	
	Product Development, Materials and Production: Core qu	alification: Elective Compulsory		
	Theoretical Mechanical Engineering: Core qualification: C	Compulsory		

Typ	Lecture	
Hrs/wk		
CP		
	Independent Study Time 92, Study Time in Lecture 28	
	Prof. Herbert Werner	
Language	<u></u>	
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 Syste	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		

odule M0867: Produ	iction Planning & Control a	nd Digital Enterprise		
ourses				
itle		Тур	Hrs/wk	СР
he Digital Enterprise (L0932)		Lecture	2	2
roduction Planning and Control (L	0929)	Lecture	2	2
roduction Planning and Control (L	0930)	Recitation Section (small)	1	1
xercise: The Digital Enterprise (L0	933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödding			
Admission Requirements	None			
Recommended Previous	Fundamentals of Production and Quality	y Management		
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledae	Students can explain the contents of th	e module in detail and take a critical position to them		
•	·	·		
Personal Competence	Students are capable of choosing and applying models and methods from the module to industrial problems.			
•	Students can develop joint solutions in mixed teams and present them to others.			
Autonomy				
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination				
Examination duration and				
scale	180 Millutell			
Assignment for the	International Management and Enginee	ering: Specialisation II. Product Development and Prod	uction: Elective Co	ompulsory
•	3	pecialisation Production and Logistics: Elective Compu		ompuisor y
Tollowing Curricula	,	Artificial Organs and Regenerative Medicine: Elective	-	
		Implants and Endoprostheses: Elective Compulsory	Compuisory	
		Medical Technology and Control Theory: Elective Com	nulsory	
		Management and Business Administration: Compulsor		
		oduction: Specialisation Product Development: Electiv	•	
	· ·	oduction: Specialisation Product Development. Electiv	C Compaisory	
	'	oduction: Specialisation Froduction: Compulsory oduction: Specialisation Materials: Elective Compulsor	7/	
	· ·	ecialisation Product Development and Production: Ele	-	
		•	ctive Compuisory	
	mediedical Mechanical Engineering: Te	chnical Complementary Course: Elective Compulsory		

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

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

Course L0930: Production Pl	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	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		

	ronic Circuits for Medical A				
Courses					
Title			Тур	Hrs/wk	СР
Electronic Circuits for Medical Appl	ications (L0696)		Lecture	2	3
Electronic Circuits for Medical Appl			Recitation Section (small)	1	2
Electronic Circuits for Medical Appl	ications (L1408)		Practical Course	1	1
Module Responsible	Prof. Matthias Kuhl				
Admission Requirements	None				
Recommended Previous	Fundamentals of electrical engineering	J			
Knowledge					
Educational Objectives	After taking part successfully, students	have reached the following	ng learning results		
Professional Competence					
Knowledge					
	Students can explain the basic factoring the students are able to explain the same in				
	Students are able to explain the Students can examplify the comp			ng an axon	
	Students can exemplify the comStudents can describe the speci			ons	
	Students can explain the function			0115	
	Students can explain the function Students are able to discuss the			cial eves	
	Students are able to discuss the	potential and innitations	or coeffica implants and artif	ciai cycs	
Chille					
Skills	Students can calculate the tim	e dependent voltage beha	vior of an action potential		
	Students can give scenarios for	further improvement of lo	w-noise and low-power signa	l acquisition.	
	Students can develop the block	diagrams of prosthetic sy	rstems		
	Students can define the building	blocks of electronic syste	ems for an articifial eye.		
Personal Competence					
Social Competence					
	Students are trained to solve	problems in the field of r	nedical electronics in teams	together with e	xperts with differen
	professional background.				
	Students are able to recognize to the students are able to the student				
	Students can document their work in a clear manner and communicate their results in a way that others can be involved.				
	whenever it is necessary				
Autonomy	Students are able to realistication	ally judge the status of	their knowledge and to def	fine actions for	improvements whe
	necessary.	, ,			,
	Students can break down their v	vork in appropriate work p	ackages and schedule their v	work in a realistic	way.
	Students can handle the completion				,
	Students are able to act in a res		·		
Workload in Hours	Independent Study Time 124, Study Ti	me in Lecture 56			
Credit points					
Course achievement		Description			
		retical and			
	practical work				
	No None Excercises				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the					
Following Curricula					
•	Biomedical Engineering: Specialisation			. ,	
	Biomedical Engineering: Specialisation		, ,		
	Biomedical Engineering: Specialisation			ompulsory	
	Microelectronics and Microsystems: Sp				
	Theoretical Mechanical Engineering: To		·	i 	
	Theoretical Mechanical Engineering: S			npulsorv	
		and Fied		,,	

Course L0696: Electronic Circ	cuits 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/

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

Module M1150: Continuum Mechanics						
Courses						
Title		Тур	Hrs/wk	СР		
Continuum Mechanics (L1533)		Lecture	2	3		
Continuum Mechanics Exercise (L1	534)	Recitation Section (small)	2	3		
Module Responsible	Prof. Christian Cyron					
Admission Requirements	None					
Recommended Previous	Basics of linear continuum mechanics as taught, e.g., in the module Mechanics II (forces and moments, stress, linear strain, free-					
Knowledge	body principle, linear-elastic constitutive laws, strain energy).					
Educational Objectives	After taking part successfully, students have reached the following learning results					
Professional Competence						
Knowledge						
	The students can explain the fundamental concepts to calculate the mechanical behavior of materials.					
Skills	The students can set up balance laws and apply basics of deformation theory to specific aspects, both in applied contexts as in research contexts.					
Personal Competence						
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 in Lecture 56					
Credit points	6					
Course achievement	None					
Examination	Written exam					
Examination duration and	60 min					
scale						
Assignment for the	Materials Science: Specialisation Modeling: Elective Com	pulsory				
Following Curricula		lechanical Engineering and Management: Specialisation Materials: 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		-			
	Biomedical Engineering: Specialisation Management and Product Development, Materials and Production: Core qu		inpuisory			
	Theoretical Mechanical Engineering: Technical Complem	• •				
	Theoretical Mechanical Engineering: Core qualification:					
	es. es.ear Meenanical Engineering. Core qualification.					

Course L1533: Continuum Me	echanics
	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	- Fundamentals of tanger calculus
	Fundamentals of tensor calculus Transformation in order as
	Transformation invariance Transformation invariance
	• Tensor algebra
	Tensor analysis Kinematics
	Motion of continuum
	Deformation of infinitesimal line, area and volume elements
	Material and spatial description
	Polar decomposition
	Spectral decomposition
	Objectivity
	Strain measures
	Time derivatives
	Partial / material time derivatives
	Objective time rates
	Strain and deformation rates
	Transport theorems
	Balance equations (global and local form)
	Balance of mass
	• The stress state
	■ Surface traction vectors
	■ Cauchy's fundamental theorem
	 Stress tensors (Cauchy, 1. and 2. Piola-Kirchhoff, Kirchhoff stress tensor)
	Balance of linear momentum
	Balance of angular momentum
	Balance of energy
	Balance of entropy
	Clausius-Duhem inequality
	Constitutive laws
	Constitutive assumptions
	• Fluids
	Elastic solids
	Hyperelasticity
	Material symmetry
	Elasto-plastic solids
	• Analysis
	Initial-boundary value problems and their numerical solution
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker
	LS Live Continuum Machanics Springer
	I-S. Liu: Continuum Mechanics, Springer
	weitere siehe in der Literaturliste des Scripts

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

Module M1151: Mater	rials Modeling			
Courses				
Title		Тур	Hrs/wk	СР
Material Modeling (L1535)		Lecture	2	3
Material Modeling (L1536)		Recitation Section (small)	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous	Basics of linear and nonlinear continuum mechanics as tau	ght, e.g., in the modules Mechanic	s II and Continuu	m Mechanics (forces
Knowledge	and moments, stress, linear and nonlinear strain, free-body	principle, linear and nonlinear cor	stitutive laws, st	rain energy)
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	The students can explain the fundamentals of multidimensi	onal consitutive material laws		
Skills	The students can implement their own material laws in fini	te element codes. In particular, th	e students can a	oply their knowledge
	to various problems of material science and evaluate the co	orresponding material models.		
Personal Competence				
Social Competence	The students are able to develop solutions, to present them	n to specialists and to develop idea	s further.	
Autonomy	The students are able to assess their own strengths and w problems in the area of materials modeling and acquire the	·	y and on their ov	vn identify and solve
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min			
scale				
Assignment for the	Materials Science: Specialisation Modeling: Elective Compu	Isory		
Following Curricula	Mechanical Engineering and Management: Specialisation M	aterials: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs and	Regenerative Medicine: Elective C	Compulsory	
	Biomedical Engineering: Specialisation Implants and Endop	rostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical Technology	and Control Theory: Elective Comp	oulsory	
	Biomedical Engineering: Specialisation Management and Bu	usiness Administration: Elective Co	mpulsory	
	Product Development, Materials and Production: Core quali	fication: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Material	s Science: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Simulati	on Technology: Elective Compulso	ry	

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

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

Module M1199: Advar	nced Functional Materials
Courses	
Title	Typ Hrs/wk CP
Advanced Functional Materials (L16	Seminar 2 6
Module Responsible	Prof. Patrick Huber
Admission Requirements	None
Recommended Previous	Basic knowledge in Materials Science, e.g. Materials Science I/II
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students will be able to explain the properties of advanced materials along with their applications in technology, in particul
	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 no
	materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview
	modern materials science, which enables them to select optimum materials combinations depending on the technic
	applications.
Personal Competence	
· ·	The students are able to present solutions to specialists and to develop ideas further.
Social competence	The state his the table to present solutions to specialists and to develop facus farther.
Autonomy	The students are able to
	assess their own strengths and weaknesses.
	gather new necessary expertise by their own.
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Credit points	
Course achievement	
Examination	
Examination duration and	
scale	
Assignment for the	Materials Science: Core qualification: Compulsory
Following Curricula	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 Fur	nctional Materials
Тур	Seminar
Hrs/wk	2
СР	6
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	1. Porous Solids - Preparation, Characterization and Functionalities
	2. Fluidics with nanoporous membranes
	3. Thermoplastic elastomers
	4. Optimization of polymer properties by nanoparticles
	5. Fiber composites in automotive
	6. Modeling of materials based on quantum mechanics
	7. Biomaterials
Literature	Aktuelle Publikationen aus der Fachliteratur werden während der Veranstaltung bekanntgegeben.

Module M12/9: MED	I: Introduction to Biochemis	stry and Molecular biology		
Courses				
Title		Тур	Hrs/wk CP	
Introduction to Biochemistry and M		Lecture	2 3	
Module Responsible	Prof. Hans-Jürgen Kreienkamp			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
Professional Competence				
Knowledge	The students can			
	 describe basic biomolecules; 			
	explain how genetic information is	s coded in the DNA:		
	 explain the connection between D 			
Skills	The students can			
	recognize the importance of mole	cular parameters for the course of a disease;		
	describe selected molecular-diagr			
	explain the relevance of these pro			
	- explain the relevance of these pre	securies for some discuses		
Personal Competence				
Social Competence	The students can participate in discussion	ons in research and medicine on a technical leve	el.	
Autonomy	The students can develop understanding	g of topics from the course, using technical litera	ature, by themselves.	
Workload in Hours	Independent Study Time 62, Study Time	in Lecture 28		
Credit points	3			
Course achievement				
Examination	Written exam			
Examination duration and	60 minutes			
scale	oo minaces			
Assignment for the	General Engineering Science (German n	rogram, 7 semester): Specialisation Biomedical	Engineering: Compulsory	
Following Curricula		program, 7 semester): Specialisation Mech		mechanic
ronowing curricula	Compulsory	program, 7 semester). Specialisation Meen	idilical Engineering, Focus Bio	incentance
	Data Science: Specialisation Medicine: C	omnulsory		
	Electrical Engineering: Specialisation Me			
	Engineering Science: Specialisation Biom			
		ogram, 7 semester): Specialisation Biomedical E	Engineering: Compulsory	
		program, 7 semester): Specialisation Biomedical E		mechanics
	Compulsory	p. 19. 1, / Semester, Specialisation Meen		cc.idiiicc
	Mechanical Engineering: Specialisation E	Biomechanics: Compulsory		
		Management and Business Administration: Electi	ive Compulsory	
		artificial Organs and Regenerative Medicine: Elections	• •	
		Medical Technology and Control Theory: Elective		
		mplants and Endoprostheses: Elective Compulso		
		ngineering Science: Elective Compulsory	·· ,	

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

Module M1334: BIO II	: Biomaterials			
Courses				
Title		Тур	Hrs/wk	СР
Biomaterials (L0593)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	Basic knowledge of orthopedic and surgical technique	s is recommended.		
Knowledge				
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 us	sed in medical engineerir	ng, and their fields of
	use.			
Skille	The students can explain the advantages and disadva	ntages of different kinds of hiom	aterials	
Skills	The students can explain the advantages and disadva	ntages of afficient kinds of bloth	ateriais.	
Personal Competence				
Social Competence	The students are able to discuss issues related to ma	terials being present or being us	ed for replacements with	student mates and
	the teachers.			
Autonomy	The students are able to acquire information on their	own. They can also judge the info	ormation with respect to	its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	1		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	International Management and Engineering: Specialisa	ation II. Process Engineering and	Biotechnology: Elective (Compulsory
Following Curricula	Materials Science: Specialisation Nano and Hybrid Materials	terials: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organ	s and Regenerative Medicine: El	ective Compulsory	
	Biomedical Engineering: Specialisation Implants and E			
	Biomedical Engineering: Specialisation Medical Technology	••		
	Biomedical Engineering: Specialisation Management a			
	Theoretical Mechanical Engineering: Technical Comple		•	
	Theoretical Mechanical Engineering: Specialisation Bio	o- and Medical Technology: Electi	ive Compulsory	

ourse L0593: Biomaterials	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Michael Morlock
Language	EN
-	WiSe
Content	Topics to be covered include: 1. 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
	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.
Literature	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
	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.

Module M0808: Finite	Elements Methods			
Courses				
Title		Typ	Hrs/wk	СР
Finite Element Methods (L0291)		Typ Lecture	nrs/wk 2	3
Finite Element Methods (L0804)		Recitation Section (large)	2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	None			
Recommended Previous	Mechanics I (Statics, Mechanics of Materials) and Mec	chanics II (Hydrostatics, Kinematics, Dyn	amics)	
Knowledge	Mathematics I, II, III (in particular differential equation		,	
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students possess an in-depth knowledge regar overview of the theoretical and methodical basis of the students of the stude		ent method and	are able to give ar
Skills	The students are capable to handle engineering problems by formulating suitable finite elements, assembling the correspondir system matrices, and solving the resulting system of equations.			
	Students can work in small groups on specific probler The students are able to independently solve chal		develop own finition	e element routines
	Problems can be identified and the results are critical	ly scrutinized.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture !	56		
Credit points	6			
Course achievement		escription		
	No 20 % Midterm			
Examination	Written exam			
Examination duration and	120 min			
scale	0.115			
_	Civil Engineering: Core qualification: Compulsory	071		
rollowing Curricula	Energy Systems: Core qualification: Elective Compuls			
	Aircraft Systems Engineering: Specialisation Aircraft S	, ,		
	Aircraft Systems Engineering: Specialisation Air Trans			
	Aircraft Systems Engineering: Core qualification: Elec-		a.m./	
	International Management and Engineering: Specialis	·	•	mnulson
	International Management and Engineering: Specialis	acion ii. Product Development and Produ	iction: Elective Co	mpuisory
	Mechatronics: Core qualification: Compulsory	Endonroctheses: Compulsor,		
	Biomedical Engineering: Specialisation Implants and I		mpulsor.	
	Biomedical Engineering: Specialisation Management			
	Biomedical Engineering: Specialisation Medical Techn			
	Biomedical Engineering: Specialisation Artificial Organ Product Development, Materials and Production: Core		сопривогу	
	Technomathematics: Specialisation III. Engineering So			
	Theoretical Mechanical Engineering: Core qualification			
	medicated mechanical Engineering. Core qualification	п. соптривогу		

Course L0291: Finite Elemen	t 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 Elemen	urse 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: Polyn				
Courses				
Title		Тур	Hrs/wk	СР
Structure and Properties of Polyme		Lecture	2	3
Processing and design with polyme		Lecture	2	3
Module Responsible	Dr. Hans Wittich			
Admission Requirements	None			
Recommended Previous	Basics: chemistry / physics / material scie	nce		
Knowledge	Afficial discount of the state	and the fellowing to the second of the		
Educational Objectives	After taking part successfully, students ha	ive reached the following learning results		
Professional Competence	Charles he are the large of all the		!_	
Knowledge	Students can use the knowledge of plastic	s and define the necessary testing and analy	/SIS.	
	They can explain the complex relationship	os structure-property relationship and		
	the interactions of chemical structure of the	he polymers, including to explain neighboring	n contexts (e.a. sustaina	hility environment
	protection).	ne polymers, merdanig to explain heighboring	g contexts (e.g. sustame	ionicy, chivil ornificin
	,			
Skills	Students are capable of			
	- using standardized calculation method	ds in a given context to mechanical prope	erties (modulus, streng	th) to calculate a
	evaluate the different materials.			
	and a first order of the set of t			
	- selecting appropriate solutions for mecr	nanical recycling problems and sizing exampl	e stiπness, corrosion re	sistance.
Personal Competence				
Social Competence	Students can			
	arrive at funded work results in heteroge	anius groups and document them		
	- arrive at funded work results in heteroge	enius groups and document them.		
	- provide appropriate feedback and handle	e feedback on their own performance constru	uctively.	
Autonomy	Students are able to			
	- assess their own strengths and weaknes	ses.		
	_			
	- assess their own state of learning in spec	cific terms and to define further work steps o	n this basis.	
	- assess possible consequences of their pr	rofessional activity.		
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points				
Course achievement				
	Written exam			
Examination duration and	180 min			
scale	Mahariala Caisasas Casaisliantian Funissas	in a Matariala Elastina Carandara		
Assignment for the	Materials Science: Specialisation Engineer			
Following Curricula	Biomedical Engineering: Specialisation Im Biomedical Engineering: Specialisation Art	piants and Endoprostrieses: Compuisory tificial Organs and Regenerative Medicine: Ele	ective Compulsory	
		anagement and Business Administration: Elec		
		edical Technology and Control Theory: Electiv		
		uction: Specialisation Production: Elective Co		
	· ·	uction: Specialisation Materials: Elective Com		
	Product Development, Materials and Produ	uction: Specialisation Product Development:	Elective Compulsory	
	Theoretical Mechanical Engineering: Tech	nical Complementary Course: Elective Comp	ulsory	
	Theoretical Mechanical Engineering: Spec	ialisation Materials Science: Elective Compuls	sory	

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 an	d 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				
Title		Тур	Hrs/wk	СР
Regenerative Medicine (L0347)		Seminar	2	3
Lecture Tissue Engineering - Reger	nerative Medicine (L1664)	Seminar	2	3
Module Responsible	Prof. Ralf Pörtner			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	After successful completion of the module stu	dents will be able to describe the basi	ic methods of regenerat	ive medicine and
	explain the use of the tissue cells for different i	nethods of tissue engineering. They are	e able to give a basic ove	erview of methods
	the cultivation of animal and human cells.			
	The students can outline the actual concept	s of Tissue Engineering and regener	rative medicine and ca	n explain the ba
	udnerlying principles of the discussed topics.	is an install Engineering and regener	anve meanine and ea	explain the sa
Skills	After successful completion of the module stud	ents are		
	able to use medical databases for acquir	ierung and presentation of relevant up-	to-date data independe	ntly
	able to present their work results in the			
	able to carry out basic cell culture methors	ods and the corresponding analysis inde	ependently	
	 able to analyse and evaluate current res 			
Dorgonal Compatones				
Personal Competence	Charlenda and alle he are alle he are the area of he area.	with 2.4 attribute to only a six on tools		
Social Competence	Students are able to work together as a team was defend them.	vith 2-4 students to solve given tasks a	na discuss their results	in the pienary and
	defend them.			
	Students are able to reflect their work orally an	d discuss it with other students and tea	ichers.	
Autonomy				
	After completion of this module, participant	s will be able to solve a technical	nrohlem in teams of a	annroy 2-4 nerso
	independently including a presentation of the r		problem in teams or a	зрргох. 2-4 регзо
	independently including a presentation of the r	esuits.		
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	Yes 20 % Written elaboration	Ausarbeitung zu Ringvorlesung / pr	otocol for lecture series	
Examination				
Examination duration and	Oral presentation + discussion (30 min)			
scale				
Assignment for the	Biomedical Engineering: Specialisation Implant	·	•	
Following Curricula	Biomedical Engineering: Specialisation Artificia	•		
	Biomedical Engineering: Specialisation Manage			
	Biomedical Engineering: Specialisation Medical	Technology and Control Theory: Flective	A 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
Cycle	WiSe
Content	The course deals with the application of biotechnological engineering principles for re-generation of human tissues. The main topics are "tissue engineering" for the generation of "artificial organs" such as cartilage, liver, blood vessel etc., and their applications: • Introduction (historical development, examples for medical and technical applications, commercial aspets) • Cell specific fundamentals (cell physiology, biochemistry, metabolism, special requirements for cell cultivation "in vitro") • Process specific fundamentals (requirements for culture systems, examples for reactor design, mathematical modelling, process and control strategies) • Examples for applications for clinical applications, drug testing and material testing The fundamentals will be presented by the lecturers. The "state of the art" of specific applications will be exploited by the students based on selected papers and presented during the course.
Literature	Regenerative Biology and Medicine (Taschenbuch) von David L. Stocum; Academic Pr Inc; ISBN-10: 0123693713, ISBN-13: 978-
	0123693716 Fundamentals of Tissue Engineering and Regenerative Medicine von Ulrich Meyer (Herausgeber), Thomas Meyer (Herausgeber), Jörg Handschel (Herausgeber), Hans Peter Wiesmann (Herausgeber): Springer, Berlin; ISBN-10: 3540777547; ISBN-13: 978-
	3540777540

Course L1664: Lecture Tissue	e 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				
Title		Тур	Hrs/wk	СР
Implants and Fracture Healing (L03	76)	Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	It is recommended to participate in "Introduction	on into Anatomie" before attending "Imp	plants and Fracture Healin	ng".
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	The students can describe the different ways h	ow bones heal, and the requirements for	or their existence.	
	The students can name different treatments for	r the spine and hollow bones under give	en fracture morphologies.	
Skills	The students can determine the forces acting v	within the human body under quasi-stat	ic situations under specifi	ic assumptions
SKIIIS	The stadents can determine the forces dethig t	vicini the naman body ander quasi state	ie situations under speem	ic assamptions.
Personal Competence				
Social Competence	The students can, in groups, solve basic numer	rical modeling tasks for the calculation of	of internal forces.	
Autonomy	The students can, in groups, solve basic nume	rical modeling tasks for the calculation (of internal forces	
natonomy	The seadenes earl, in groups, solve basic name	real modeling tasks for the calculation (or internal forces.	
Workload in Hours	Independent Study Time 62, Study Time in Lec	ture 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	General Engineering Science (German prog	ram, 7 semester): Specialisation Me	chanical Engineering, Fo	ocus Biomechani
Following Curricula	Compulsory			
	General Engineering Science (German program	n, 7 semester): Specialisation Biomedica	al Engineering: Compulsor	ry
	Engineering Science: Specialisation Biomedical	Engineering: Compulsory		
	General Engineering Science (English program	, 7 semester): Specialisation Biomedica	Engineering: Compulsor	у
	General Engineering Science (English progr	am, 7 semester): Specialisation Med	chanical Engineering, Fo	ocus Biomechani
	Compulsory			
	Mechanical Engineering: Specialisation Biomec	hanics: Compulsory		
	Biomedical Engineering: Specialisation Implant	s and Endoprostheses: Elective Compul	sory	
	Biomedical Engineering: Specialisation Artificia			
	Biomedical Engineering: Specialisation Manage			
	Biomedical Engineering: Specialisation Medical			
	near and a second a second and a second a second and a second a		pa.so.,	
	Orientation Studies: Core qualification: Elective	Compulsory		

Course L0376: Implants and	Fracture Healing
Тур	Lecture
Hrs/wk	
СР	
	Independent Study Time 62, Study Time in Lecture 28 Prof. Michael Morlock
Language	
Cycle	
Content	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)
	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
Literature	Cochran V.B.: Orthopädische Biomechanik
	Mow V.C., Hayes W.C.: Basic Orthopaedic Biomechanics
	White A.A., Panjabi M.M.: Clinical biomechanics of the spine
	Nigg, B.: Biomechanics of the musculo-skeletal system
	Schiebler T.H., Schmidt W.: Anatomie
	Platzer: dtv-Atlas der Anatomie, Band 1 Bewegungsapparat

Module M0630: Robot	tics and Naviga	ation in Medicine			
Courses					
Title			Тур	Hrs/wk	СР
Robotics and Navigation in Medicin	e (L0335)		Lecture	2	3
Robotics and Navigation in Medicine (L0338)			Project Seminar	2	2
Robotics and Navigation in Medicin	e (L0336)		Recitation Section (small)	1	1
Module Responsible	Prof. Alexander Schla	aefer			
Admission Requirements	None				
Recommended Previous					
Knowledge		nath (algebra, analysis/calculus)			
		rogramming, e.g., in Java or C+	+		
	solid R or Matl	IAD SKIIIS			
Educational Objectives	After taking part succ	cessfully, students have reached	the following learning results		
Professional Competence					
Knowledge	The students can ex	xplain kinematics and tracking	systems in clinical contexts and illustr	ate systems and	their components
	detail. Systems can	be evaluated with respect to	collision detection and safety and reg	gulations. Student	s can assess typic
	systems regarding de	esign and limitations.			
Ckilla	The students are able	o to decign and evaluate naviga	tion systems and robotic systems for me	odical applications	
SKIIIS	The students are able	e to design and evaluate haviga	tion systems and robotic systems for the	edicai applications	
Davisanal Commetence					
Personal Competence	The students discuss	. bl			Ale a la consula
Social Competence	The students discuss	s the results of other groups, pro	vide helpful feedback and can incoorpor	ate reedback into	their work.
Autonomy	The students can ref	flect their knowledge and docur	nent the results of their work. They car	n present the resu	Its in an appropria
	manner.				
Workload in Hours	Indopondent Study T	ime 110, Study Time in Lecture	70		
		ille 110, Study Tille III Lecture	70		
Credit points	Compulsory Bonus	Form D	escription		
Course achievement	Yes 10 %	Written elaboration	escription		
	Yes 10 %	Presentation			
Examination	1				
Examination duration and					
scale	30 minutes				
	Computer Science: S	specialisation II: Intelligence Eng	ineering: Flective Compulsory		
Following Curricula			incernig. Elective compaisory		
			logy: Flective Compulsory		
3			ology: Elective Compulsory sation II. Electrical Engineering: Elective	Compulsorv	
3	International Manage	ement and Engineering: Speciali	sation II. Electrical Engineering: Elective		Compulsorv
3	_	ement and Engineering: Speciali alisation Intelligent Systems and	sation II. Electrical Engineering: Elective sation II. Process Engineering and Biotec		Compulsory
3	Mechatronics: Specia	alisation Intelligent Systems and	sation II. Electrical Engineering: Elective sation II. Process Engineering and Biotec	chnology: Elective	Compulsory
3	Mechatronics: Specia Biomedical Engineeri	alisation Intelligent Systems and ing: Specialisation Artificial Orga	sation II. Electrical Engineering: Elective sation II. Process Engineering and Biotec Robotics: Elective Compulsory	chnology: Elective	Compulsory
J	Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri	alisation Intelligent Systems and ing: Specialisation Artificial Orga ing: Specialisation Implants and	sation II. Electrical Engineering: Elective sation II. Process Engineering and Biotec Robotics: Elective Compulsory ins and Regenerative Medicine: Elective	chnology: Elective	Compulsory
J	Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri	alisation Intelligent Systems and ing: Specialisation Artificial Orga ing: Specialisation Implants and ing: Specialisation Medical Tech	sation II. Electrical Engineering: Elective sation II. Process Engineering and Biotec Robotics: Elective Compulsory ins and Regenerative Medicine: Elective Endoprostheses: Elective Compulsory	chnology: Elective Compulsory	Compulsory
J	Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri	alisation Intelligent Systems and ing: Specialisation Artificial Orgaing: Specialisation Implants and ing: Specialisation Medical Teching: Specialisation Management	sation II. Electrical Engineering: Elective sation II. Process Engineering and Biotec Robotics: Elective Compulsory ins and Regenerative Medicine: Elective Endoprostheses: Elective Compulsory nology and Control Theory: Elective Com	Chnology: Elective Compulsory npulsory compulsory	Compulsory
J	Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Product Developmen	alisation Intelligent Systems and ing: Specialisation Artificial Orgaing: Specialisation Implants and ing: Specialisation Medical Teching: Specialisation Management at, Materials and Production: Specialisation Management	sation II. Electrical Engineering: Elective sation II. Process Engineering and Biotec Robotics: Elective Compulsory ins and Regenerative Medicine: Elective Endoprostheses: Elective Compulsory nology and Control Theory: Elective Com and Business Administration: Elective C	chnology: Elective Compulsory npulsory compulsory ve Compulsory	Compulsory
	Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Product Developmen Product Developmen	alisation Intelligent Systems and ing: Specialisation Artificial Orgaing: Specialisation Implants and ing: Specialisation Medical Teching: Specialisation Management at, Materials and Production: Spet, Materials and Production: Spet, Materials and Production: Spet, Materials and Production: Spet,	sation II. Electrical Engineering: Elective sation II. Process Engineering and Bioted Robotics: Elective Compulsory ins and Regenerative Medicine: Elective Endoprostheses: Elective Compulsory nology and Control Theory: Elective Com and Business Administration: Elective Cialisation Product Development: Elective	Chnology: Elective Compulsory npulsory compulsory ve Compulsory vory	Compulsory
	Mechatronics: Specia Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Biomedical Engineeri Product Developmen Product Developmen Product Developmen	alisation Intelligent Systems and ing: Specialisation Artificial Orga ing: Specialisation Implants and ing: Specialisation Implants and ing: Specialisation Management it, Materials and Production: Spet,	sation II. Electrical Engineering: Elective sation II. Process Engineering and Bioted Robotics: Elective Compulsory and Regenerative Medicine: Elective Endoprostheses: Elective Compulsory nology and Control Theory: Elective Comand Business Administration: Elective Cialisation Product Development: Electicalisation Production: Elective Compuls	chnology: Elective Compulsory npulsory compulsory ve Compulsory ory ry	Compulsory

Course L0335: Robotics and	Course L0335: Robotics and Navigation in Medicine		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Alexander Schlaefer		
Language	EN		
Cycle	SoSe		
Content	- kinematics		
	- calibration		
	- tracking systems		
	- navigation and image guidance		
	- motion compensation		
	The seminar extends and complements the contents of the lecture with respect to recent research results.		
Literature	Spong et al.: Robot Modeling and Control, 2005		
	Troccaz: Medical Robotics, 2012		
	Further literature will be given in the lecture.		
1			

Course L0338: Robotics and	rse 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 M1384: Case	Studies for Regenerative Med	icine and Tissue Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Case Studies for Regenerative Med	icine and Tissue Engineering (L1963)	Seminar	3	6
Module Responsible	Prof. Ralf Pörtner			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 138, Study Time in	Lecture 42		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	45 min			
scale				
Assignment for the	Biomedical Engineering: Specialisation Artifi	cial Organs and Regenerative Medicine: Com	pulsory	
Following Curricula	Biomedical Engineering: Specialisation Impla	' '	,	
		agement and Business Administration: Electiv		
	Biomedical Engineering: Specialisation Medi	cal Technology and Control Theory: Elective	Compulsory	

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

Module M0634: Introd	duction	into Me	edical Technology	and System	าร		
Courses							
Title					Тур	Hrs/wk	СР
	Introduction into Medical Technology and Systems (L0342)				Lecture	2	3
Introduction into Medical Technolog	gy and Syste	ms (L0343)			Project Seminar	2	2
Introduction into Medical Technolog	gy and Syste	ms (L1876)			Recitation Section (large)	1	1
Module Responsible	Prof. Alexa	nder Schla	efer				
Admission Requirements	None						
Recommended Previous	principles	of math (al	gebra, analysis/calculus)				
Knowledge	principles (of stochas	tics				
	principles	of program	ming, R/Matlab				
Educational Objectives	After takin	g part succ	essfully, students have rea	ched the followi	ng learning results		
Professional Competence		9	,,				
· ·	The stude	nts can ex	plain principles of medica	ıl technology, in	ncluding imaging systems,	computer aided s	surgery, and medical
					atory affairs and standards	·	
		•	,		•		3,
Skills	The studer	nts are able	e to evaluate systems and r	medical devices	in the context of clinical app	olications.	
Personal Competence							
Social Competence	The studer	nts describe	e a problem in medical tech	nnology as a proj	ject, and define tasks that a	re solved in a join	t effort.
·		_					
Autonomy		nts can ref	lect their knowledge and d	ocument the res	sults of their work. They ca	n present the resu	ılts in an appropriate
	manner.						
Workload in Hours	Independe	nt Study Ti	me 110, Study Time in Lec	ture 70			
Credit points	6						
Course achievement	Compulsory	Bonus	Form	Description			
	Yes	10 %	Presentation				
	Yes	10 %	Written elaboration				
Examination		am					
Examination duration and	90 minutes	S					
scale							
Assignment for the					ecialisation Biomedical Eng		ory
Following Curricula	-				eering: Elective Compulsory		
			ualification: Elective Compu		ng Science: Elective Compul	sory	
			g: Core qualification: Elective	•			
			Specialisation Biomedical I		mnulsory		
	_				ecialisation Biomedical Engi	neerina: Compulso	irv
					matics & Engineering Scien		
					enerative Medicine: Elective		,
		-	ng: Specialisation Implants	-		. ,	
	Biomedica	l Engineeri	ng: Specialisation Medical 1	Technology and	Control Theory: Elective Cor	mpulsory	
	Biomedica	l Engineeri	ng: Specialisation Managen	nent and Busine	ss Administration: Elective (Compulsory	
	Technoma	thematics:	Specialisation III. Engineer	ing Science: Elec	ctive Compulsory		

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

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

Course L1876: Introduction in	nto 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: Nonlin	near Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Dynamics (L0702)		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 f	ollowing learning results		
Professional Competence				
	Students are able to reflect existing terms and concepts.			
Personal Competence	Students are able to apply existing methods and procesure	es of Nonlinear Dynamics and to	o develop novel meth	ods and procedures.
·	Students can reach working results also in groups.			
,	Students are able to approach given research tasks individ	lually and to identify and follow	un novel research ta	sks by themselves
,	Independent Study Time 124, Study Time in Lecture 56	daily and to identify and follow	up nover research ta	sks by themselves.
Credit points				
Course achievement				
Examination				
Examination duration and	2 Hours			
scale				
Assignment for the	Aircraft Systems Engineering: Core qualification: Elective (Compulsory		
Following Curricula	International Management and Engineering: Specialisation	II. Mechatronics: Elective Comp	pulsory	
	Mechanical Engineering and Management: Specialisation M	Mechatronics: Elective Compuls	ory	
	Mechatronics: Specialisation System Design: Elective Com	pulsory		
	Mechatronics: Specialisation Intelligent Systems and Robo	tics: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs an	d Regenerative Medicine: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation Implants and Endo			
	Biomedical Engineering: Specialisation Medical Technology	•		
	Biomedical Engineering: Specialisation Management and B		e Compulsory	
	Product Development, Materials and Production: Core qual		an.	
	Theoretical Mechanical Engineering: Technical Complemer Theoretical Mechanical Engineering: Core qualification: Ele	,	эт у	
	medieda mechanica Engineering: Core qualification: Ele	ctive compulsory		

Course L0702: Nonlinear Dyn	namics
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 Technology (L0722		Lecture	4	4
Semiconductor Technology (L0723)	Practical Course	2	2
Module Responsible	Prof. Hoc Khiem Trieu			
Admission Requirements				
	Basics in physics, chemistry, material science and semi-	conductor devices		
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge				
	Students are able			
	to describe and to explain current fabrication techn	igues for Si and GaAs substrates		
	to describe and to explain current labrication techni	iques for 31 affa GaAs substrates	7	
	to discuss in details the relevant fabrication	processes, process flows and	the impact thereof o	n the fabrication
	semiconductor devices and integrated circuits and			
	to present integrated process flows.			
Skills				
	Students are capable			
	to analyze the impact of process parameters on the	processing results,		
	to coloct and to evaluate processes and			
	to select and to evaluate processes and			
	to develop process flows for the fabrication of semi	conductor devices.		
Personal Competence				
Social Competence				
	Students are able to prepare and perform their lab exp	eriments in team work as well as	s to present and discus	ss the results in fro
	of audience.		·	
Autonomy	None			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Nanoelectronics a	nd Microsystems Technology: Fla	ective Compulsory	
Following Curricula	Biomedical Engineering: Specialisation Natioelectronics and			
	Biomedical Engineering: Specialisation Implants and En	J .	. ,	
	Biomedical Engineering: Specialisation Medical Technol	·	•	
	Biomedical Engineering: Specialisation Management an	• •		
	Microelectronics and Microsystems: Core qualification: I	lective Compulsory		

0722: Semiconducto	
Тур	
Hrs/wk	
Orkload in Hours	Independent Study Time 64, Study Time in Lecture 56
	Prof. Hoc Khiem Trieu
Language	
Cycle	SoSe
Content	 Introduction (historical view and trends in microelectronics) Basics in material science (semiconductor, crystal, Miller indices, crystallographic defects) Crystal fabrication (crystal pulling for Si and GaAs: impurities, purification, Czochralski, Bridgeman and float zone process Wafer fabrication (process flow, specification, SOI) Fabrication processes Doping (energy band diagram, doping, doping by alloying, doping by diffusion: transport processes, doping profile, high order effects and process technology, ion implantation: theory, implantation profile, channeling, implantation damas annealing and equipment) Oxidation (silicon dioxide: structure, electrical properties and oxide charges, thermal oxidation: reactions, kinetinfluences on growth rate, process technology and equipment, anodic oxidation, plasma oxidation, thermal oxidation
	 GaAs) Deposition techniques (theory: nucleation, film growth and structure zone model, film growth process, reaction kinetic temperature dependence and equipment; epitaxy: gas phase, liquid phase, molecular beam epitaxy; CVD techniques APCVD, LPCVD, deposition of metal silicide, PECVD and LECVD; basics of plasma, equipment, PVD techniques: high vacuule evaporation, sputtering)
	 Structuring techniques (subtractive methods, photolithography: resist properties, printing techniques: contact, proxim and projection printing, resolution limit, practical issues and equipment, additive methods: liftoff technique a electroplating, improving resolution: excimer laser light source, immersion lithography and phase shift lithography, electr beam lithography, X-ray lithography, EUV lithography, ion beam lithography, wet chemical etching: isotropic a anisotropic, corner undercutting, compensation masks and etch stop techniques; dry etching: plasma enhanced etchin backsputtering, ion milling, chemical dry etching, RIE, sidewall passivation)
	Process integration (CMOS process, bipolar process)
	 Assembly and packaging technology (hierarchy of integration, packages, chip-on-board, chip assembly, electrical containing, TAB and flip chip, wafer level package, 3D stacking)
Literature	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: Huma	noid Robotics			
Courses				
Title		Тур	Hrs/wk	СР
Humanoid Robotics (L0663)		Seminar	2	2
Module Responsible	Patrick Göttsch			
Admission Requirements	None			
Recommended Previous				
Knowledge	Introduction to control systems			
	Control theory and design			
	- Control tricory and design			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	 Students can explain humanoid robots. 			
	· ·	oncepts for different tasks in humanoid ro	hotics	
	stadents ream to apply basic control of	sheepes for different tasks in humanoid to	botics.	
Skills	Students acquire knowledge about sele	ected aspects of humanoid robotics, based	d on specified literature	
	Students generalize developed results	·	. on specifica meratare	
	Students practice to prepare and give a			
Personal Competence				
Social Competence	Students are capable of developing solutions in interdisciplinary teams and present them			
	They are able to provide appropriate feedback and handle constructive criticism of their own results			
Autonomy	Students evaluate advantages and d	rawbacks of different forms of presenta	tion for specific tasks	and select the best
	solution			
	 Students familiarize themselves with a 	a scientific field, are able of introduce it	and follow presentation	ns of other students,
	such that a scientific discussion develo	ps		
Workload in Hours	Independent Study Time 32, Study Time in Le	ecture 28		
Credit points	2			
Course achievement	None			
Examination	Presentation			
Examination duration and	30 min			
scale				
Assignment for the	Mechatronics: Specialisation Intelligent System	ms and Robotics: Elective Compulsory		
Following Curricula	Mechatronics: Specialisation System Design:	Elective Compulsory		
	Biomedical Engineering: Specialisation Artifici	al Organs and Regenerative Medicine: Ele	ective Compulsory	
	Biomedical Engineering: Specialisation Implar	·	•	
	Biomedical Engineering: Specialisation Medical	•		
	Biomedical Engineering: Specialisation Manag			
	Theoretical Mechanical Engineering: Technica	·	•	
	Theoretical Mechanical Engineering: Specialis	ation Robotics and Computer Science: Ele	ective Compulsory	

Course L0663: Humanoid Ro	ourse 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).		

Module M0838: Linea	r and Nonlinear System Identifikati	on		
Courses				
Title		Тур	Hrs/wk	СР
Linear and Nonlinear System Identi	fication (L0660)	Lecture	2	3
Module Responsible	Prof. Herbert Werner			
Admission Requirements	None			
Recommended Previous Knowledge	 Classical control (frequency response, root low State space methods Discrete-time systems Linear algebra, singular value decomposition Basic knowledge about stochastic processes 	cus)		
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence Knowledge	•			
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 groups on specific prob	lems to arrive at joint solutions.		
Autonomy	Students are able to find required information in solution solve given problems.	urces provided (lecture notes, liter	ature, software documen	tation) and use it to
Workload in Hours	Independent Study Time 62, Study Time in Lecture	28		
Credit points	3			
Course achievement	None			
Examination	Oral exam			
Examination duration and scale	30 min			
_	Electrical Engineering: Specialisation Control and Po		Compulsory	
Following Curricula	Mechatronics: Specialisation Intelligent Systems and			
	Mechatronics: Specialisation System Design: Electiv		ti C	
	Biomedical Engineering: Specialisation Artificial Org Biomedical Engineering: Specialisation Implants and	3	, ,	
	Biomedical Engineering: Specialisation Medical Tech	·	•	
	Biomedical Engineering: Specialisation Management			
	Theoretical Mechanical Engineering: Technical Com			
	Theoretical Mechanical Engineering: Core qualificati			

Course L0660: Linear and No	onlinear 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

C					
Courses					
Title Optimal and Robust Control (L0658		Typ Lecture	Hrs/wk 2	CP 3	
Optimal and Robust Control (L065) Optimal and Robust Control (L065)		Recitation Section (small)	2	3	
Module Responsible	Prof. Herbert Werner	,			
Admission Requirements	None				
Recommended Previous	None				
Knowledge	Classical control (frequency response, root le	ocus)			
	State space methods				
	 Linear algebra, singular value decomposition 	1			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results			
Professional Competence	, , , , , , , , , , , , , , , , , , ,	3 3			
Knowledge					
	Students can explain the significance of the				
	They can explain the duality between optimal	•			
	 They can explain how the H2 and H-infinity i They can explain how an LQG design proble 				
	They can explain how model uncertainty can	•			
	They can explain how - based on the small	•		-	
	an uncertain plant.	gam ancoroni a robast controller can ga	arantee stability	and performance	
	 They understand how analysis and synthesis 	s conditions on feedback loops can be repre	esented as linear	matrix inequalitie	
G1.111					
Skills	 Students are capable of designing and tunin 	g LQG controllers for multivariable plant m	odels.		
	They are capable of representing a H2 or H-	infinity design problem in the form of a ge	neralized plant, a	and of using stand	
	software tools for solving it.				
	 They are capable of translating time and fr 	equency domain specifications for control	loops into const	raints on closed-l	
	sensitivity functions, and of carrying out a m	functions, and of carrying out a mixed-sensitivity design.			
	 They are capable of constructing an LFT u 	ncertainty model for an uncertain system	, and of designi	ng a mixed-object	
robust controller.					
	They are capable of formulating analysis an	d synthesis conditions as linear matrix ine	qualities (LMI), a	ind of using stand	
	LMI-solvers for solving them.They can carry out all of the above using standard software tools (Matlab robust control toolbox).				
	• They can carry out all of the above using sta	indard software tools (Matiab Tobust Contro	ii tooibox).		
Personal Competence					
Social Competence	e Students can work in small groups on specific problems to arrive at joint solutions.				
Autonomy	Students are able to find required information in so	ources provided (lecture notes, literature, s	oftware docume	ntation) and use i	
	solve given problems.				
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56			
Credit points	6				
Course achievement	None				
Examination	Oral exam				
Examination duration and	30 min				
scale					
Assignment for the	Electrical Engineering: Specialisation Control and P	ower Systems Engineering: Elective Comp	ulsory		
Following Curricula	Energy Systems: Core qualification: Elective Comp	ulsory			
	Aircraft Systems Engineering: Core qualification: El	ective Compulsory			
	Mechatronics: Specialisation Intelligent Systems ar	d Robotics: Elective Compulsory			
	Mechatronics: Specialisation System Design: Electi	·			
	Biomedical Engineering: Specialisation Artificial Organization	•	Compulsory		
	Biomedical Engineering: Specialisation Implants an		oulcom.		
	Biomedical Engineering: Specialisation Medical Tec	•	-		
	Biomedical Engineering: Specialisation Managemer Product Development, Materials and Production: Sp				
	Product Development, Materials and Production: Sp Product Development, Materials and Production: Sp	·			
	Product Development, Materials and Production: Sp	·	•		
	Theoretical Mechanical Engineering: Technical Con	·			
	3 3				

Course L0658: Optimal and F	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 F	ourse 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		

Module M0855: Marko	eting (Sales and Services / Innovation	Marketing)			
Courses					
Title		Тур	Hrs/wk	СР	
Marketing of Innovations (L2009)		Lecture	4	4	
PBL Marketing of Innovations (L086	52)	Project-/problem-based Learning	1	2	
Module Responsible	Prof. Christian Lüthje				
Admission Requirements	None				
Recommended Previous	Module International Business				
Knowledge	Basic understanding of business administration	on principles (strategic planning, decisi	on theory, pro	oject management,	
	international business)				
	Bachelor-level Marketing Knowledge (Marketing		egies, Basics o	f Buying Behavior)	
	 Unerstanding the differences beweeth B2B and I Understanding of the importance of managing in 				
	Good English proficiency; presentation skills	movation in global industrial markets			
	After taking part successfully, students have reached the	ne following learning results			
Professional Competence					
Knowledge	Students will have gained a deep understanding of				
	 Specific characteristics in the marketing of innoverse 	rative poroducts and services			
	Approaches for analyzing the current market situ		t		
	The gathering of information about future custor				
	 Concepts and approaches to integrate lead users Approaches and tools for ensuring customer-orie 				
	Marketing mix elements that take into consider				
	services		3		
	Pricing methods for new products and services				
	The organization of complex sales forces and pe	rsonal selling			
	Communication concepts and instruments for ne	w products and services			
Skills	Based on the acquired knowledge students will be able	to:			
	Design and to evaluate decisions regarding mark	ceting and innovation strategies			
	 Analyze markets by applying market and techno 	logy portfolios			
	Conduct forecasts and develop compelling scena				
	Translate customer needs into concepts, protot	• •	fully apply adv	anced methods for	
	customer-oriented product and service development • Use adequate methods to foster efficient diffusion of innovative products and services				
	Use adequate methods to foster efficient diffusion of innovative products and services Choose suitable pricing strategies and communication activities for innovations				
	Make strategic sales decisions for products and services (i.e. selection of sales channels)				
	Apply methods of sales force management (i.e. of the sales)	customer value analysis)			
Personal Competence					
· ·	The students will be able to				
,					
	 have fruitful discussions and exchange argumen develop original results in a group 	ts			
	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 conference	contact and to man this knowledge and	hor now same	ov problem fielde	
	 Acquire knowledge independently in the specific Consider proposed business actions in the field of 	·	ner new compi	ex problem fields.	
	Consider proposed business decions in the field of	in marketing and reneet on them.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points					
Course achievement					
	Subject theoretical and practical work	icination			
Examination duration and scale	Written elaboration, excercises, presentation, oral parti	cipati011			
Assignment for the	Global Technology and Innovation Management & Entre	epreneurship: Core qualification: Compuls	orv		
Following Curricula	•		-		
	Mechanical Engineering and Management: Specialisation		,		
	Biomedical Engineering: Specialisation Artificial Organs	and Regenerative Medicine: Elective Con	npulsory		
	Biomedical Engineering: Specialisation Implants and En				
	Biomedical Engineering: Specialisation Medical Technol		sory		
	Biomedical Engineering: Specialisation Management ar	ia Business Administration: Compulsory			

se L2009: Marketing of		
Тур		
Hrs/wk		
CP Workload in Hours		
Lecturer		
Language	,	
	SoSe	
Content	I. Introduction	
	 Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing) 	
	II. Methods and approaches of strategic marketing planning	
	patterns of industrial development, patent and technology portfolios	
	III. Strategic foresight and scenario analysis	
	objectives and challenges of strategic foresight, scenario analysis, Delphi method	
	IV. User innovations	
	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 Marketing	g 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: Applie	ed Design Methodology in Mechatron	iics			
Courses					
Title		Тур	Hrs/wk	СР	
Applied Design Methodology in Med		Lecture	2	2	
Applied Design Methodology in Med	chatronics (L1524)	Project-/problem-based Learning	3	4	
Module Responsible	Prof. Thorsten Kern				
Admission Requirements	None				
Recommended Previous	Basics of mechanical design, electrical design or comp	outer-sciences			
Knowledge					
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence					
Knowledge	Science-based working on interdisciplinary product de	sign considering targeted application of sp	ecific product	design techniques	
Skills	Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.				
Personal Competence					
Social Competence	Students will solve and execute technical-scientific	tasks from an industrial context in small	design-teams	with application of	
	common, creative methodologies.				
Autonomy	Students are enabled to optimize the design and development process according to the target and topic of the design				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0			
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	30 min Presentation for a group design-work				
scale					
Assignment for the	International Management and Engineering: Specialisa	ation II. Product Development and Production	on: Elective Co	ompulsory	
Following Curricula	International Management and Engineering: Specialisa	ation II. Mechatronics: Elective Compulsory			
	Mechanical Engineering and Management: Specialisat	ion Product Development and Production: E	Elective Comp	ulsory	
	Mechatronics: Specialisation System Design: Elective	Compulsory			
	Biomedical Engineering: Specialisation Artificial Organ	-	npulsory		
	Biomedical Engineering: Specialisation Implants and E	• • •			
	Biomedical Engineering: Specialisation Medical Technol	•	-		
	Biomedical Engineering: Specialisation Management a	·	-		
	Theoretical Mechanical Engineering: Specialisation Pro	·	e Compulsory		
	Theoretical Mechanical Engineering: Technical Comple	ementary Course: Elective Compulsory			

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

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

Knowledge	mistry" module "fundame	Typ Lecture Recitation Section (large) Practical Course	Hrs/wk 2 2 2	CP 3
Bioprocess Engineering - Fundamentals (L0841) Bioprocess Engineering - Fundamentals (L0842) Bioprocess Engineering - Fundamental Practical Course (L0843) Module Responsible Prof. Andreas Liese Admission Requirements None Recommended Previous none, module "organic che Knowledge Educational Objectives After taking part successfi	omistry" module "fundame	Lecture Recitation Section (large)	2	3
Bioprocess Engineering - Fundamentals (L0842) Bioprocess Engineering - Fundamental Practical Course (L0843) Module Responsible Prof. Andreas Liese Admission Requirements None Recommended Previous Knowledge Educational Objectives After taking part successfi	mistry" module "fundame	Recitation Section (large)	2	
Bioprocess Engineering - Fundamental Practical Course (L0843) Module Responsible Prof. Andreas Liese Admission Requirements None Recommended Previous Knowledge Educational Objectives After taking part successfi	omistry" module "fundame			
Module Responsible Prof. Andreas Liese Admission Requirements None Recommended Previous none, module "organic che Knowledge Educational Objectives After taking part successfi	emistry" module "fundame	Tractical course		1 2
Admission Requirements Recommended Previous Knowledge Educational Objectives After taking part successfi	mistry" module "fundame		2	
Recommended Previous none, module "organic che Knowledge Educational Objectives After taking part successful Company (Company Company (Company Company (Company Company (Company (Compa	mistry" module "fundame			
Knowledge Educational Objectives After taking part successful	mistry" module "fundame			
Educational Objectives After taking part successfi	none, module "organic chemistry", module "fundamentals for process engineering"			
	After taking part successfully, students have reached the following learning results			
Professional Competence	llly, students have reached	the following learning results		
Knowledge Students are able to desc enzymes and microorgar rheology can be named	Students are able to describe the basic concepts of bioprocess engineering. They are able to classify different types of kinetics f enzymes and microorganisms, as well as to differentiate different types of inhibition. The parameters of stoichiometry ar rheology can be named and mass transport processes in bioreactors can be explained. The students are capable to expla fundamental bioprocess management, sterilization technology and downstream processing in detail.			
Skills After successful completic	n of this module, students	should be able to		
 predict qualitativel fermentation proce analyze bioprocess distinguish between to compare them a propose solutions t to explore new kno identify scientific process 	 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 			
take position to their own Autonomy After completion of this m	After completion of this module participants should be able to debate technical questions in small teams to enhance the ability take position to their own opinions and increase their capacity for teamwork in engineering and scientific environments.			
Workload in Hours Independent Study Time 9	6 Study Time in Lecture 8	4		
Credit points 6	.,			-
Course achievement Compulsory Bonus For Yes 5 % Su	Compulsory Bonus Form Description			
Examination Written exam				
Examination duration and 90 min scale				
Assignment for the General Engineering Scien	ce (German program, 7 se	mester): Specialisation Process Engine	ering: Compulsory	
		mester): Specialisation Bioprocess Eng	gineering: Compulso	ory
Bioprocess Engineering: C			_	
		isation Bioresource Technology: Electi		
		ins and Regenerative Medicine: Compu	ilsory	
	·	Endoprostheses: Elective Compulsory		
		nology and Control Theory: Elective Co		
		and Business Administration: Elective	Compulsory	
Technomathematics: Spec Process Engineering: Core	ialisation III. Engineering S	cience: Elective 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		
Language	DE		
Cycle	SoSe		
Content	 Introduction: state-of-the-art and development trends in the biotechnology, introduction to the lecture Enzyme kinetics: Michaelis-Menten, differnt types of enzyme inhibition, linearization, conversion, yield, selectivity (Prof. Liese) Stoichiometry: coefficient of respiration, electron balance, degree of reduction, coefficient of yield, theoretical oxygen demand (Prof. Liese) Microbial growth kinetic: batch- and chemostat culture (Prof. Zeng) Kinetic of subtrate consumption and product formation (Prof. Zeng) Rheology: non-newtonian fluids, viscosity, agitators, energy input (Prof. Liese) Transport process in a bioreactor (Prof. Zeng) Technology of sterilization (Prof. Zeng) Fundamentals of bioprocess management: bioreactors and calculation of batch, fed-batch and continuouse bioprocesses (Prof. Zeng/Prof. Liese) Downstream technology in biotechnology: cell breakdown, zentrifugation, filtration, aqueous two phase systems (Prof. Liese) 		
Literature	K. Buchholz, V. Kasche, U. Bornscheuer: Biocatalysts and Enzyme Technology, 2. Aufl. Wiley-VCH, 2012 H. Chmiel: Bioprozeßtechnik, Elsevier, 2006 R.H. Balz et al.: Manual of Industrial Microbiology and Biotechnology, 3. edition, ASM Press, 2010 H.W. Blanch, D. Clark: Biochemical Engineering, Taylor & Francis, 1997 P. M. Doran: Bioprocess Engineering Principles, 2. edition, Academic Press, 2013		

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

Course L0843: 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 M1277: MED I	l: Introduction to Anatomy			
Courses				
Title	Typ Hrs/wk CP			
Introduction to Anatomy (L0384)	Lecture 2 3			
Module Responsible	Prof. Udo Schumacher			
Admission Requirements	None			
Recommended Previous	None			
Knowledge				
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; the			
	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 acqui			
	the relevant knowledge themselves.			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Credit points				
	90 minutes			
scale				
Assignment for the	General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory			
Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic			
	Compulsory			
	Data Science: Specialisation Medicine: Compulsory			
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory			
	Engineering Science: Specialisation Biomedical Engineering: Compulsory			
	General Engineering Science (English program, 7 semester): Specialisation 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			
	recinionadicinades. Specialisation in: Engineering Science, Elective Compulsory			

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

Module M1278: MED I	l: Introduction to Radiology and Radiation Therapy				
Courses					
Title	Typ Hrs/wk CP				
Introduction to Radiology and Radio					
Module Responsible Admission Requirements					
Recommended Previous					
Knowledge					
	After taking part successfully, students have reached the following learning results				
Professional Competence Knowledge	Therapy				
Momeage	The students can distinguish different types of currently used equipment with respect to its use in radiation therapy.				
	The students can explain treatment plans used in radiation therapy in interdisciplinary contexts (e.g. surgery, internal medicine).				
	The students can describe the patients' passage from their initial admittance through to follow-up care.				
	Diagnostics				
	The students can illustrate the technical base concepts of projection radiography, including angiography and mammography, as well as sectional imaging techniques (CT, MRT, US).				
	The students can explain the diagnostic as well as therapeutic use of imaging techniques, as well as the technical basis for those techniques.				
	The students can choose the right treatment method depending on the patient's clinical history and needs.				
	The student can explain the influence of technical errors on the imaging techniques.				
	The student can draw the right conclusions based on the images' diagnostic findings or the error protocol.				
Skills	Therapy				
	The students can distinguish curative and palliative situations and motivate why they came to that conclusion.				
	The students can develop adequate therapy concepts and relate it to the radiation biological aspects.				
	The students can use the therapeutic principle (effects vs adverse effects)				
	The students can distinguish different kinds of radiation, can choose the best one depending on the situation (location of the tumor) and choose the energy needed in that situation (irradiation planning).				
	The student can assess what an individual psychosocial service should look like (e.g. follow-up treatment, sports, social he groups, self-help groups, social services, psycho-oncology).				
	Diagnostics				
	The students can suggest solutions for repairs of imaging instrumentation after having done error analyses.				
	The students can classify results of imaging techniques according to different groups of diseases based on their knowledge o 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 therapeuti 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					
Course achievement					
Examination Examination duration and	Written exam				
examination duration and scale	30 minutes				
Assignment for the Following Curricula					
	Data Science: Specialisation Medicine: Compulsory				
	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory				
	Engineering Science: Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation 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 t	to Radiology and Radiation Therapy
Тур	Lecture
Hrs/wk	2
	3
	Independent Study Time 62, Study Time in Lecture 28
Language	Prof. Ulrich Carl, Prof. Thomas Vestring
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
Literature	"Technik der medizinischen Radiologie" von T. + J. Laubenberg –
	7. Auflage – Deutscher Ärzteverlag – erschienen 1999
	• "Klinische Strahlenbiologie" von Th. Herrmann, M. Baumann und W. Dörr –
	4. Auflage - Verlag Urban & Fischer – erschienen 02.03.2006
	ISBN: 978-3-437-23960-1
	"Strahlentherapie und Onkologie für MTA-R" von R. Sauer –
	5. Auflage 2003 - Verlag Urban & Schwarzenberg – erschienen 08.12.2009
	ISBN: 978-3-437-47501-6
	"Taschenatlas der Physiologie" von S. Silbernagel und A. Despopoulus-
	8. Auflage – Georg Thieme Verlag - erschienen 19.09.2012
	ISBN: 978-3-13-567708-8
	• "Der Körper des Menschen " von A. Faller u. M. Schünke -
	16. Auflage 2004 - Georg Thieme Verlag - erschienen 18.07.2012
	ISBN: 978-3-13-329716-5
	"Praxismanual Strahlentherapie" von Stöver / Feyer –
	1. Auflage - Springer-Verlag GmbH – erschienen 02.06.2000

I: Introduction to Physiology
Typ Hrs/wk CP
Lecture 2 3
Dr. Roger Zimmermann
None
None
After taking part successfully, students have reached the following learning results
The students can
describe the basics of the energy metabolism;
 describe the basics of the energy metabolism, describe physiological relations in selected fields of muscle, heart/circulation, neuro- and sensory physiology.
, , , , , , , , , , , , , , , , , , ,
The students can describe the effects of basic bodily functions (sensory, transmission and processing of information, developme
of forces and vital functions) and relate them to similar technical systems.
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.
The students can derive answers to questions arising in the course and other physiological areas, using technical literature,
themselves.
Independent Study Time 62, Study Time in Lecture 28
3
None
Written exam
60 minutes
General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic
Compulsory
Data Science: Specialisation Medicine: Compulsory
Electrical Engineering: Specialisation Medical Technology: Elective Compulsory
Engineering Science: Specialisation Biomedical Engineering: Elective Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanic Compulsory
General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Elective 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

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

Module M1335: BIO II	: Artificial Joint Replacement			
Courses				
Title		Тур	Hrs/wk	СР
Artificial Joint Replacement (L1306)		Lecture	2	3
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous	Basic knowledge of orthopedic and surgical tech	niques is recommended.		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students can name the different kinds of art	ificial limbs.		
Skille	The students can explain the advantages and dis	sadvantages of different kinds of endonr	otheses	
SKIIIS	The students can explain the advantages and dis	sadvantages of different kinds of endopto	otileses.	
Personal Competence				
Social Competence	The students are able to discuss issues related to	o endoprothese with student mates and	the teachers.	
Autonomy	The students are able to acquire information on	their own. They can also judge the inforn	nation with respect to	its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lectu	ire 28		
Credit points	3			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	International Management and Engineering: Spe	cialisation II. Process Engineering and Bio	otechnology: Elective	Compulsory
Following Curricula	Materials Science: Specialisation Nano and Hybri	id Materials: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial G	Organs and Regenerative Medicine: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation Implants			
	Biomedical Engineering: Specialisation Medical T	• • • • • • • • • • • • • • • • • • • •		
	Biomedical Engineering: Specialisation Managem		re Compulsory	
	Orientation Studies: Core qualification: Elective C	' '		
	Theoretical Mechanical Engineering: Technical Co	·	•	
	Theoretical Mechanical Engineering: Specialisation	on Bio- and Medical Technology: Elective	Compulsory	

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

Module M0845: Feedl	oack Control in Medical Tech	nology		
Courses				
Title		Тур	Hrs/wk	СР
Feedback Control in Medical Techn	ology (L0664)	Lecture	2	3
Module Responsible	Johannes Kreuzer			
Admission Requirements	None			
Recommended Previous	Basics in Control, Basics in Physiology			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	The lecture will introduce into the fascir human physiology will be similarly introdu	nating area of medical technology with the enguced like knowledge in control theory.	gineering point of vie	w. Fundamentals in
	Internal control loops of the human bod example in for anesthesia control.	y will be discussed in the same way like the	design of external clo	osed loop system fo
	The handling of PID controllers and mo- illustrated. The operation of simple equiva	dern controller like predictive controller or fuz alent circuits will be discussed.	zzy controller or neu	ral networks will be
Skills	Application of modeling, identification, co	ntrol technology in the field of medical technolo	gy.	
Personal Competence Social Competence	Students can develop solutions to specific	problems in small groups and present their res	ults	
Autonomy		sture and to set it into the context of the lecture their learning process. They can combine kno		
Workload in Hours	Independent Study Time 62, Study Time i	n Lecture 28		
Credit points	3			
Course achievement	None			
Examination	Oral exam			
Examination duration and	20 min			
scale				
Assignment for the	Electrical Engineering: Specialisation Med	ical Technology: Elective Compulsory		
Following Curricula	Electrical Engineering: Specialisation Conf	trol and Power Systems Engineering: Elective Co	mpulsory	
	Biomedical Engineering: Specialisation Im	plants and Endoprostheses: Elective Compulsor	у	
	Biomedical Engineering: Specialisation Ar	tificial Organs and Regenerative Medicine: Elect	ive Compulsory	
	Biomedical Engineering: Specialisation Ma	anagement and Business Administration: Electiv	e Compulsory	
	Biomedical Engineering: Specialisation Me	edical Technology and Control Theory: Compulso	ory	

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

Module M0635: Medic	al Technology Lab					
Courses						
Title				Тур	Hrs/wk	СР
Medical Technology Lab (L1096)				Project-/problem-based Learning	6	6
Module Responsible	Prof. Alexander Schlaefer					
Admission Requirements	None					
Recommended Previous	sound programming skills (Jav	/a / C++)				
Knowledge	skills in R/Matlab					
	knowledge of image processi	ng				
	principles of math (algebra, a	nalysis/calculus)				
	principles of stochastics					
Educational Objectives	After taking part successfully	students have read	hed the followin	g learning results		
Professional Competence						
Knowledge	The students recognize the c	omplexity of medica	al technology and	d can explain, which methods a	are appropriat	e to solve a problem
	at hand.					
Skills	The students are able to anal	yze and solve proble	ems in medical to	echnology.		
Personal Competence						
Social Competence	The students can define pro appropriate manner.	ject aims and scop	e and organize	the project as team work. The	ey can preser	nt their results in an
Autonomy	•	•		eir individual work with other g by doing a specific literature res	•	s. They deliver their
Workload in Hours	Independent Study Time 96, 9	Study Time in Lectur	re 84			
Credit points	6					
Course achievement	CompulsoryBonusFormYesNoneGroup	discussion	Description			
Examination	Written elaboration					
Examination duration and scale	approx. 8 pages, time frame:	over the course of t	the semester			
Assignment for the	Electrical Engineering: Specia	lisation Medical Tec	hnology: Elective	e Compulsory		
Following Curricula	Biomedical Engineering: Spec	ialisation Medical Te	echnology and Co	ontrol Theory: Elective Compuls	sory	

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

	nced Topics in Control			
Courses				
Title		Тур	Hrs/wk	СР
Advanced Topics in Control (L0661) Advanced Topics in Control (L0662)		Lecture Recitation Section (small)	2	3
Module Responsible		Nectration Section (Smail)	2	3
Admission Requirements				
	H-infinity optimal control, mixed-sensitivity des	ign linear matrix inequalities		
Knowledge		ign, inteal matrix inequalities		
	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	Students can explain the advantages and They can explain the representation of n They can explain how stability and perfo They can explain how gridding technique	d shortcomings of the classical gain scheduling onlinear systems in the form of quasi-LPV systrmance conditions for LPV systems can be fornes can be used to solve analysis and synthesis FT representations of LPV systems and somuctures	ems nulated as LMI co problems for LPV	systems
	systems • They can explain the convergence prope	retic concepts are used to represent the concepts of first order consensus protocols conditions for formation control loops involving		
	to an actuator/sensor array	presentation of spatially invariant distributed synsion of the bounded real lemma to such distributers		
Skills	Students are capable of constructing L scheduled controllers; they can do this u They are able to use standard software t	PV models of nonlinear plants and carry our sing polytopic, LFT or general LPV models ools (Matlab robust control toolbox) for these to formation controllers for groups of agents with the controllers for groups with the controll	asks	
Personal Competence Social Competence Autonomy	Students can work in small groups and arrive a	•	·	
Workload in House	Independent Study Time 124 Study Time in La	cture 56		
Workload in Hours		cture 56		
Credit points	6	cture 56		
Credit points Course achievement	6 None	cture 56		
Credit points Course achievement Examination	6 None Oral exam	cture 56		
Credit points Course achievement	6 None Oral exam 30 min	cture 56		
Credit points Course achievement Examination Examination duration and scale	6 None Oral exam 30 min		ulsory	
Credit points Course achievement Examination Examination duration and scale	6 None Oral exam 30 min Electrical Engineering: Specialisation Control ar	nd Power Systems Engineering: Elective Compu	ulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Oral exam 30 min Electrical Engineering: Specialisation Control ar	nd Power Systems Engineering: Elective Compu ionic Systems: Elective Compulsory	ulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Oral exam 30 min Electrical Engineering: Specialisation Control ar Aircraft Systems Engineering: Specialisation Av Aircraft Systems Engineering: Specialisation Air Aircraft Systems Engineering: Core qualification	nd Power Systems Engineering: Elective Compu ionic Systems: Elective Compulsory rcraft Systems: Elective Compulsory n: Elective Compulsory	·	
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 None Oral exam 30 min Electrical Engineering: Specialisation Control ar Aircraft Systems Engineering: Specialisation Av Aircraft Systems Engineering: Specialisation Air	nd Power Systems Engineering: Elective Compu ionic Systems: Elective Compulsory rcraft Systems: Elective Compulsory n: Elective Compulsory	·	
Credit points Course achievement Examination Examination duration and scale Assignment for the	Oral exam 30 min Electrical Engineering: Specialisation Control ar Aircraft Systems Engineering: Specialisation Av Aircraft Systems Engineering: Specialisation Air Aircraft Systems Engineering: Core qualification International Management and Engineering: Sp Mechatronics: Specialisation System Design: El	nd Power Systems Engineering: Elective Computionic Systems: Elective Compulsory craft Systems: Elective Compulsory n: Elective Compulsory ecialisation II. Mechatronics: Elective Compulsor	·	
Credit points Course achievement Examination Examination duration and scale Assignment for the	Oral exam 30 min Electrical Engineering: Specialisation Control ar Aircraft Systems Engineering: Specialisation Av Aircraft Systems Engineering: Specialisation Air Aircraft Systems Engineering: Core qualification International Management and Engineering: Sp Mechatronics: Specialisation System Design: El Mechatronics: Specialisation Intelligent System	nd Power Systems Engineering: Elective Compu- ionic Systems: Elective Compulsory craft Systems: Elective Compulsory n: Elective Compulsory ecialisation II. Mechatronics: Elective Compulsor ective Compulsory s and Robotics: Elective Compulsory	·	
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Oral exam 30 min Electrical Engineering: Specialisation Control ar Aircraft Systems Engineering: Specialisation Av Aircraft Systems Engineering: Specialisation Air Aircraft Systems Engineering: Core qualification International Management and Engineering: Sp Mechatronics: Specialisation System Design: El Mechatronics: Specialisation Intelligent System Biomedical Engineering: Specialisation Implants	nd Power Systems Engineering: Elective Compu- ionic Systems: Elective Compulsory craft Systems: Elective Compulsory n: Elective Compulsory ecialisation II. Mechatronics: Elective Compulsor ective Compulsory s and Robotics: Elective Compulsory s and Endoprostheses: Elective Compulsory	ory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Oral exam 30 min Electrical Engineering: Specialisation Control ar Aircraft Systems Engineering: Specialisation Av Aircraft Systems Engineering: Specialisation Air Aircraft Systems Engineering: Core qualification International Management and Engineering: Sp Mechatronics: Specialisation System Design: El Mechatronics: Specialisation Intelligent System Biomedical Engineering: Specialisation Implant: Biomedical Engineering: Specialisation Medical	nd Power Systems Engineering: Elective Computionic Systems: Elective Compulsory craft Systems: Elective Compulsory n: Elective Compulsory ecialisation II. Mechatronics: Elective Compulsor ective Compulsory s and Robotics: Elective Compulsory s and Endoprostheses: Elective Compulsory Technology and Control Theory: Elective Comp	ory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Oral exam 30 min Electrical Engineering: Specialisation Control ar Aircraft Systems Engineering: Specialisation Av Aircraft Systems Engineering: Specialisation Air Aircraft Systems Engineering: Core qualification International Management and Engineering: Sp Mechatronics: Specialisation System Design: El Mechatronics: Specialisation Intelligent System Biomedical Engineering: Specialisation Implant: Biomedical Engineering: Specialisation Medical Biomedical Engineering: Specialisation Manage	nd Power Systems Engineering: Elective Computionic Systems: Elective Compulsory craft Systems: Elective Compulsory n: Elective Compulsory ecialisation II. Mechatronics: Elective Compulsory es and Robotics: Elective Compulsory s and Endoprostheses: Elective Compulsory Technology and Control Theory: Elective Compunent and Business Administration: Elective Compunent	ory pulsory mpulsory	
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Oral exam 30 min Electrical Engineering: Specialisation Control ar Aircraft Systems Engineering: Specialisation Av Aircraft Systems Engineering: Specialisation Air Aircraft Systems Engineering: Core qualification International Management and Engineering: Sp Mechatronics: Specialisation System Design: El Mechatronics: Specialisation Intelligent System Biomedical Engineering: Specialisation Implant: Biomedical Engineering: Specialisation Medical	nd Power Systems Engineering: Elective Computionic Systems: Elective Compulsory craft Systems: Elective Compulsory n: Elective Compulsory ecialisation II. Mechatronics: Elective Compulsory s and Robotics: Elective Compulsory s and Endoprostheses: Elective Compulsory Technology and Control Theory: Elective Compunent and Business Administration: Elective Coll Organs and Regenerative Medicine: Elective Co	ory pulsory mpulsory	

Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Course L0661: Advanced Top	oics 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
	Linear and Nonlinear Model Predictive Control based on LMIs
Literature	Werner, H., Lecture Notes "Advanced Topics in Control"
	Selection of relevant research papers made available as pdf documents via StudIP

Course L0662: Advanced Top	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	

important effects that these models predict for biological tissue, they can order the effects corresponding to wavelength a frequency, respectively, and they can analyze them in a quantitative way. They are able to develop validation strategies for the	module 140340. Block	ectromagnetics: Principles a	ma Applications			
Biolectormagnetics Principles and Applications (1973) Solidation (1973) Rectation Section (1974) 2 1 Module Responsible Prof. Christian Schuster Prof.	Courses					
Recitation Section (small) 2 1	Title			Тур	Hrs/wk	СР
Module Responsible Admission Requirements None Recommended Previous Knowledge Educational Objectives After taking part successfully, students have reached the following learning results Educational Objectives After taking part successfully, students have reached the following learning results After taking part successfully, students have reached the following learning results Accommended Previous Students can explain the basic principles, relationships, and methods of bloelectromagnetics, i.e. the quantification and applicat of electromagnetic fields in biological tissue. They can define and exemplify the most important physical phenomena and or them corresponding to wavelength and frequency of the fields. They can give an overview ower meanment and numer techniques for characterization 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 do this they can relate to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the m important effects that these models predict for biological Busse, they can order the effects ordered the ordered previously to the elementary solutions of Maxwell's Equations. They are able to assess the m important effects that these models predict for biological Busse, they can order the effects or predictions. They are able to assess the m important effects that these models predict for biological Busse, they can order the effects organized provides Personal Competence Personal Competence Social Competence	,					
Admission Requirements Recommended Previous Basic principles of physics Nowledge Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students can explain the basic principles, relationships, and methods of bioelectromagnetics, i.e. the quantification and applicate of electromagnetic fields in biological tissue. They can define and exemplify the most important physical phenomena and on them corresponding to wavelength and frequency of the fields. They can give an overview over measurement and numeri techniques for characterization of electromagnetic fields in practical applications. They can give examples for therapeutic a diagnostic utilization of electromagnetic fields in medical technology. Skillis Students know how to apply various methods to characterize the behavior of electromagnetic fields in proceeding the process of the elementary solutions of Maxwell's Equations. They are able to assess the minoratant effects that these models predict for biological tissue, they can order the effects correctly applications and refer the refrest or electromagnetic fields for therapeutic and diagnostic applications and make appropriate choice. Personal Competence Social Competence Socia	Bioelectromagnetics: Principles and	d Applications (L0373)		Recitation Section (small)	2	1
Recommended Previous Knowledge Educational Objectives Professional Competence Knowledge Students can explain the basic principles, relationships, and methods of bioelectromagnetics, i.e. the quantification and applicate of electromagnetic fields in biological tissue. They can define and exemplify the most important physical phenomena and on them corresponding to wavelength and frequency of the fields. They can give an overview over measurement and numeri techniques for characterization of electromagnetic fields in practical applications. They can give examples for therapeutic a diagnostic utilization of electromagnetic fields in medical technology. Skillb Students know how to apply various methods to characterize the behavior of electromagnetic fields in biological tissue. In order to the predictions. They are able to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the mimportant effects that these models predict for biological tissue, they can order the effects corresponding to wavelength a predictions. They are able to evaluate the effects of electromagnetic fields for therapeutic and diagnostic applications and make appropriate choice. Personal Competence Social Competence Soc	Module Responsible	Prof. Christian Schuster				
Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Students can explain the basic principles, relationships, and methods of bioelectromagnetics, i.e. the quantification and applicate of electromagnetic fields in biological tissue. They can define and exemptify the most important physical phenomena and or them: corresponding to wavelength and frequency of the fields. They can give an overview over measurement and numer to chinques for characterization of electromagnetic fields in practical applications. They can give examples for therapeutic a diagnostic utilization 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 apply various methods to characterize the behavior of electromagnetic fields in biological tissue. In order do this they can relate to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the mimportant effects that these models predict for biological tissue, they can order the effects corresponding to wavelength a frequency, respectively, and they can analyze them in a quantitative way. They are able to wavelength a frequency, respectively, and they can analyze them in a quantitative way. They are able to mavelength a frequency, respectively, and they can analyze them in a quantitative way. They are able to present their results effectively english (e.g. during small group exercises). Personal Competence Social Competence Social Competence Sudents are capable to work together on subject related tasks in small groups. They are able to present their results effectively english (e.g. during small group exercises). Autonomy Sudents are able to work together on subject related tasks in small groups. They are able to present their information from subject related, professional publications and relate that information to the co	Admission Requirements	None				
Personal Competence		Basic principles of physics				
Professional Competence Knowledge Knowledge Knowledge Knowledge Students can explain the basic principles, relationships, and methods of bioelectromagnetics, i.e. the quantification and applicate of electromagnetic fields in biological tissue. They can define and exemplify the most important physical phenomena and or them corresponding to wavelength and frequency of the fields. They can give an overview over measurement and numerity techniques for characterization of electromagnetic fields in mactical applications. They can give examples for therapeutic a 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 do this they can relate to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the mimportant effects that these models predict for biological tissue, they can order the effects corresponding to wavelength a frequency, respectively, and they can enable the effects of electromagnetic fields for therapeutic and diagnostic applications and make appropriate choice. Personal Competence Social Competence Social Competence Social Competence Social Competence Social Competence Social Competence Sudents are capable to work together on subject related tasks in small groups. They are able to present their results effectively English (e.g. during small group exercises). Autonomy Students are capable to gather information from subject related, professional publications and relate that information to to context of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communic problems and effects in the field of bioelectromagnetic fields, fundamentals of electrical engineering / physics). They can communicate problems and effects in the field of	Knowledge					
Professional Competence Knowledge Knowledge Knowledge Knowledge Students can explain the basic principles, relationships, and methods of bioelectromagnetics, i.e. the quantification and applicate of electromagnetic fields in biological tissue. They can define and exemplify the most important physical phenomena and or them corresponding to wavelength and frequency of the fields. They can give an overview over measurement and numerity techniques for characterization of electromagnetic fields in mactical applications. They can give examples for therapeutic a 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 do this they can relate to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the mimportant effects that these models predict for biological tissue, they can order the effects corresponding to wavelength a frequency, respectively, and they can enable the effects of electromagnetic fields for therapeutic and diagnostic applications and make appropriate choice. Personal Competence Social Competence Social Competence Social Competence Social Competence Social Competence Social Competence Sudents are capable to work together on subject related tasks in small groups. They are able to present their results effectively English (e.g. during small group exercises). Autonomy Students are capable to gather information from subject related, professional publications and relate that information to to context of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communic problems and effects in the field of bioelectromagnetic fields, fundamentals of electrical engineering / physics). They can communicate problems and effects in the field of	Educational Objections	A Strand Library and Automotive Inc.				
Xnowledge **Xnowledge** **Students can explain the basic principles, relationships, and methods of bioelectromagnetics, i.e. the quantification and applicat of electromagnetic fields in biological bissue. They can define and exemplify the most important physical phenomena and the morresponding to wavelength and frequency of the fields. They can give an overview over measurement and numeri techniques for characterization of electromagnetic fields in practical applications. They can give examples for therapeutic a diagnostic utilization of electromagnetic fields in medical technology. **Skills** **Skudents** know how to apply various methods to characterize the behavior of electromagnetic fields in biological tissue. In order do this they can relate to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the mimportant effects that these models predict for biological tissue, they can order the effect corresponding to wavelength a frequency, respectively, and they can analyze them in a quantitative way. They are able to develop validation strategies for the predictions. They are able to evaluate the effects of electromagnetic fields for therapeutic and diagnostic applications and make appropriate choice. **Personal Competence** **Scial Competence** **Scial Competence** **Scial Competence** **Scial Competence** **Sudents are capable to gather information from subject related tasks in small groups. They are able to present their results effectively context of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communical problems and effects in the field of bioelectromagnetic fields, fundamentals of electrical engineering / physics). They can communical problems and effects in the field of bioelectromagnetic fields, fundamentals of electrical engineering / physics). They can communically probl	-		lave reached the followi	ng learning results		
of electromagnetic fields in biological tissue. They can define and exemplify the most important physical phenomena and or them corresponding to wavelength and frequency of the fields. They can give an overview over measurement and numeri techniques for characterization of electromagnetic fields in practical applications. They can give examples for therapeutic a 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 do this they can relate to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the minportant effects that these models predict for biological tissue, they can order the effects corresponding to wavelength a requency, respectively, and they can analyze them in a quantitative way. They are able to evaluate the effects of electromagnetic fields for therapeutic and diagnostic applications and make appropriate choice. Personal Competence Social Competence Social Competence Sudents are able to work together on subject related tasks in small groups. They are able to present their results effectively English (e.g. during small group exercises). Students are capable to gather information from subject related, professional publications and relate that information to tontext of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content of their lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communical problems and effects in the field of bioelectromagnetics in English. Workload in Hours North lectures (e.g., theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communically the problems and effects in the field of bioelectromagnetics in English. Semination duration and scale is a seminary of the problems of the problems of the problems of the problems of the	•		relationshins and met	hads of hipelectromagnetics	i e the quantific:	ation and applicati
do this they can relate to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the m important effects that these models predict for biological tissue, they can order the effects corresponding to wavelength a frequency, respectively, and they can analyze them in a quantitative way. They are able to develop validation strategies for the predictions. They are able to evaluate the effects of electromagnetic fields for therapeutic and diagnostic applications and make appropriate choice. Personal Competence Social Competence Students are able to work together on subject related tasks in small groups. They are able to present their results effectively English (e.g. during small group exercises). Autonomy Students are capable to gather information from subject related, professional publications and relate that information to tocontext of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communic problems and effects in the field of bioelectromagnetics in English. Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points Compulsory Bonus Form Description Examination Compulsory Bonus Form Description Examination duration and scale Assignment for the Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Special		of electromagnetic fields in biological ti them corresponding to wavelength and techniques for characterization of elect	ssue. They can define a f frequency of the field romagnetic fields in pra	and exemplify the most imposes. They can give an overvieus catical applications. They ca	ortant physical ph ew over measure	nenomena and ord ment and numerio
Scial Competence Students are able to work together on subject related tasks in small groups. They are able to present their results effectively English (e.g. during small group exercises). Autonomy Students are capable to gather information from subject related, professional publications and relate that information to tocontext of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communical problems and effects in the field of bioelectromagnetics in English. Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points Course achievement Yes None Presentation Examination Examination duration and scale Assignment for the Following Curricula Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Computibility: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology: Elective Medicine: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	Skills	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 are				
context of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communicate problems and effects in the field of bioelectromagnetics in English. Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points Course achievement Compulsory Bonus Form Description Yes None Presentation Examination duration and scale Assignment for the Following Curricula Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: 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 Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	•	Students are able to work together on s	•	small groups. They are able	to present their	results effectively
Credit points 6 Course achievement	Autonomy	context of the lecture. They are able to other lectures (e.g. theory of electroma	make a connection bet	ween their knowledge obtain	ned in this lecture	with the content
Course achievement Yes None Presentation Examination Oral exam Examination duration and scale Assignment for the Following Curricula International Management and Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 70			
Yes None Presentation Examination Oral exam Assignment for the Following Curricula Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: 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 Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	Credit points	6				
Examination duration and scale Assignment for the Following Curricula Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	Course achievement	Compulsory Bonus Form	Description			
Assignment for the Following Curricula Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory		Yes None Presentation				
Assignment for the Following Curricula Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	Examination	Oral exam				
Assignment for the Following Curricula Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	Examination duration and	45 min				
Following Curricula Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	scale					
Following Curricula Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	Assignment for the	Flectrical Engineering: Specialisation Mic	crowave Engineering Or	ntics and Electromagnetic Co	mnatihility: Flecti	ve Compulsory
International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory	•	3 3 1	3 3. 1		,,,, 2,000	
Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory			•		Compulsory	
Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory		3	3 1	3 3	. ,	
Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory						
Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory			•			
Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory		, ,		•	puisoi y	
					mulson	
					iipaisoi y	

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

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

Thesis

	er Thesis		
Courses			
Γitle	Тур	Hrs/wk	СР
Module Responsible	Professoren der TUHH		
Admission Requirements			
	According to General Regulations §21 (1):		
	At least 60 credit points have to be achieved in study programme. The examinations boar	d decides on e	excentions
	Actions of creat points have to be defined an study programme. The examinations boar	a acciacs on c	жеериона.
Recommended Previous			
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge			
	The students can use specialized knowledge (facts, theories, and methods) of their states.	ubject compet	ently on specialize
	issues.		
	The students can explain in depth the relevant approaches and terminologies in one	e or more are	eas of their subjec
	describing current developments and taking up a critical position on them.		
	The students can place a research task in their subject area in its context and describe	and critically	assess the state of
	research.		
Skills	The students are able:		
	To select, apply and, if necessary, develop further methods that are suitable for solving the methods the methods that are suitable for solving the methods the methods that are suitable for solving the methods the methods the methods the methods that are suitable for solving the methods the methods the method that are		
	To apply knowledge they have acquired and methods they have learnt in the course of the course	of their studies	s to complex and/o
	incompletely defined problems in a solution-oriented way.		
	To develop new scientific findings in their subject area and subject them to a critical asset	ssment.	
Personal Competence			
Social Competence	Students can		
	Both in writing and orally outline a scientific issue for an expert audience accurately, u	nderstandably	and in a structure
	way.		
	Deal with issues competently in an expert discussion and answer them in a manner that	t is appropria	te to the addressee
	while upholding their own assessments and viewpoints convincingly.		
Autonomy	Students are able:		
Autonomy	Students are able.		
	To structure a project of their own in work packages and to work them off accordingly.		
	To work their way in depth into a largely unknown subject and to access the information r	equired for the	em to do so.
	To apply the techniques of scientific work comprehensively in research of their own.		
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0		
Credit points	. 30		
Course achievement	None		
Examination	Thesis		
Examination duration and	According to General Regulations		
scale			
	Civil Engineering: Thesis: Compulsory		
Following Curricula			
. July ming curricula	Chemical and Bioprocess Engineering: Thesis: Compulsory		
	Computer Science: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory		
	Energy and Environmental Engineering: Thesis: Compulsory		
	Energy Systems: Thesis: Compulsory		
	Environmental Engineering: Thesis: Compulsory		
	Aircraft Systems Engineering: Thesis: Compulsory		
	Global Innovation Management: Thesis: Compulsory		
	Computational Science and Engineering: Thesis: Compulsory		
	Information and Communication Systems: Thesis: Compulsory		
	Interdisciplinary Mathematics: Thesis: Compulsory		
	Interdisciplinary Mathematics: Thesis: Compulsory		
	Interdisciplinary Mathematics: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory		
	Interdisciplinary Mathematics: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Compulsory		
	Interdisciplinary Mathematics: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory		

Module Manual M.Sc. "Biomedical Engineering"

I	Mechatronics: Thesis: Compulsory
	Biomedical Engineering: Thesis: Compulsory
	Microelectronics and Microsystems: Thesis: Compulsory
	Product Development, Materials and Production: Thesis: Compulsory
	Renewable Energies: Thesis: Compulsory
	Naval Architecture and Ocean Engineering: Thesis: Compulsory
	Ship and Offshore Technology: Thesis: Compulsory
	Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory
	Theoretical Mechanical Engineering: Thesis: Compulsory
	Process Engineering: Thesis: Compulsory
	Water and Environmental Engineering: Thesis: Compulsory
	Certification in Engineering & Advisory in Aviation: Thesis: Compulsory