Karlsruhe Institute of Technology

Module Handbook
BSc Mechatronics and Information Technology (B.Sc.)

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Faculty of Mechanical Engineering
Faculty of Electrical Engineering and Information Technology

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1 Actual Changes

Important changes are pointed out in this section in order to provide a better orientation. Although this process was done with great care, other/minor changes may exist.

2595466 - Foundations of Digital Services (S. 188)

Anmerkungen

This course was formerly named “eServices”.
The credits have been changed from 5 to 4,5.

2 Modules

2.1 All Modules

Module: Advanced Mathematics [BSc-Modul 01, HM]

Coordination: A. Kirsch, T. Arens, F. Hettlich
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
21	Every term	3

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
0131000	Advanced Mathematics I (p. 241)	4	W	7	A. Kirsch, T. Arens, F. Hettlich
0180800	Advanced Mathematics II (p. 242)	4	S	7	A. Kirsch, T. Arens, F. Hettlich
0131400	Advanced Mathematics III (p. 243)	4	W	7	A. Kirsch, T. Arens, F. Hettlich

Learning Control / Examinations
written exam
The module grade will be computed by the grades of the lectures of the module weighted by credit points.

Conditions
None.

Qualification Goals
The students know the basic facts and tools of one dimensional analysis. The students know the basics on vector spaces and multi-dimensional calculus and the basic techniques to solve differential equations. The students know techniques and applications of the multi-dimensional calculus (vector calculus) and have basic knowledge on partial differential equations and stochastics.

Content
Basic concepts, sequences and convergence, functions and continuity, series, differential calculus of one variable, integral calculus, vector spaces, differential equations, Laplace transform, vector-valued functions of several variables, applications of multi-dimensional calculus, domain integral, vector analysis, partial differential equations, Fourier theory, stochastics

Module: Engineering Mechanics [BSc-MIT - B2]

Coordination: T. Böhlke, W. Seemann
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
16	Every term	3

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2161245	Engineering Mechanics I (p. 495)	5	W	6	T. Böhlke, T. Langhoff
2162250	Engineering Mechanics II (p. 496)	4	S	5	T. Böhlke, T. Langhoff
2161203	Engineering Mechanics III (p. 497)	4	W	5	W. Seemann, Assistenten

Learning Control / Examinations
prerequisite: attestation each semester by weekly homework assignments
"Engineering Mechanics I", written, 90 minutes;
"Engineering Mechanics II", written, 90 minutes;
"Engineering Mechanics III", written, 90 minutes

Conditions
None.

Qualification Goals
After finishing the lectures EM I and EM II the students can

- assess stress and strain distributions for the basic load cases within the framework of thermoelasticity
- compute and evaluate 3D stress and strain states
- apply the principle of virtual displacements
- apply energy methods and compute approximate solutions
- evaluate the stability of equilibrium positions
- list elastic-plastic material laws
- solve worksheet problems to topics of the lecture using the computer algebra system MAPLE.

In this lecture and tutorial students learn how to describe models of systems for a plain motion. They realize how to calculate speed and acceleration. The derivation of equations of motion for systems of particles and rigid bodies can be done. The students know the dependence of the kinetic energy on the kinetic quantities and the inertia parameters of the system and can apply the principle of work or the principle of the conservation of mechanical energy for conservative systems.

Content
See detailed descriptions to lectures "Engineering Mechanics I-III"

Module: Electronics Basics I [BSc-MIT - B3]

Coordination: A. Stahl
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13.5		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23256	Linear Electronic Networks (p. 288)	4	W	6	O. Dössel
23617	Tutorial - Linear Electronic Networks (p. 518)	1	W	1.5	G. Lenis
23655	Electronic Devices and Circuits (p. 150)	4	S	6	M. Siegel

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Basics of Information Technology [BSc-MIT - B4]

Coordination: A. Stahl
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13.5		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23615	Digital System Design (p. 127)	3	W	4	J. Becker
23617	Tutorial in Digital System Design (p. 523)	1	W	2	J. Heißwolf
23622	Information Technology (p. 256)	2	S	3	K. Müller-Glaser
23624	Tutorial Information Technology (p. 520)	1	S	1.5	K. Müller-Glaser
23626	Information Technology Lab (p. 401)	2	S	3	K. Müller-Glaser

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Electronics Basics II [BSc-MIT - B5]

Coordination: A. Stahl
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
15		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23055	Electromagnetic Fields and Waves (p. 177)	4	W	6	G. Trommer
23057	Tutorial - Electromagnetic Fields and Waves (p. 517)	2	W	3	G. Trommer
23307	Electrical Machines and Power Electronics (p. 146)	2	W	6	M. Braun

Learning Control / Examinations

Conditions

None.

Qualification Goals

Content

Module: Mechanical Design [BSc-MIT - B6]

Coordination: S. Matthiesen
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
7	Every term	2

Courses in module

ID	Course		Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2145179	Mechanical Design (CIW/VT/MIT/IP-M) (p. 301)	I	3	W	3	S. Matthiesen
2146195	Mechanical Design (CIW/VT/MIT/IP-M) (p. 303)	II	4	S	4	S. Matthiesen

Learning Control / Examinations
The written examination with theoretical and design part concerning the whole teaching program of mechanical design I - II.

Conditions
Requirement for a qualification for the exam is the successful participation in mechanical design I and II.

Qualification Goals
The students are able to ...

- analyze the function of unknown machine elements.
- use the interpretation and dimensioning guidelines according the common standardization regulations.
- identify technical problems and to work out and evaluate systematic solutions.
- illustrate problem solving's in technical drawings and cad models according the common standardization regulations.
- estimate the volume and time need of the given tasks and to split them between the team members.
- synthesize the design steps of product engineering by means of a complex technical system.

Content
See detailed descriptions to mechanical design I and II.

Module: Automation Technology [BSc-MIT - B7]

Coordination: A. Stahl
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
9		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23157	Tutorial - System Dynamics and Control Engineering (p. 519)	2	S	3	S. Hohmann
23109	Signals and Systems (p. 446)	2/2	W	6	F. Puente, F. Puente León
23155	System Dynamics and Control Engineering (p. 487)	2	S	3	M. Kluwe, S. Hohmann

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Mechatronics and Products [BSc-MIT - B8]

Coordination: S. Matthiesen
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
11		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2110085	Production Operations Management (p. 93)	4	S	5	K. Furmans, G. Lanza, F. Schultmann, B. Deml
2145161	Mechatronical Systems and Products (p. 319)	3	W	3.5	S. Matthiesen, S. Hohmann
2145162	Workshop Mechatronical Systems and Products (p. 564)	2	W	2.5	S. Matthiesen, S. Hohmann

Learning Control / Examinations
The assessment is carried out as a written exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
none

Recommendations
none

Qualification Goals
according to the single module components

Content
according to the single module components

Module: Energie- und Elektrische Antriebstechnik (ETIT) [BSc-MIT - B-PE1]

Coordination: M. Doppelbauer
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13.5		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23324	Design of electrical machines (p. 162)	3	W	4.5	M. Doppelbauer
23311	Practical Aspects of Electrical Drives (p. 402)	3	S	4.5	M. Braun
23391/23393	Systems for Electrical Energy (p. 148)	2/1	S	4,5	T. Leibfried

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Bauelemente der Elektrotechnik (ETIT) [BSc-MIT - B-PE2]

Coordination: C. Koos
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13.5		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23704	Solid-State Electronics (p. 182)	3	S	4.5	U. Lemmer
23206	Passive Components (p. 383)	3	W	4.5	E. Ivers-Tiffée
23456	Semiconductor Components (p. 227)	2+1	W	4,5	C. Koos

Learning Control / Examinations

Conditions

None.

Qualification Goals

Content

Module: Kommunikationstechnik (ETIT) [BSc-MIT - B-PE3]

Coordination: T. Zwick
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
15		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23406	Fundamentals of Microwave Engineering (p. 206)	3	W	4.5	T. Zwick
23506	Nachrichtentechnik I (p. 349)	3/1	S	6	F. Jondral
23505 + 23507	Probability Theory (p. 547)	3	W	4,5	F. Jondral

Learning Control / Examinations

Conditions

None.

Qualification Goals

Content

Module: Werkstoffe des Maschinenbaus (MACH) [BSc-MIT - B-PM1]

Coordination: J. Schneider
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
9		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2181555	Materials Science and Engineering for ciw, vt, MIT (p. 552)	4	W	4	J. Schneider
2182562	Materials Science and Engineering II for ciw, vt, MIT (p. 553)	4	S	5	J. Schneider

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Thermodynamik (MACH) [BSc-MIT - B-PM2]

Coordination: U. Maas
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13.5		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2165501	Technical Thermodynamics and Heat Transfer I (p. 500)	3	W	7	U. Maas
2153412	Fluid Mechanics (p. 475)	4	W	7	B. Frohnapfel

Learning Control / Examinations
Written

Conditions
None.

Recommendations
Attendence of tutorials.

Qualification Goals

Content

Module: Entwicklung und Konstruktion (MACH) [BSc-MIT - B-PM3]

Coordination: A. Albers
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
14		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2145151	Mechanical Design III (p. 305)	4	W	4	A. Albers, N. Burkardt
2146177	Mechanical Design IV (p. 306)	3	S	4	A. Albers, N. Burkardt
2146190	Lightweight Engineering Design (p. 274)	2	S	4	A. Albers, N. Burkardt
2145154	MD - Team Orientated Mechanical Design (3 + 4) (p. 334)	2	W/S	2	A. Albers, N. Burkardt

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Informatik (Technische Informatik) [BSc-MIT - B-PI1]

Coordination: W. Karl
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
12		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
24576	Real-Time Systems (p. 130)	3/1	S	6	B. Hein, T. Längle, H. Wörn
24502	Computer Organization (p. 425)	3/1/2	S	6	T. Asfour, J. Henkel, W. Karl, Ömer Terlemez

Learning Control / Examinations

Conditions

None.

Qualification Goals

Content

Module: Informatik (Softwareentwicklung) [BSc-MIT - B-PI2]

Coordination: G. Snelting
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
12		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
24518	Software Technology I (p. 455)	6	S	6	W. Tichy, T. Karcher
24004	Programming (p. 409)	4	W	6	R. Reussner, G. Snelting

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Informatik (Robotik) [BSc-MIT - B-PI3]

Coordination: T. Asfour
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
10		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
24151	Steuerungstechnik für Roboter (p. 467)	2	W	3	H. Wörn
2400077	Mechano-Informatics and Robotics (p. 318)	4	W	4	T. Asfour
24152	Robotics I – Introduction to robotics (p. 431)	2	W	3	R. Dillmann, S. Schmidt-Rohr

Learning Control / Examinations

Conditions

None.

Qualification Goals

Content

Module: Betriebswirtschaft (Wirtschaftswissenschaften) [BSc-MIT - B-PW1]

Coordination: P. Gratzfeld
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2530043	Introduction to Operations Research II (p. 133)	4	W	4,5	S. Nickel, O. Stein, K. Waldmann
2550040	Introduction to Operations Research I (p. 132)	2/2/2	S	4,5	S. Nickel, O. Stein, K. Waldmann
2610026	Business Administration: Finance and Accounting (p. 96)	2/0/2	W	4	M. Ruckes, M. Uhrig-Homburg

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Elective Subjects ETIT [BSc-MIT - B-W-ETIT]

Coordination: M. Doppelbauer, A. Stahl
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13,5-23,5		2

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23447 + 23449	Advanced Radio Communications I (p. 50)	3	W	4,5	M. Younis
23538 + 23540	Advanced Radio Communications II (p. 51)	3	S	4,5	H. Jäkel
23064	Analysis and Design of Multisensor Systems (p. 57)	2/0	S	3	G. Trommer, G. Trommer
23537 + 23539	Applied Information Theory (p. 60)	3+1	W	6	H. Jäkel
23416	Antennas and Antenna Systems (p. 62)	3+1	W	6	T. Zwick
23390	Design and Operation of Power Transformers (p. 74)	2/0	S	3	M. Schäfer
23396	Automation of Power Grids (p. 85)	2/0	S	3	R. Eichler
23160	Automation of Discrete Event and Hybrid Systems (p. 88)	2/0	S	3	M. Kluwe
23214	Battery- and Fuel Cell Systems (p. 92)	2	S	3	A. Weber
23371/23373	Power Network Analysis (p. 144)	2/2	W	6	T. Leibfried
23090	Image processing for Navigation (p. 100)	2	S	3	N. Link
23261	Medical Imaging Techniques I (p. 101)	2	W	3	O. Dössel
23262	Medical Imaging Techniques II (p. 102)	2	S	3	O. Dössel, O. Dössel
23264	Bioelectric Signals (p. 103)	2	S	3	G. Seemann, G. Seemann
23269	Biomedical Measurement Techniques I (p. 104)	2	W	3	W. Stork, A. Bolz
23270	Biomedical Measurement Techniques II (p. 105)	2	S	3	W. Stork, A. Bolz
23678	Detectors for Applications in Space and Astronomy (p. 123)	2	W	3	T. Scherer
23683 + 23685	Digital Circuit Design (p. 120)	3	S	4,5	I. Peric
23664 + 23666	Analog Circuit Design (p. 119)	3	W	4,5	I. Peric
23062	Introduction to Flight Physics, Guidance & Control (p. 135)	2	S	3	A. Schöttl
23474	Einführung in die Quantentheorie für Elektrotechniker mit Übungen (p. 139)	3	W	4,5	G. Grau
23263	Electromagnetics and Numerical Calculation of Fields (p. 143)	3	W	4,5	O. Dössel
23382	Technique of Electrical Installation (p. 145)	2/0	S	3	A. Kühner
23746	Electronic Circuits for Light Sources and Laser (p. 151)	2	S	3	R. Kling, W. Heering
23378	Electronic Systems and EMC (p. 152)	2	S	3	M. Sack

23383	Energy Economics (p. 159)	2	W	3	G. Weissmüller
23356	Electric Power Generation & Power Grid (p. 165)	2/0	W	3	B. Hoferer
23466 + 23467	Field Propagation and Coherence (p. 183)	3	W	4,5	W. Freude
23734	Introduction into plasma technologies (p. 213)	2	S	3	R. Kling
23608 + 23610	Hardware Modeling and Simulation (p. 230)	3	S	4,5	E. Sax
23620 + 23623	Hardware/Software Codesign (p. 233)	3	W	4,5	O. Sander
23619 + 23621	Hardware-Synthesis-Optimization (p. 231)	4	S	6	J. Becker
23319	High Power Converters (p. 237)	2	W	3	M. Braun
23419 + 23421	Semiconductor Circuits for microwave and millimeter-wave application (p. 236)	3	W	4,5	T. Zwick
23392/23394	High-Voltage Test Technique (p. 238)	2/1	W	4,5	R. Badent
23360/23362	High-Voltage Technology I (p. 239)	2/1	W	4,5	R. Badent
23361/23363	High-Voltage Technology II (p. 240)	2/1	S	4,5	R. Badent
23476	Quantum Functional Devices and Semiconductor Technology (p. 228)	2	S	3	M. Walther
23445	Industrial Microwave and Materials Processing Technology (p. 251)	2	W	3	L. Feher
23144	Informationstechnik in der industriellen Automation (p. 257)	2	S	3	P. Bort
23688 + 23690	Integrated Systems and Circuits (p. 263)	3	W	4,5	M. Siegel
23840	Laser Physics (p. 281)	2/1	W	4,5	M. Eichhorn
23347	Power Electronics for Regenerative Energy Sources (p. 285)	3	W	4,5	B. Burger
23739 + 23741	Light Engineering (p. 286)	3	W	4,5	C. Neumann
23729	Plasma Sources (p. 393)	3	W	4,5	R. Kling, W. Heering
23747	Light and Display Engineering (p. 287)	3	W	4,5	R. Kling
23211	Materials and Devices in Electrical Engineering (p. 311)	2	W	3	A. Weber
23184	Methoden der Automatisierungstechnik (p. 323)	3	S	4,5	S. Hohmann
23113	Methods of Signal Processing (p. 324)	3/1	W	6	Puente León
23625	Microsystems Technology (p. 331)	2	W	3	S. Hey
23420 + 23422	Microwave Measurement Techniques (p. 332)	3	S	4,5	M. Pauli
23448	Space-born Microwave Radiometry - Advanced Methods and Applications (p. 459)	2	S	3	H. Süß
23188	Model Predictive Control (p. 338)	2	S	3	B. Pfeiffer
23166 + 23168	Modelling and Identification (p. 339)	3	S	4,5	S. Hohmann
23430	Modern Radio Systems Engineering (p. 343)	3	S	4,5	T. Zwick
23548 + 23549	Multirate Systems (p. 348)	3	W	4,5	H. Göckler
23511	Nachrichtentechnik II (p. 350)	3/1	W	4,5	H. Jäkel, F. Jondral
23668	Nanoelectronics (p. 351)	2	S	3	M. Siegel
23743	Nanoplasmonics (p. 352)	2	W	3	H. Eisler
23173	Nonlinear Control Systems (p. 360)	2/0	S	3	M. Kluwe

23289	Nuclear Medicine and Measuring Techniques I (p. 361)	1	W	1,5	F. Maul, H. Doerfel
23290	Nuclear Medicine and Measuring Techniques II (p. 362)	1	S	1,5	H. Doerfel, F. Maul
23386	Numerical field calculation in Computer Aided Design environments (p. 363)	2	S	3	B. Schaub
23545	OFDM Based Transmission Techniques (p. 371)	2	W	3	M. Schnell
23740	Optical Technology in cars (p. 377)	2	S	3	C. Neumann
23464 + 23465	Optical Waveguides and Fibers (p. 374)	2	W	3	C. Koos
23486	Optoelectronic Components (p. 378)	2 / 1	S	4,5	W. Freude
23726 + 23728	Optoelectronics (p. 380)	3	S	4,5	U. Lemmer
23736	Optoelctronic measurement technology (p. 381)	2	S	3	K. Trampert
23716	Nanoscale Systems for Optoelectronics (p. 353)	2	S	3	H. Eisler
23737	Photovoltaics (p. 385)	3	S	6	M. Powalla
23380	Photovoltaic Systems Technology (p. 386)	2	S	3	Schmidt
23709	Plastic Electronics (p. 396)	2	W	3	U. Lemmer
23097	Prädiktive Fahrerassistenzsysteme (p. 400)	2	W	3	P. Knoll
23069	Principles of sensor fusion in integrated navigation systems (p. 403)	2	W	3	J. Wendel
23405	Radar Systems Engineering (p. 417)	2	W	3	W. Wiesbeck
23093	Space Electronics and Telemetry (p. 418)	2	W	3	H. Kaltschmidt
23060	Computer Aided Circuit Design (p. 423)	2	S	3	H. Wolf
23312 + 23314	Control of Electrical Drives (p. 429)	4	S	6	M. Braun
23509	Special Areas in Communications (p. 434)	2	W	3	F. Jondral
23327	Industrial circuitry (p. 436)	2	W	3	A. Liske
23231	Sensors (p. 441)	2	W	3	W. Menesklou
23240	Sensor Systems (Integrated Sensor Actuator Systems) (p. 442)	2	S	3	W. Wersing
23534	Signal Processing in Communications (p. 447)	2/0	S	3	H. Jäkel
23611	Software Engineering (p. 453)	2	W	3	C. Reichmann
23510	Software Radio (p. 454)	2	S	3	F. Jondral
23424 + 23426	Spaceborne SAR Remote Sensing (p. 460)	3	S	4,5	A. Moreira
23547	Spectrum Management (p. 461)	2	W	3	D. Löffler
23330	converter control technique (p. 476)	2	S	3	A. Liske
23745	Solar Energy (p. 458)	4	W	6	B. Richards
23171	Stochastic Control Systems (p. 468)	2/0	W	3	M. Kluwe
23136	Interference-resistant Communication (p. 469)	4	S	6	K. Dostert
23682	Superconducting Materials for Energy Applications (p. 479)	2	S	3	F. Grilli
23681	Superconducting Systems of Energy Technologies (p. 481)	2	W	3	B. Holzapfel

23676	Superconductive Technologies (p. 482)	2	S	3	M. Noe
23344	System Analysis and Dynamic Operation of Three-Phase-Machine (p. 485)	4	S	6	J. Becker
23606	System Analysis and Design (p. 484)	2	W	3	E. Sax
23641	System Design under Industrial Constraints (p. 489)	2	W	3	M. Nolle
23642 + 23644	Systems Engineering for Automotive Electronics (p. 490)	2	S	3	J. Bortolazzi
23546	Error-Control Coding (p. 531)	2	S	3	B. Friedrichs
23106	Verteilte ereignisdiskrete Systeme (p. 537)	3/0	S	4.5	Puente León
23717	Visuelle Wahrnehmung im KFZ (p. 542)	2	S	3	C. Neumann
23660	VLSI Technology (p. 543)	2	W	3	M. Siegel
23505 + 23507	Probability Theory (p. 547)	3	W	4,5	F. Jondral
23411 + 23413	Wave Propagation and Radio Channels for Mobile Communications (p. 548)	3	S	4,5	T. Fügen
23543	2D Signals and Systems (p. 566)	2/0	W	3	M. Tacke, M. Tacke, K. Lütjen
23391/23393	Systems for Electrical Energy (p. 148)	2/1	S	4,5	T. Leibfried
23324	Design of electrical machines (p. 162)	3	W	4.5	M. Doppelbauer
23311	Practical Aspects of Electrical Drives (p. 402)	3	S	4.5	M. Braun
23704	Solid-State Electronics (p. 182)	3	S	4.5	U. Lemmer
23206	Passive Components (p. 383)	3	W	4.5	E. Ivers-Tiffée
23456	Semiconductor Components (p. 227)	2+1	W	4,5	C. Koos
23406	Fundamentals of Microwave Engineering (p. 206)	3	W	4.5	T. Zwick
23506	Nachrichtentechnik I (p. 349)	3/1	S	6	F. Jondral
23321	Hybrid and Electric Vehicles (p. 244)	3	W	4,5	M. Doppelbauer, M. Schiefer
2118077	Safe mechatronic systems (p. 443)	3	W/S	4	M. Golder

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Elective Subjects MACH [BSc-MIT - B-W-MACH]

Coordination: P. Gratzfeld
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13,5-23,5		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2134150	Analysis of Exhaust Gas und Lubricating Oil in Combustion Engines (p. 48)	2	S	4	M. Gohl
2105012	Adaptive Control Systems (p. 49)	2	W	4	J. Matthes, L. Gröll, M. Reischl
2154436	Aerothermodynamics (p. 52)	2	S	4	F. Seiler, B. Frohnapfel
2145181	Applied Tribology in Industrial Product Development (p. 61)	2	W	4	A. Albers, B. Lorentz
2113077	Drive Train of Mobile Machines (p. 64)	3	W	4	M. Geimer, M. Scherer
2146180	Powertrain Systems Technology A: Automotive Systems (p. 65)	2	S	4	A. Albers, S. Ott
2145150	Powertrain Systems Technology B: Stationary Machinery (p. 66)	2	W	4	A. Albers, S. Ott
2117064	Application of technical logistics in modern crane systems (p. 67)	2	W	4	M. Golder
2118089	Application of technical logistics in sorting- and distribution technology (p. 68)	2	S	4	J. Föller
2182735	Application of advanced programming languages in mechanical engineering (p. 69)	2	S	4	D. Weygand
2109035	Human Factors Engineering I: Ergonomics (p. 72)	2	W	4	B. Deml
2181740	Atomistic simulations and molecular dynamics (p. 73)	2	S	4	P. Gumbsch, L. Pastewka
2118087	Selected Applications of Technical Logistics (p. 75)	3	S	4	M. Mittwollen, V. Madzharov
2118092	Selected Topics in Manufacturing Technologies (p. 76)	2	S	4	V. Schulze
2170454	Selected Topics in Aeronautics and Astronautics I (p. 77)	2	S	4	S. Wittig
2169486	Selected Topics in Aeronautics and Astronautics II (p. 78)	2	W	4	S. Wittig
2143892	Selected Topics on Optics and Microoptics for Mechanical Engineers (p. 79)	2	W/S	4	T. Mappes
2167541	Selected chapters of the combustion fundamentals (p. 80)	2	W/S	4	U. Maas
2190411	Selected Problems of Applied Reactor Physics and Exercises (p. 81)	2	S	4	R. Dagan
2181745	Design of highly stresses components (p. 82)	2	W	4	J. Aktaa
2113079	Design and Development of Mobile Machines (p. 83)	2	W	4	M. Geimer, J. Siebert

2146208	Dimensioning and Optimization of Power Train System (p. 84)	2	S	4	E. Kirchner
2150904	Automated Manufacturing Systems (p. 86)	6	S	8	J. Fleischer
2106005	Automation Systems (p. 89)	2	S	4	M. Kaufmann
2113809	Automotive Engineering I (p. 90)	4	W	8	F. Gauterin, M. Gießler
2115919	Rail System Technology (p. 91)	2	W/S	4	P. Gratzfeld
2110085	Production Operations Management (p. 93)	4	S	5	K. Furmans, G. Lanza, F. Schultmann, B. Deml
2133108	Fuels and Lubricants for Combustion Engines (p. 94)	2	W	4	B. Kehrwald
2141864	BioMEMS-Microsystems Technologies for Life-Sciences and Medicine I (p. 108)	2	W	4	A. Guber
2142883	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II (p. 106)	2	S	4	A. Guber
2142879	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III (p. 107)	2	S	4	A. Guber
2142140	Bionics for Engineers and Natural Scientists (p. 109)	2	S	4	H. Hölscher
2114092	BUS-Controls (p. 111)	2	S	4	M. Geimer
2130910	CFD for Power Engineering (p. 112)	2	S	4	I. Otic
2106014	Datenanalyse für Ingenieure (p. 117)	3	S	5	R. Mikut, M. Reischl
2105016	Computational Intelligence (p. 113)	2	W	4	R. Mikut, W. Jakob, M. Reischl
2114914	Railways in the Transportation Market (p. 124)	2	S	4	P. Gratzfeld
2153405	Finite Difference Methods for numerial solution of thermal and fluid dynamical problems (p. 125)	2	W	4	C. Günther
2137309	Digital Control (p. 126)	2	W	4	M. Knoop
2163111	Dynamics of the Automotive Drive Train (p. 129)	4	W	5	A. Fidlin
2189903	Introduction to Nuclear Energy (p. 136)	3	W	6	X. Cheng
2105011	Introduction into Mechatronics (p. 137)	3	W	6	M. Lorch
2154430	Introduction to modeling of aerospace systems (p. 138)	2	S	4	G. Schlöffel, B. Frohnapfel
2162247	Introduction to Nonlinear Vibrations (p. 140)	4	S	7	A. Fidlin
2114346	Electric Rail Vehicles (p. 147)	2	S	4	P. Gratzfeld
2117096	Elements of Technical Logistics (p. 153)	3	W	4	M. Mittwollen, Madzharov
2117500	Energy efficient intralogistic systems (p. 155)	2	W	4	F. Schönung, M. Braun
2170832	Energy and Process Technology II (p. 154)	6	S	9	C. Höfler, H. Wirbser
2129901	Energy Systems I: Renewable Energy (p. 157)	3	W	6	R. Dagan
2130921	Energy Systems II: Nuclear Energy and Reactor Technology (p. 158)	3	S	4	A. Badea
2149903	Design Project Machine Tools and Industrial Handling (p. 161)	2	W	4	J. Fleischer
2106008	Organ support systems (p. 164)	2	S	4	C. Pylatiuk

2154446	Experimental Fluid Mechanics (p. 166)	2	S	4	J. Kriegseis
2113807	Handling Characteristics of Motor Vehicles I (p. 168)	2	W	4	H. Unrau
2114838	Handling Characteristics of Motor Vehicles II (p. 169)	2	S	4	H. Unrau
2113806	Vehicle Comfort and Acoustics I (p. 170)	2	W	4	F. Gauterin
2114825	Vehicle Comfort and Acoustics II (p. 171)	2	S	4	F. Gauterin
2113102	Vehicle Lightweight design – Strategies, Concepts, Materials (p. 172)	2	W	4	F. Henning
2113816	Vehicle Mechatronics I (p. 173)	2	W	4	D. Ammon
2114845	Tires and Wheel Development for Passenger Cars (p. 174)	2	S	4	G. Leister
2138340	Automotive Vision (p. 175)	2	S	4	C. Stiller, M. Lauer
2114053	Composite Manufacturing – Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies (p. 176)	2	S	4	F. Henning
2183716	FEM Workshop – constitutive laws (p. 178)	2	W/S	4	K. Schulz, D. Weygand
2143882	Fabrication Processes in Microsystem Technology (p. 179)	2	W/S	4	K. Bade
2149657	Manufacturing Technology (p. 180)	6	W	8	V. Schulze, F. Zanger
2154431	Finite Volume Methods for Fluid Flow (p. 184)	2	S	4	C. Günther
2154401	Fluid-Structure-Interaction (p. 185)	2	S	4	M. Mühlhausen, B. Frohnapfel
2114093	Fluid Technology (p. 186)	4	W	5	M. Geimer, M. Scherer
2169483	Fusion Technology A (p. 189)	2	W	4	R. Stieglitz
2190492	Fusion Technology B (p. 190)	2	S	4	R. Stieglitz
2154200	Gasdynamics (p. 191)	2	S	4	F. Magagnato
2134141	Gas Engines (p. 192)	2	S	4	R. Golloch
2114850	Global vehicle evaluation within virtual road test (p. 194)	2	S	4	B. Schick
2174575	Foundry Technology (p. 195)	2	S	4	C. Wilhelm
2149610	Global Production and Logistics - Part 1: Global Production (p. 196)	2	W	4	G. Lanza
2149600	Global Production and Logistics - Part 2: Global Logistics (p. 198)	2	S	4	K. Furmans
2181744	Size effects in micro and nanostructures materials (p. 200)	2	W	4	P. Gumbsch, D. Weygand, P. Gruber, M. Dienwiebel
2130927	Fundamentals of Energy Technology (p. 202)	5	S	8	A. Badea
2113805	Automotive Engineering I (p. 203)	4	W	8	F. Gauterin, H. Unrau
2114835	Automotive Engineering II (p. 204)	2	S	4	F. Gauterin, H. Unrau
2193010	Basic principles of powder metallurgical and ceramic processing (p. 205)	2	W	4	R. Oberacker
2134138	Fundamentals of catalytic exhaust gas aftertreatment (p. 207)	2	S	4	E. Lox
2105992	Principles of Medicine for Engineers (p. 208)	2	W	4	C. Pylatiuk
2137301	Measurement and Control Systems (p. 209)	3	W	7	C. Stiller
2141861	Introduction to Microsystem Technology I (p. 210)	2	W	4	A. Guber, J. Korvink

2142874	Introduction to Microsystem Technology II (p. 211)	2	S	4	A. Guber, J. Korvink
2181720	Foundations of nonlinear continuum mechanics (p. 212)	2	W	4	M. Kamlah
2190465	Fundamentals of reactor safety for the operation and dismantling of nuclear power plants (p. 215)	2	W	4	V. Sánchez-Espinoza
2117095	Basics of Technical Logistics (p. 216)	4	W	6	M. Mittwollen, V. Madzharov
2165515	Fundamentals of Combustion I (p. 217)	2	W	4	U. Maas
2166538	Fundamentals of Combustion II (p. 218)	2	S	4	U. Maas
2133113	Combustion Engines I (p. 530)	2	W	4	H. Kubach, T. Koch
2153410	Optical Flow Measurement: Fundamentals and Applications (p. 220)	2	W	4	F. Seiler, B. Frohnapfel
2113814	Fundamentals for Design of Motor-Vehicles Bodies I (p. 221)	1	W	2	H. Bardehle
2114840	Fundamentals for Design of Motor-Vehicles Bodies II (p. 222)	1	S	2	H. Bardehle
2113812	Fundamentals in the Development of Commercial Vehicles I (p. 223)	1	W	2	J. Zürn
2114844	Fundamentals in the Development of Commercial Vehicles II (p. 224)	1	S	2	J. Zürn
2113810	Fundamentals of Automobile Development I (p. 225)	1	W	2	R. Frech
2114842	Fundamentals of Automobile Development II (p. 226)	1	S	2	R. Frech
2157432	Hydraulic Fluid Machinery I (Basics) (p. 246)	4	W	8	M. Gabi
2158105	Hydraulic Fluid Machinery II (p. 247)	2	S	4	S. Caglar, M. Gabi
2154437	Hydrodynamic Stability: From Order to Chaos (p. 248)	2	S	4	A. Class
2153425	Industrial aerodynamics (p. 249)	2	W	4	T. Breitling, B. Frohnapfel
2109042	Introduction to Industrial Production Economics (p. 250)	2	W	4	S. Dürrschnabel
2110037	Occupational Safety and Environmental Protection (in German) (p. 252)	2	S	4	R. von Kiparski
2121390	Computer Science for Engineers (p. 254)	2	W	8	J. Ovtcharova, S. Rogalski
2118094	Information Systems in Logistics and Supply Chain Management (p. 255)	2	S	4	C. Kilger
2105022	Information Processing in Mechatronic Systems (p. 258)	2	W	4	M. Kaufmann
2115916	Innovation Workshop: Mobility concepts for the year 2050 (p. 259)	2	W/S	4	P. Gratzfeld
2130973	Innovative Nuclear Systems (p. 260)	2	S	4	X. Cheng
2150660	Integrated production planning (p. 261)	6	S	8	G. Lanza
2190490	Introduction to Neutron Cross Section Theory and Nuclear Data Generation (p. 264)	2	S	4	R. Dagan
3118031	Introduction to Production Operations Management (p. 265)	4	S	5	K. Furmans, F. Schultmann, B. Deml, S. Peters

2118183	IT-Fundamentals of Logistics (p. 266)	2	S	4	F. Thomas
2125757	Introduction to Ceramics (p. 269)	4	W	6	M. Hoffmann
2174571	Design with Plastics (p. 273)	2	S	4	M. Liedel
2146190	Lightweight Engineering Design (p. 274)	2	S	4	A. Albers, N. Burkardt
2170463	Cooling of thermally high loaded gas turbine components (p. 277)	2	S	4	H. Bauer, A. Schulz
2118097	Warehousing and distribution systems (p. 279)	2	S	4	M. Schwab, J. Weiblen
2182642	Laser in automotive engineering (p. 283)	2	S	4	J. Schneider
2145184	Leadership and Product Development (p. 284)	2	W	4	A. Ploch
2118078	Logistics - organisation, design and control of logistic systems (p. 290)	4	S	6	K. Furmans
2118085	Automotive Logistics (p. 291)	2	S	4	K. Furmans
2117056	Airport logistics (p. 292)	2	W	4	A. Richter
2137308	Machine Vision (p. 294)	4	W	8	C. Stiller, M. Lauer
2153429	Magnetohydrodynamics (p. 295)	2	W	4	L. Bühler
2110017	Leadership and Conflict Management (in German) (p. 297)	2	S	4	H. Hatzl
2161224	Machine Dynamics (p. 299)	3	S	5	C. Proppe
2161225	Übungen zu Maschinendynamik (p. 521)	1	S	0	C. Proppe
2162220	Machine Dynamics II (p. 300)	2	W	4	C. Proppe
2185000	Machinery and Processes (p. 298)	4	W/S	7	H. Kubach, M. Gabi, H. Bauer, U. Maas
2149669	Materials and Processes for Body Lightweight Construction in the Automotive Industry (p. 310)	2	W	4	D. Steegmüller, S. Kienzle
2162241	Mathematical methods of vibration theory (p. 312)	3	S	5	W. Seemann
2162242	Mathematical methods of vibration theory (Tutorial) (p. 522)	1	S	1	W. Seemann, C. Baum
2154432	Mathematical Methods in Fluid Mechanics (p. 313)	3	S	6	B. Frohnapfel
2165525	Mathematical models and methods in combustion theory (p. 314)	2	W	4	V. Bykov, U. Maas
2117059	Mathematical models and methods for Production Systems (p. 315)	4	W	6	K. Furmans, J. Stoll
2173580	Mechanics and Strengths of Polymers (p. 316)	2	W	4	B. Graf von Bernstorff
2181710	Mechanics in Microtechnology (p. 317)	2	W	4	P. Gruber, C. Greiner
2138326	Measurement II (p. 321)	2	S	4	C. Stiller
2174598	Metals (p. 322)	3	S	6	M. Heilmaier, K. von Klinski-Wetzel
2134134	Analysis tools for combustion diagnostics (p. 325)	2	S	4	U. Wagner
2142884	Microoptics and Lithography (p. 326)	2	S	4	T. Mappes
2142881	Microactuators (p. 327)	2	S	4	M. Kohl
2183702	Modelling of Microstructures (p. 329)	3	W	5	A. August, B. Nestler, D. Weygand
2114073	Mobile Machines (p. 335)	4	S	8	M. Geimer
2134139	Model based Application Methods (p. 337)	3	S	4	F. Kirschbaum

2167523	Modeling of Thermodynamical Processes (p. 340)	3	W/S	6	R. Schießl, U. Maas
2183703	Modelling and Simulation (p. 341)	3	W/S	5	B. Nestler, P. Gumbsch
2158206	Modeling and simulation of energy systems for buildings (p. 342)	2	S	4	F. Schmidt
2105024	Modern Control Concepts I (p. 344)	2	W	4	L. Gröll
2134137	Engine measurement techniques (p. 345)	2	S	4	S. Bernhardt
2143876	Nanotechnology with Clusterbeams (p. 354)	2	W	4	J. Gspann
2181712	Nanotribology and -Mechanics (p. 355)	2		4	M. Dienwiebel, H. Hölscher
2141865	Novel actuators and sensors (p. 358)	4	W	6	M. Kohl, M. Sommer
2189473	Neutron physics of fusion reactors (p. 359)	2	W	4	U. Fischer
2130934	Numerical Modeling of Multiphase Flows (p. 366)	2	S	4	M. Wörner
2169458	Numerical simulation of reacting two phase flows (p. 367)	2	W	4	R. Koch
2153449	Numerical Simulation of Turbulent Flows (p. 368)	3	W	4	G. Grötzbach
2147161	Intellectual Property Rights and Strategies in Industrial Companies (p. 384)	2	W/S	4	F. Zacharias
2181612	Physical basics of laser technology (p. 389)	3	W	4	J. Schneider
2189906	Physical and chemical principles of nuclear energy in view of reactor accidents and back-end of nuclear fuel cycle (p. 391)	1	W	2	R. Dagan, Dr. Volker Metz
2142890	Physics for Engineers (p. 388)	2	S	4	P. Gumbsch, A. Nesterov-Müller, D. Weygand, T. Förtsch
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2122376	PLM for Product Development in Mechatronics (p. 394)	2	S	4	M. Eigner
2121366	PLM in the Manufacturing Industry (p. 395)	2	W	4	G. Meier
2173590	Polymer Engineering I (p. 397)	2	W	4	P. Elsner
2174596	Polymer Engineering II (p. 398)	2	S	4	P. Elsner
2121350	Product Lifecycle Management (p. 404)	4	W	6	J. Ovtcharova
2110032	Production Planning and Control (p. 408)	2	W	4	A. Rinn
2123364	Product, Process and Resource Integration in the Automotive Industry (p. 406)	3	S	4	S. Mbang
2113072	Development of Oil-Hydraulic Powertrain Systems (p. 411)	2	W	4	G. Geerling, I. Ays
2115995	Project Management in Rail Industry (p. 412)	2	W	4	P. Gratzfeld
2145182	Project management in Global Product Engineering Structures (p. 413)	2	W	4	P. Gutzmer
2126749	Advanced powder metals (p. 414)	2	S	4	R. Oberacker
2149667	Quality Management (p. 415)	2	W	4	G. Lanza

2118090	Quantitative Methods for Supply Chain Risk Management (p. 416)	4	S	6	A. Cardeneo
2189465	Reactor Safety I: Fundamentals (p. 419)	2	S	4	V. Sánchez-Espinoza
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2162216	Computerized Multibody Dynamics (p. 422)	2	S	4	W. Seemann
2122387	Computer Integrated Planning of New Products (p. 424)	2	S	4	R. Kläger
2121392	Computer Lab for Computer Science in Mechanical Engineering (p. 426)	2	W	0	J. Ovtcharova
2166543	Reduction methods for the modeling and the simulation of combustion processes (p. 428)	2	S	4	V. Bykov, U. Maas
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2173571	Welding Technology (p. 438)	2	W	4	M. Farajian
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2117061	Safety Engineering (p. 445)	2	W	4	H. Kany
2114095	Simulation of Coupled Systems (p. 448)	4	S	4	M. Geimer
2185264	Simulation in product development process (p. 449)	2	W	4	T. Böhlke
2149605	Simulation of production systems and processes (p. 450)	4	W	5	K. Furmans, V. Schulze
2154044	Scaling in fluid dynamics (p. 452)	2	S	4	L. Bühler
2163113	Theory of Stability (p. 464)	4	W	6	A. Fidlin
2150683	Control Technology (p. 465)	2	S	4	C. Gönnheimer
2146198	Strategic product development - identification of potentials of innovative products (p. 471)	2	S	4	A. Siebe
2154407	Flows in rotating systems (p. 472)	2	S	4	R. Bohning, B. Frohnapfel
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2189910	Flows and Heat Transfer in Energy Technology (p. 474)	2	W	4	X. Cheng
2153412	Fluid Mechanics (p. 475)	4	W	7	B. Frohnapfel
2126775	Structural Ceramics (p. 478)	2	S	4	M. Hoffmann
2125763	Structural and phase analysis (p. 477)	2	W	4	S. Wagner
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2146192	Sustainable Product Engineering (p. 483)	2	S	4	K. Ziegahn
2158107	Technical Acoustics (p. 491)	2	S	4	M. Gabi
2106002	Computer Engineering (p. 492)	3	S	4	M. Lorch, H. Keller
2121001	Integrated Information Systems for engineers (p. 494)	3	S	5	J. Ovtcharova
2161212	Vibration Theory (p. 499)	3	W	5	A. Fidlin
2165501	Technical Thermodynamics and Heat Transfer I (p. 500)	3	W	7	U. Maas
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2174579	Technology of steel components (p. 503)	2	S	4	V. Schulze
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2169472	Thermal Solar Energy (p. 508)	2	W	4	R. Stieglitz
2169453	Thermal Turbomachines I (p. 510)	3	W	6	H. Bauer
2170476	Thermal Turbomachines II (p. 511)	3	S	6	H. Bauer
2113080	Tractors (p. 512)	2	W	4	M. Kremmer
2181114	Tribology (p. 513)	4	W	8	M. Scherge, M. Dienwiebel
2170478	Turbo Jet Engines (p. 516)	2	S	4	H. Bauer, A. Schulz
2169462	Turbine and compressor Design (p. 515)	2	W	4	H. Bauer, A. Schulz
2150681	Metal Forming (p. 524)	2	S	4	T. Herlan
2190499	Vacuum and Tritium Technology (p. 528)	2	S	4	C. Day, B. Bornschein, D. Demange
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2138336	Behaviour Generation for Vehicles (p. 533)	2	S	4	C. Stiller, M. Werling
2181715	Failure of Structural Materials: Fatigue and Creep (p. 534)	2	W	4	O. Kraft, P. Gumbsch, P. Gruber
2181711	Failure of structural materials: deformation and fracture (p. 535)	2	W	4	P. Gumbsch, O. Kraft, D. Weygand
2149655	Gear Cutting Technology (p. 538)	2	W	4	M. Klaiber
2121352	Virtual Engineering I (p. 540)	5	W	6	J. Ovtcharova
2122378	Virtual Engineering II (p. 541)	3	S	4	J. Ovtcharova
2166534	Heatpumps (p. 545)	2	S	4	H. Wirbser, U. Maas
2189907	Heat Transfer in Nuclear Reactors (p. 546)	2	S	4	X. Cheng
2161219	Wave Propagation (p. 549)	2	W	4	W. Seemann
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2182562	Materials Science and Engineering II for ciw, vt, MIT (p. 553)	4	S	5	J. Schneider
2173553	Materials Science and Engineering III (p. 554)	5	W	8	M. Heilmaier
2182740	Materials modelling: dislocation based plasticy (p. 555)	2	S	4	D. Weygand
2149902	Machine Tools and Industrial Handling (p. 556)	6	W	8	J. Fleischer
2181738	Scientific computing for Engineers (p. 558)	2	W	4	D. Weygand, P. Gumbsch
2162231	Engineering Mechanics IV (p. 498)	4	S	5	W. Seemann, Assistenten
2174565	Experimentelles Praktikum in Werkstoffkunde für ciw, vt, phys, MIT (p. 167)	2	S	3	M. Heilmaier, K. Weidenmann, A. Möslang
2145151	Mechanical Design III (p. 305)	4	W	4	A. Albers, N. Burkardt
2146177	Mechanical Design IV (p. 306)	3	S	4	A. Albers, N. Burkardt
2145154	MD - Team Orientated Mechanical Design (3 + 4) (p. 334)	2	W/S	2	A. Albers, N. Burkardt
2118077	Safe mechatronic systems (p. 443)	3	W/S	4	M. Golder
2110969	Working Methods in Mechanical Engineering (p. 70)	1	W	2	B. Deml
2117051	Material flow in logistic systems (p. 308)	4	W	6	K. Furmans

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Elective Subjects INF [BSc-MIT - B-W-INF]

Coordination: P. Gratzfeld
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13,5-23,5		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
24001	Basic Notions of Computer Science (p. 201)	2/1/2	W	4	T. Worsch
24500	Algorithms I (p. 54)	3/1/2	S	6	P. Sanders, H. Meyerhenke, D. Hofheinz
24079	Algorithms II (p. 56)	3/1	W	6	D. Wagner, P. Sanders
24502	Computer Organization (p. 425)	3/1/2	S	6	T. Asfour, J. Henkel, W. Karl, Ömer Terlemez
24007	Digital Circuits Design (p. 128)	3/1/2	W	6	M. Tahoori, T. Asfour, J. Henkel, W. Karl, Ömer Terlemez
24518	Software Technology I (p. 455)	6	S	6	W. Tichy, T. Karcher
24076	Software Engineering II (p. 456)	3/1	W	6	R. Reussner, W. Tichy, A. Koziolek
24009	Operating Systems (p. 95)	3/1	W	6	F. Bellosa
24005	Theoretical Foundations of Computer Science (p. 506)	3/1/2	W	6	J. Müller-Quade, D. Wagner
24516	Database Systems (p. 118)	2/1	S	4	K. Böhm
24030	Programming Paradigms (p. 410)	3/1	W	6	G. Snelting, R. Reussner
24576	Real-Time Systems (p. 130)	3/1	S	6	B. Hein, T. Längle, H. Wörn
24086	Formal Systems (p. 187)	3/2	W	6	B. Beckert
24519	Introduction in Computer Networks (p. 142)	2/1	S	4	M. Zitterbart
24572	Cognitive Systems (p. 271)	3/1	S	6	R. Dillmann, A. Waibel
24016	Public Law I - Basic Principles (p. 369)	2/0	W	3	G. Sydow
24012	Civil Law for Beginners (p. 98)	4/0	W	4	T. Dreier, O. Knöfel
2577900	Management and Strategy (p. 527)	2/0	S	3.5	H. Lindstädt
24151	Steuerungstechnik für Roboter (p. 467)	2	W	3	H. Wörn
24128	Telematics (p. 504)	3	W	6	M. Zitterbart
24570	Computer Architecture (p. 427)	3/1	S	6	J. Henkel, W. Karl
24081	Computer Graphics (p. 114)	4	W	6	C. Dachsbacher
24149	IT-Security Management for Networked Systems (p. 268)	2/1	W	5	H. Hartenstein
24143	Optimization and synthesis of embedded systems (ES1) (p. 376)	2	W	3	J. Henkel
24106	Design and architectures of embedded systems (ES2) (p. 163)	2	W	3	J. Henkel
24117	Heterogeneous Parallel Computing Systems (p. 235)	2	W	3	W. Karl
24600	Multilingual Human-Machine Communication (p. 346)	4	S	6	T. Schultz, F. Putze
24105	Biosignals and User Interfaces (p. 110)	4	W	6	T. Schultz, C. Herff, D. Heger

24132	Multimedia Communications (p. 347)	2/0	W	4	R. Bless, M. Zitterbart
24601	Network Security: Architectures and Protocols (p. 357)	2/0	S	4	M. Zitterbart
2400026	Geometric Optimzation (p. 193)	2	W	3	H. Prautzsch
24122	Meshes and point clouds (p. 356)	2	W	3	H. Prautzsch
24011	Commercial and Corporate Law (p. 229)	2/0	W	3	Z. (ZAR), O. Knöfel
24520	Public Law II - Public Economic Law (p. 370)	2/0	S	3	G. Sydow
2600024	Business Administration: Production Economics and Marketing (p. 97)	2/0/2	S	4	M. Ruckes, W. Fichtner, M. Klarmann, Th. Lützkendorf, F. Schultmann
2610026	Business Administration: Finance and Accounting (p. 96)	2/0/2	W	4	M. Ruckes, M. Uhrig-Homburg
2540508	Customer Relationship Management (p. 115)	2/1	W	4,5	A. Geyer-Schulz
2540522	Analytical CRM (p. 58)	2/1	S	4,5	A. Geyer-Schulz
2540520	Operative CRM (p. 372)	2/1	W	4,5	A. Geyer-Schulz
2595466	Foundations of Digital Services (p. 188)	2/1	S	4,5	C. Weinhardt, H. Fromm
2590452	Management of Business Networks (p. 296)	2/1	W	4,5	C. Weinhardt
2540454	eFinance: Information Engineering and Management for Securities Trading (p. 131)	2/1	W	4,5	C. Weinhardt
0187400	Numerical Mathematics (p. 365)	2/1	S	4,5	C. Wieners, D. Weiß, Neuß, Rieder
2540498	Special Topics in Information Engineering & Management (p. 462)	3	W/S	4,5	C. Weinhardt
2581950	Fundamentals of Production Management (p. 214)	2/2	S	5,5	F. Schultmann
2581960	Production Economics and Sustainability (p. 407)	2/0	W	3,5	M. Fröhling
2581996	Logistics and Supply Chain Management (p. 289)	2/0	S	3,5	M. Wiens
2577902	Managing Organizations (p. 382)	2/0	W	3.5	H. Lindstädt
2581010	Introduction to Energy Economics (p. 134)	2/2	S	5,5	W. Fichtner
2581005	Corporate Governance in Energy Economics (p. 526)	2/0	S	3,5	H. Villis
2581959	Energy Policy (p. 156)	2/0	S	3,5	M. Wietschel
24103	Design and Evaluation of innovative user interfaces (p. 122)	2	W	3	T. Schultz, F. Putze, M. Georgi
2400036	Power Management (p. 399)	2	W	3	F. Bellosa
0133500	Grundlagen der Wahrscheinlichkeitstheorie und Statistik für Studierende der Informatik (p. 219)	2/1	W	4,5	N. Henze, D. Hug
24941	Security (p. 444)	3/1	S	6	J. Müller-Quade
24688	Microprocessors I (p. 328)	2	S	3	W. Karl
24612	Cognitive Modeling (p. 270)	2	S	3	T. Schultz, F. Putze
24681	Medical Robotics (p. 433)	2	S	3	J. Raczkowsky, Raczkowsky
24643	Mobile Communication (p. 336)	2/0	W	4	O. Waldhorst, M. Zitterbart
24614	Algorithms for Planar Graphs (p. 53)	2/1	W/S	5	D. Wagner
24672	Low Power Design (p. 293)	2	S	3	J. Henkel
24504	Advanced Civil Law (p. 99)	2/0	S	3	T. Dreier

2581012	Renewable Energy – Resources, Technology and Economics (p. 430)	2/0	W	3,5	R. McKenna
24004	Programming (p. 409)	4	W	6	R. Reussner, G. Snelting
2400077	Mechano-Informatics and Robotics (p. 318)	4	W	4	T. Asfour
2530043	Introduction to Operations Research II (p. 133)	4	W	4,5	S. Nickel, O. Stein, K. Waldmann
2550040	Introduction to Operations Research I (p. 132)	2/2/2	S	4,5	S. Nickel, O. Stein, K. Waldmann
24635	Robotik III - Sensors in Robotics (p. 432)	2	S	3	R. Dillmann, Meißner, Gonzalez, Aguirre
24626	Curves and surfaces for Geometric Design (p. 278)	4/2	W/S	9	H. Prautzsch
24152	Robotics I – Introduction to robotics (p. 431)	2	W	3	R. Dillmann, S. Schmidt-Rohr

Learning Control / Examinations

Conditions
None.

Qualification Goals

Content

Module: Key Competences [BSc-MIT - B-SQ]

Coordination: M. Doppelbauer
Degree programme: BSc Mechatronik und Informationstechnik (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
6		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23901	Electronics Workshop I (p. 559)	1	W	1.5	T. Zwick
23902	Electronics Workshop II (p. 561)	1	S	1.5	T. Zwick
2145166	Kooperation in interdisziplinären Teams (p. 275)		W	2	S. Matthiesen, S. Hohmann
2146197	Workshop Mechanical Design II (ciw/VT/MIT) (p. 563)	1	S	1	S. Matthiesen

Learning Control / Examinations
see submodule descriptions

Conditions
None.

Qualification Goals
After completion this module, the students are able

1. to identify and coordinate goals and the resulting working tasks, to apply a systematic and goal-oriented approach, to set priorities and to evaluate the feasibility of a task,
2. to describe and to apply goal- and resource-oriented methods for the planning of a working task under defined conditions,
3. to describe and apply methods for scientific research and the selection of relevant information according to defined criteria of quality,
4. to evaluate the quality of a scientific source,
5. to describe and apply empirical methods in mechanical engineering,
6. to document scientific information in a clear, structured and convincing style in different formats (e.g. poster, expose, abstract, bachelor thesis, construction diagrams, flow diagrams),
7. to evaluate the quality of a scientific text or poster,
8. to present scientific information in a convincing and appealing style,
9. to work in a heterogeneous team, to solve conflicts and to resume responsibility for themselve and others,
10. to communicate objective within a team, to achieve their own interests, to describe the interests of others in own words and to moderate a discussion.

Content
The module B-SQ is fixed with 6 ECTS. 3 ECTS are given by Electronic Workshop I + II and 3 ECTS are given by Cooperation in Interdisziplinary Teams.
Further key competencies can be achieved outside B-SQ.

3 Courses

3.1 All Courses

Course: Analysis of Exhaust Gas und Lubricating Oil in Combustion Engines [2134150]

Coordinators: M. Gohl
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Letter of attendance or oral exam (25 minutes, no auxillary means)

Conditions
none

Recommendations
Knowledge in the field of engine technology and measurement techniques is advantageous

Learning Outcomes
The Students can point out the challenges concerning the current emission standards in engine development. They can name and explain the basic principles of measurement techniques and methods to analyse exhaust gas components and components of engine oil. Hence, the students have the ability to choose the right methods for a given Problem and to interpret the results.

Content
The students get involved in the application of different measurement techniques in the field of exhaust gas and lubricating oil analysis. The functional principles of the systems as well as the application areas of the latter are discussed. In addition to a general overview of standard applications, current specific development and research activities are introduced.

Media
Lecture with Powerpoint slides

Literature
The lecture documents are distributed during the courses.

Course: Adaptive Control Systems [2105012]

Coordinators: J. Matthes, L. Gröll, M. Reischl
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination (1 hour)

Duration: 1 hours, also possible as an optional or part of a major subject

Auxilary means: none

Conditions
None.

Recommendations
Measuring and Automatic Control

Learning Outcomes
The students know different types, structures and operation of adaptive control systems. They are capable of setting up system equations theoretically and experimentally. By experimenting with examples students are prepared to apply adaptive control systems in practice.

Content
Introduction: definitions, classification of adaptive control systems, objectives

Structures of adaptive control systems: overview, parameter-, structure- and signal-adaptive control systems, open-loop and closed loop ARS, ARS with reference/identification model, application

Modeling: methods, experimental conditions, experimental modeling, identifcation methods for single input single output systems and multi input multi output systems

Parameter adaptive control systems: definitions, design methods

Literature
W. Weber. Adaptive Regelungssysteme, volume I, II. R. Oldenbourg, München, 1971.

Course: Advanced Radio Communications I [23447 + 23449]

Coordinators: M. Younis
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	en

Learning Control / Examinations
Written Exam

Conditions
Basic knowledge of physics, electromagnetic waves and communication systems

Learning Outcomes
At the end of the course the students will know the components of communication systems and understand the interaction between the physical phenomena and the system. The knowledge given in the lecture is sufficient to allow proceeding for an in-depth lecture/thesis on any of the topics covered in the lecture.
The course gives a general overview of radio communication system. Further it covers and describes in detail the parts of a communication system between (and including) the transmit/receive antennas up to the receiver. The emphasis is on a description of the physical phenomena and their influence on communication systems. In addition several practical engineering topics are addressed and their influence on communication systems is explained.

Content
Introduction to Wireless Communication Systems
- the spread of wireless communication systems
- elements of wireless communication systems
Antennas
- radiation mechanism of antennas
- field regions
- antenna parameters
- antenna arrays
Radio Wave Propagation Fundamentals
- free-space propagation model
- the basic propagation mechanisms
- multipath and spatial interference pattern
Time and Frequency Selective Radio Channel
- introduction to small-scale fading
- distribution of the receive signal strength
- channel transfer function and impulse response
- characterization of the frequency-selective channel
- characterization of the time-variant channel
Noise in Communication Systems
- statistical description of signals
- system noise
- naturally occurring noise
- oscillator phase noise
- quantization and clipping noise
Noise Applications
- noise in cascaded systems
- microwave receiver noise temperature

Literature
Material to the lecture can be found online at www.ihe.kit.edu.

Remarks
Current information can be found at the webpage of the IHE (www.ihe.kit.edu).

Course: Advanced Radio Communications II [23538 + 23540]

Coordinators: H. Jäkel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	en

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
Theoretical fundamentals of digital wireless communications are to be covered.
The lecture complements the topics discussed within the basic course Nachrichtentechnik I. For this purpose, new perspectives are added to already known topics and problems are covered, which were not part of Nachrichtentechnik I.
Supporting the lecture, assignments to the curriculum are distributed. Their solution is presented and discussed during lecture hall exercises. The presentation is assisted by computer simulations.

Content
The lecture complements the knowledge developed in bachelor courses by improving scientific foundations and implications. Additionally, new topics are introduced which were not part of any other lecture. Preliminaries of probability theory, system theory, and communications are recommended.
Band-pass sub-sampling is discussed and its relevance is made clear by the super-heterodyne receiver. Thereafter, numerical realization of Fourier transformation by FFT is recapitulated and complemented. Frequency selective digital filters are an important component of communication systems. Therefore, their design is discussed from scratch and design methods are elaborated.
Additionally, the lecture contends an extensive discussion of channel modeling. The objective is to achieve a detailed description of wireless channels such that these models can be used for the simulation of wireless communication systems. Channel models and their parameters are directly related the transmission technique and the corresponding frequency range.

Literature
Slides are provided. Further reading is recommended in the lecture.

Course: Aerothermodynamics [2154436]

Coordinators: F. Seiler, B. Frohnapfel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary means

Conditions
none

Learning Outcomes
The students can describe the aerodynamic problems occurring during re-entry of space vehicles into the earth's atmosphere. They are able to explain the interrelation of high Mach number flow regimes and the co-occurring real gas effects (physics and chemistry of hot gases). Furthermore, they can discuss the link between the thermodynamics of hot air and the flow development at hypersonic flow conditions coupled with extreme heat flux phenomena in the frame of the term “Aerothermodynamics”. Beyond the basic knowledge gained in the lecture on “Fluid Mechanics” the students are qualified to discuss all fundamentals as necessary to cover the fluid mechanics of re-entry flight trajectory of a space vehicle. They are able to distinguish the applicability of gaskinetic methods and continuum theory with respect to atmospheric altitude. The students are able to apply scaling laws as needed to transfer hypersonic flow to ground facilities (shock tunnels). They are qualified to explain the working principle of such tunnels and can explain the required measuring techniques based on recently achieved results.

Content

- Nature of a hypersonic flow
- Fundamentals of aerothermodynamics
- Problems during re-entry
- Flow regimes during re-entry
- Applied hypersonic research

Literature
H. Oertel jun.: Aerothermodynamik, Springer-Verlag, Berlin Heidelberg New York,
1994
F. Seiler: Skript zur Vorlesung über Aerothermodynamik

Remarks
Block course with limited number of participants, registration in the secretary's office required. See details at www.istm.kit.edu

Course: Algorithms for Planar Graphs [24614]

Coordinators: D. Wagner
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
5	2/1	Winter / Summer Term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Basic knowledge of graph theory and algorithm design is helpful.

Learning Outcomes
The lecture aims at providing students with an overview on the field of planar graphs and especially focuses on algorithmic aspects. The students obtain a systematic understanding of the central concepts and techniques for tackling algorithmic questions on planar graphs, which builds upon the students' knowledge in the areas of graph theory and algorithmics. In this course problems are reduced to their algorithmic core and are afterwards, if possible from a complexity theoretical point of view, solved efficiently. The students learn to apply the presented methods and techniques autonomously to related problems. With the obtained knowledge they are able to to work on current reasearch problems in the area of planar graphs

Content
A planar graph is defined as a graph that can be drawn in the plane such that no edges intersect. Planar graphs have many interesting properties that can be used to solve several problems in a particularly simple, fast and elegant way. In addition, some problems that are (NP-)hard in general graphs can be efficiently solved in planar graphs. The lecture presents a selection of these problems and corresponding algorithmic approaches.

Media
Blackboard, script.

Literature
Elective literature:
Takao Nishizeki and Norishige Chiba. Planar Graphs: Theory and Algorithms, volume 32 of Annals of Discrete Mathematics. North-Holland, 1988.

Remarks
The course is lectured irregular.

Course: Algorithms I [24500]

Coordinators: P. Sanders, H. Meyerhenke, D. Hofheinz
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1/2	Summer term	de

Learning Control / Examinations
The assessment of this module consists of a written exam (120 min) according to sec. 4 subsec. 2 no. 1 study and examination regulations.
The grade of the module corresponds to the grade of the written exam.

Conditions
None.

Learning Outcomes
The student is supposed to

- know and understand basic, frequently used algorithms, their conception, analysis of their efficiency, implementation, documentation and application
- be able to use their comprehension to work on new algorithmic problems
- apply the knowledge acquired in the module Grundlagen der Informatik (B.Sc. Information Engineering and Management) to non-trivial algorithms
- be able to analyze and compare basic algorithms,
- apply the knowledge acquired in the module "Grundbegriffe der Informatik" (Bachelor Informatics) or in "Grundlagen der Informatik" (B.Sc. Information Engineering and Management) and the mathematical methodologies learned in the mathematics lectures to solve problems, the focus being on mathematical efficiency analysis

Content
The module provides basic algorithms and data structures.
The following topics are covered in particular:

- basic terms of algorithm engineering
- asymptotic algorithm analysis (worst case, average case, probabilistic, amortised)
- data structures like arrays, heaps, queues and linked lists
- hash tables
- sorting: comparsion based algorithms (e.g. mergesort, quicksort), lower border, radix sort
- sorted sequences, search trees and selection
- graphs (representation, traversing: breadth search, deep search, shortest path, spanning trees)
- generic optimisation algorithms (greedy, dynamic programming, systematic search, local search)
- geometric algorithms

Media
slides, blackboard

Literature
Algorithmen - Eine Einführung
T. H. Cormen, C. E. Leiserson, R. L. Rivest, und C. Stein
Oldenbourg, 2007

Elective literature:
Algorithms and Data Structures – The Basic Toolbox
K. Mehlhorn und P. Sanders
Springer 2008

Algorithmen und Datenstrukturen
T. Ottmann und P. Widmayer
Spektrum Akademischer Verlag, 2002

Algorithmen in Java. Teil 1-4: Grundlagen, Datenstrukturen, Sortieren, Suchen
R. Sedgewick
Pearson Studium 2003
Algorithm Design
J. Kleinberg and É. Tardos
Addison Wesley, 2005
Vöcking et al.
Taschenbuch der Algorithmen
Springer, 2008

Course: Algorithms II [24079]

Coordinators: D. Wagner, P. Sanders
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Winter term	de

Learning Control / Examinations

The assessment consists of a written exam (approx. 120 minutes) according to section 4 subsection 2 no. 1 study and examination regulations.

Conditions

See module description.

Learning Outcomes

The student

- gains profound insight into the most important aspects of algorithmics
- identifies algorithmic problems in different areas of application and can formulate these in a formal manner
- comprehends and determines the running times of algorithms
- knows fundamental algorithms and data structures and can apply this knowledge to new problems.

Content

This course conveys knowledge of basic theoretical and practical aspects of algorithmics. It covers common methods for the design and analysis of basic algorithmic problems as well as the fundamentals of common algorithmic methods such as approximations algorithms, linear programming, randomized algorithms, parallel algorithms and parameterized algorithms.

Course: Analysis and Design of Multisensor Systems [23064]

Coordinators: G. Trommer, G. Trommer
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes
The goal is to relay fundamentals of integrated navigation systems.
This course's aim is to familiarise with the principles of fusing data of different and complementary sensors by the example of integrated navigation systems. The lecture gives an overview about a wide range of different sensor systems used in navigation systems especially accelerometers, gyroscopes and GPS.

Content
This lecture presents the fundamentals of complex, integrated navigation systems. It presents both data fusion techniques and different sensor systems.
First main topic of this lecture deals with fundamental functioning of different gyroscopes and accelerometers. The lecture delves into the fundamentals of ring laser gyroscopes and fibre optic gyroscope in detail. Afterwards micro mechanic sensors are introduced which are used more and more often in navigation systems due to low cost and increasing accuracy.
Next topic deals with the strap down mechanisation, which integrates acceleration information and angular rate information to calculate absolute attitude, velocity, and position information. The strap down algorithm is derived from the differential equation of motion in detail.
By means of integration of acceleration and angular rate measurements measurement errors cause an increasing navigation error. To prevent these errors additional aiding sensors has to be used. The Global Positioning System (GPS) is used most often. Therefore, this lecture concentrates on this system. Different aspects of GPS are mentioned and explained: GPS signal structure and acquisition and tracking of the GPS signal.
Angular rate measurements, acceleration measurements as well as absolute GPS position and velocity measurements are fused by a Kalman filter to achieve the optimal position, velocity and attitude estimations. This lecture finally delves into the principle of Kalman filtering and the different techniques of sensor integration in an illustrative way.

Literature
Elective literature:

- Jan Wendel: Integrierte Navigationssysteme : Sensordatenfusion, GPS und Inertiale Navigation, München 2007.
- D. H. Titterton, J. L. Weston: Strapdown Inertial Navigation Technology.
- R. Brown, P. Hwang: Introduction to Random Signals and Applied Kalman Filtering, John Wiley & Sons.
- Farrell, J.; Barth, M.: The Global Positioning System & Inertial Navigation, McGraw-Hill, 1999, New York.
- Grewal, M.S. u.a.: Global Positioning Systems, Inertial Navigation and Integration, John Wiley & Sons, 2001, New York.

Remarks
Online material is available on: www.ite.kit.edu.

Course: Analytical CRM [2540522]

Coordinators: A. Geyer-Schulz
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Summer term	de

Learning Control / Examinations
Assessment consists of a written exam of 1 hour length following §4 (2), 1 of the examination regulation and by submitting written papers as part of the exercise following §4 (2), 3 of the examination regulation.

The course is considered successfully taken, if at least 50 out of 100 points are acquired in the written exam. In this case, all additional points (up to 10) from excersise work will be added. The grades of this lecture are assigned following the table below:

Grade	Minimum points
1.0	95
1.3	90
1.7	85
2.0	80
2.3	75
2.7	70
3.0	65
3.3	60
3.7	55
4.0	50
5.0	0

Conditions
None.

Recommendations
We expect knowledge about data models and the UML modelling language concerning information systems.

Learning Outcomes
The Student

- understands the principal scientific methods from statistics and informatics used in analytical CRM and their application to enterprise decision problems and independently applies these methods to standard cases,
- understands the components for creating and managing a data warehouse from operative system sources including the processes and steps involved and applies these methods to a simple example, and
- uses his knowledge to conduct a standard CRM analysis on enterprise data for a busines decision problem and deduces and justifies a recommendation for appropriate action.

Content
The course Analytical CRM deals with methods and techniques for analysis concerning the management and improval of customer relationships. Knowledge about customers is aggregated and used for enterprise decision problems like product line planning, customer loyality, etc. A necessary precondition for these analyses is the transformation of data stemming from operative systems into a common data warehouse that assembles all necessary information. This requires transformation of data models and processes for creating and managing a data warehouse, like ETL processes, data quality and monitoring. The generation of customer oriented and flexible reports for different business purposes is covered. The course finally treats several different statistical analysis methods like clustering, regression etc. that are necessary for generating important indicators (like customer lifetime value, customer segmenatation). As external data source, customer surveys are introduced.

Media
slides

Literature

Ponnia, Paulraj. Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals. Wiley, New York, 2001.
Duda, Richard O. und Hart, Peter E. und Stork, David G. Pattern Classification. Wiley-Interscience, New York, 2. Ausgabe, 2001.
Maddala, G. S. Introduction to Econometrics. Wiley, Chichester, 3rd Ed., 2001.
Theil, H. Principles of Econometrics. Wiley, New York, 1971.

Remarks

The lecture ultimately takes place in summer term of 2014. Afterwards the lecture is hold in alternation with "2540520 - Operative CRM". The current schedule can be seen on the chair's website (http://www.em.uni-karlsruhe.de/studies/).

Course: Applied Information Theory [23537 + 23539]

Coordinators: H. Jäkel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	3+1	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
Communications 1, Probability Theory

Learning Outcomes
The goal is to relay theoretical fundamentals
The lecture discusses the fundamentals of information theory, especially focussing on their application in communications.
Supporting the lecture, assignments to the curriculum are distributed. Their solution is presented and discussed during lecture hall exercises.

Content
The methods of information theory defined by C. Shannon are very important for the analysis of source coding techniques. In order to provide a sound basis, the lecture starts with defining the tools of information theory. Based on information theory, both fixed and variable length coding of discrete sources are presented, and their advantages and disadvantages are discussed. Afterwards, practical methods of source coding are introduced and their properties are analyzed. Due to the fact that all methods discussed so far operate for discrete sources, information theory of continuous variables and the relations of continuous signals and their digitized versions is another subject in the lecture.
Regarding the security of transmitted data, cryptography is an important element of today's communication. The algorithms of cryptology are conducted in the transmitter and map data blocks onto data blocks, thus being a coding operation. Therefore, the lecture also covers the principles of cryptology. Based on simple ciphering mechanisms, fundamental principles and problems of cryptology are discussed, and block ciphering and stream ciphering are introduced. Today's e-commerce is based on secure ad-hoc communication which provides security without prior key exchange. Originating from a short survey of mathematical basics, the principles of public-key-cryptography are described.

Literature
Script is provided. Those topics which are not extensively elaborated in the script are taught according to well-established information theory textbooks. Further reading is recommended in the lecture.

Course: Applied Tribology in Industrial Product Development [2145181]

Coordinators: A. Albers, B. Lorentz
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	

Learning Control / Examinations
oral exam

Conditions
none

Learning Outcomes
The goal of the lecture is to discuss tribological problems, tribological features and the tribological variety on examples of the automobile industry.
The students are able to ...

- define a tribological system.
- design a tribological system.
- discuss wear and damage impacts.
- explain measurement techniques to investigate tribological systems.
- show the limits of a tribological system.

Content
Friction, Wear, Wear Measurement
Lubricant (Oil, Grease, etc.)
Hydrodynamic and elastohydrodynamic Lubrication
Design of Tribologic Working Surface Pairs
Technique of Measurement in Lubricated Contacts
Prevention of Maschine Failure
Protective Surface Layers
Journal Bearings, Roller Bearings
Gear Wheels and Transmissions

Literature
The lecture script will be allocated at Ilias.

Course: Antennas and Antenna Systems [23416]

Coordinators: T. Zwick
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	3+1	Winter term	de

Learning Control / Examinations
Oral Exam

Conditions
Basic knowledge of higher mathematics, of fields and waves and fundamentals of microwave engineering.

Learning Outcomes
The lecture aims at giving a deep insight into antennas and antenna systems.
Specialisation lecture about microwave engineering: the main tasks of the lecture are the functionality of all essential antenna structures as well as an insight into modern antenna systems.

Content
Lecture
This lecture concerning antennas and antenna systems is a specailisation in the area of microwace engineering and is intended for students in the 2nd semester of Master in electrical engineering. Besides the theoretical basics this lecture emphasises the practical implementation of the various antenna types. Comprehensive examples of all variations from single element antennas to complete base station antennas for mobile telephony make an optimum combination of theory and praxis possible.
At the beginning of the lecture there is a short recapitulation of essential electromagnetic wave fundamentals (Maxwells equations, plane wave). Afterwards, characteristic parameters of antennas (gain, antenna pattern etc.) and the electrodynamic potentials are defined. Using the latter the Hertzian dipole is derived. Based on this linear antennas are treated in detail. Considerations to antenna groups complete this part of the lecture.
Aperture antennas are widely spread (e.g. for satellite communications). Therefore, a separate chapter is dedicated to this group of antennas. After an introduction to the general theory of area radiators the main representatives of this category, the horn antenna and the lens antenna, are discussed in detail.
The duality principle is introduced for the theoretical treatment of the slot antenna. Furthermore, special dipoles (e.g. Yagi antenna) are presented.
Broadband antennas run through a fast development caused by increased demand. Thus, this lecture treats the different concepts for frequency independent or ultra wideband antennas in detail.
The measurement of antennas is a very special area of the microwave measurement technique. In a separate chapter the state-of-the art measurement techniques for the gain and the antenna pattern of an antenna are described.
In the last part of the lecture different antenna systems are introduced and their configuration as well as the functionality are discussed in detail. Especially the determination of the total performance and the requirements for the single elements are emphasised. Moreover, the consequences of non-ideal behaviour are considered. To visualise the contents examples of current antenna systems are given.
Exercises
Accompanying exercises to the lecture content and the corresponding solutions are given and discussed in a lecture hall tutorial.
Tutorial
The tutorial offers the possibility to put the theoretical content of the lecture into practice. The participation is optional and thus not relevant for the examination.
The tutorial aims at the design, the assembly and measurement of an antenna, usually in planar technology. CST microwave studio is used as design and simulation tool. The tutorial features six afternoon sessions (each 3.5 hours). Three of those afternoons are held in a pool room of the Steinbuch centre for computing and the remaining three afternoons comprise the assembly and measurement of the antenna in the IHE laboratory.
The first two afternoons comprise a general introduction to CST microwave studio and the finite integration method used by the program. This includes modelling of structures, the definition of waveguide ports as well as boundary and symmetry conditions, the consequences and influences of the discretisation (meshing), the application of the available solvers and the visualisation of the simulation results. On the third afternoon the students design their own antenna independently.

On the fourth afternoon the designed antenna is assembled in the IHE microwave laboratory. On the fifth afternoon there is a practical demonstration of the antenna measurement facility, which can be applied on the last afternoon, when the antenna patterns are measured in the IHE anechoic chamber.

Literature
Material to the lecture can be found online at www.ihe.kit.edu.

Remarks
The lecture consists of the two closely intermeshed parts lecture and tutorial as well as an additional optional tutorial. Current information is available on the webpage of the IHE (www.ihe.kit.edu).

Course: Drive Train of Mobile Machines [2113077]

Coordinators: M. Geimer, M. Scherer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
oral examination

Conditions
None.

Recommendations

- general basics of mechanical engineering
- basic knowledge in hydraulics
- interest in mobile machines

Learning Outcomes
Get to know all relevant aspects and components of a drive train of a mobile machine and also the construction of various drive trains. Knowing and understandung interactions and independancies of components on a besic level.

Content
In this course will be discussed the different drive train of mobile machinerys. The fokus of this course is:
- improve knowledge of fundamentals
- mechanical gears
- torque converter
- hydrostatic drives
- continuous variable transmission
- eletrical drives
- hybrid drives
- axles
- terra mechanic

Media
projector presentation

Literature
download of scriptum via ILIAS

Course: Powertrain Systems Technology A: Automotive Systems [2146180]

Coordinators: A. Albers, S. Ott
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The type of examination (written or oral) will be announced at the beginning of the lecture.
written examination: 60 min duration
oral examination: 20 min duration

Conditions
none

Recommendations
Power Train Systems Technology B: Stationary Machinery

Learning Outcomes
The student acquires the basic skills which are necessary to design energy-efficient and comfortable automotive powertrain solutions.

Content
Powertrain System
Driver System
Environment System
System Components
Development Process

Literature
Kirchner, E.; "Leistungsübertragung in Fahrzeuggetrieben: Grundlagen der Auslegung, Entwicklung und Validierung von Fahrzeuggetrieben und deren Komponenten", Springer Verlag Berlin Heidelberg 2007
Naunheimer, H.; "Fahrzeuggetriebe: Grundlagen, Auswahl, Auslegung und Konstruktion", Springer Verlag Berlin Heidelberg 2007

Course: Powertrain Systems Technology B: Stationary Machinery [2145150]

Coordinators: A. Albers, S. Ott
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The type of examination (written or oral) will be announced at the beginning of the lecture.
written examination: 60 min duration
oral examination: 20 min duration

Conditions
none

Recommendations
Powertrain Systems Technology A: Automotive Systems

Learning Outcomes
The student acquires the basic skills which are necessary to design energy-efficient and secure solutions for the design of stationary powertrain applications.

Content
Powertrain System
Operator System
Environment System
System Components
Development Process

Literature
VDI-2241: "Schaltare fremdbetätigte Reibkupplungen und -bremsen", VDI Verlag GmbH, Düsseldorf
Geilker, U.: "Industriekupplungen - Funktion, Auslegung, Anwendung", Die Bibliothek der Technik, Band 178, verlag moderne industrie, 1999

Course: Application of technical logistics in modern crane systems [2117064]

Coordinators: M. Golder
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral, approx. 20min, appointment after acknowledgement

Conditions
none

Recommendations
technical interest; Beneficial: Knowledge of the lecture 'Technical logistics I, basics'

Learning Outcomes
Students are capable to

- explain and apply relevant terms and their definitions like load, stress and strain
- name technical rules and standards applicable in crane design
- explain and discuss the importance of safety factors and dynamic factors
- name and describe the required verification measures in crane design
- describe the objective, approach and aspects when transferring the dynamic behavior of a crane into an elasto-kinetic model
- transfer the approach of dimensioning a bridge crane to any other material handling equipment

Content
Fundamentals of modern (bridge) crane design

- Content and application of relevant technical rules, standards and guidelines
- Terminology, definitions, dimensioning methods and verification measures in (bridge) crane design
- Concept of safety and dynamic factors
- Dimensioning of a bridge crane considering operating conditions, classification of different crane components as well as safety factors and dynamic factors
- Environmental factors on a crane system regarding strain, stability and fatigue strength
- Elasto-kinetic modelling of the dynamic behavior of a crane system and its quality

Media
presentations, black board

Literature
None.

Remarks
none

Course: Application of technical logistics in sorting- and distribution technology [2118089]

Coordinators: J. Föller
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral 30 min

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe and classify basics and characteristics of application of sorting and distribution of goods,
- Solve drive and control tasks with appropriate concept selection,
- Design systems with appropriate calculation methods and evaluate them financially, and
- Judge about the confirmity of the system by using relevant standards and set of rules.

Content
Basics of goods sorting and distribution technology, employment characteristics, classification, interpretation, dimensioning, costs considerations. Relevant control, modern sets of rules and propulsion principles

Media
presentations, black board

Literature
None.

Remarks
none

Course: Application of advanced programming languages in mechanical engineering [2182735]

Coordinators: D. Weygand
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
None.

Learning Outcomes
The student can

- utilise the programming language Fortran 95 and Fortran 2003 to implement simple numerical simulations
- apply a script languages awp resp. python for data treatment

Content
This lecture gives an introduction to advances programming and scripting languages and numerical methods under UNIX/Linux:

* Fortran 95/2003
\- structure of source code
\- progamming
\- compiling
\- debugging
\- parallelization with OpenMP
* numerical methods
* script languages: Python, awk
* visualisation

Literature

1. fortran 95/2003 explained, M. Metcalf, J. Reid, M. Cohen, Oxford University Press 2004.
2. Intel Fortran compiler handbook.

Course: Working Methods in Mechanical Engineering [2110969]

Coordinators: B. Deml
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	en

Learning Control / Examinations
Five online-tests and active participation during all four workshop sessions.

Conditions
None.

Learning Outcomes
By the end of the lecture, the participants have obtained core working techniques, which form an important basis for the scientific work as a Mechanical Engineer and which enable the participants to write their degree theses self-dependently:
The students are able to complete a sound scientific literature research and to acquire scholarly literature or information on their own. Besides, they know techniques that make it easier for them to get into the scientific writing process and they are aware of formal aspects (e. g. citation rules, plagiarism) that have to be considered when writing a scientific work. Further on the students know, which aspects are to be considered in order to give a convincing scientific presentation.
Finally, on completion of the course, they know essential techniques in the field of self- and time-management as well as social-psychological principles of team-work.

Content

1. Time and self-management
    - Time planning – from the semester outline to a day's schedule
    - Time planning – Why should I set priorities?
    - The Eisenhower-principle – How do I set priorities?
    - Definition of goals – How do I set realistic learning goals?
    - Low motivation – What to do by a lack of motivation?
    - Organization of breaks – How do I optimize my learning result by breaks?
    - Design of learning place – Where and how do I learn in a right way?
2. Literature research
    - Principles of literature research
    - Research preparation
    - Literature research in KIT-catalogue
    - Literature research in specialist databases
    - Literature research in the internet
    - Literature procurement
3. Team work
    - Team phases
    - Team meetings
    - Team roles
    - Group performance
    - Communication
    - Finishing teamwork productively

4. Scientific writing
    - Process of writing: in five steps from the idea to the text
    - Structure of a scientific work
    - To get into writing
    - Tips for formulating a scientific work
    - Plagiarism and how it is avoided
    - Citing, referring, listing: Reference techniques in scientific works
    - Keeping information from lectures and texts
    - Laboratory journal: documenting experiments in a systematic manner
5. Scientific presentation
    - Reception and overview
    - Focussing
    - Structuring
    - Formulating
    - Visualizing
    - Editing
    - Presenting

Media
The lecture is organized as an e-learning programme, which is enhanced by two classroom-based sessions at the beginning and the end of the semester, respectively. The online-lecture, the corresponding tests as well as further information are available in ILIAS.

Course: Human Factors Engineering I: Ergonomics [2109035]

Coordinators: B. Deml
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Compulsory Core Subject: oral exam
Elective Subject: oral exam (approx. 30 min)
Compulsory Optional Subject: written exam (60 min)
Optional Subject: oral exam (approx. 30 min)
The exams are only offered in German!

Conditions
None.

Learning Outcomes
The students acquire a basic knowledge in the field of ergonomics:

- They are able to consider cognitive, physiological, anthropometric, and safety technical aspects in order to design workplaces ergonomically.
- Just as well they know physical and psycho-physical fundamentals (e. g. noise, lighting, climate) in the field of work-environmental design.
- Furthermore the students are able to evaluate workplaces by knowing and being able to apply essential methods of time studies and payment systems.
- Finally, they get a first, overall insight into the German labour law as well as into the organisation of advocacy groups beyond companies.

Further on the participants get to know basic methods of behavioral-science data acquisition (e. g. eye-tracking, ECG, dual-task-paradigm).

Content

1. Principles of human work
2. Behavioural-science data acquisition
3. workplace design
4. work environment design
5. work management
6. labour law and advocay groups

Literature
The lecture material is available on ILIAS for download.

Course: Atomistic simulations and molecular dynamics [2181740]

Coordinators: P. Gumbsch, L. Pastewka
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral exam 30 minutes

Conditions
compulsory preconditions: none

Recommendations
preliminary knowlegde in mathematics, physics and materials science

Learning Outcomes
The student can

- describe the physical foundation of particle based simulation method (e.g. molecular dynamics)
- apply particle based simulation methods to problems in materials science

Content
The lecture introduces the foundation of particle based simulation methods focussing on molecular dynamics:

1. Introduction
2. Physics of Materials
3. MD Basics, Atom-Billard
* particle, position, energy, forces, pair potentials
* initial and boundary conditions
* time integration
4. algorithms
5. statics, dynamics, thermodynamics
6. MD output
7. interaction between particles
* pair potential – many body potentials
* principles of quantum mechanics
* tight binding methods
* dissipative particle dynamics
8. application of particle based methods

Literature

1. Understanding Molecular Simulation: From Algorithms to Applications, Daan Frenkel and Berend Smit (Academic Press, 2001)
2. Computer simulation of liquids, M. P. Allen and Dominic J. Tildesley (Clarendon Press, Oxford, 1996)

Course: Design and Operation of Power Transformers [23390]

Coordinators: M. Schäfer
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at the beginning of the recess period (according to Section 4 (2), 2 of the examination regulation). The exam takes place in every summer semester. Re-examinations are offered at every ordinary examination date.

Conditions
Basics in electrical engineering

Learning Outcomes
Students know the basics of electromagnetic lay-out design of power transformers as being used in power transformers. They know the design, the components and the technology being used, as well as the used material. The operating performance of power transformers can be calculated. Important aspects for the operation and maintenance of power transformers are known. Students are familiar with the major maintenance measures and are capable to adopt their knowledge onto other high-voltage equipment.

Content
The lectue is divided into the following clauses

- Applications and design variations of power transformers
- Components and design of power transformers
- Working principle of power transformers and shunt reactors. Induction law and its application for the precalculation of transformers. The magnetic field in iron coress, core designs, variations and air gaps in magnetic circuits. Magnetic materials and their properties, application in transformers and shunt reactors. Main and stray flux in transformers and calculation of the equivalent circuit. Stresses inside transformers during inrush and short circuits.
- Winding connections and vector groups of transformers,three phase power system, connected voltages and line to earth voltage, description of three phase systems, parallel connection of transformers.
- Precalculation of transformers.
- Losses in transformers and its origins in core and in the windings. Possible measures to influence loss generation. Cooling systems and its applications.
- High voltage DC transformers
- Factory testing of transformers. Persformance of type tests, standard test and special tests.
- Ovaerload capability of transformaer. Controlled overloading and emergency overload.
- Cervive and monitoring.
- Future trends and research and development activities.

Media
The material is distributed during any lecture

Remarks
The course consists of seven lecture blocks and one factory visit. Date and time is announced on the blackboards.

Course: Selected Applications of Technical Logistics [2118087]

Coordinators: M. Mittwollen, V. Madzharov
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
after each lesson period; oral / written (if necessary) => (look at "Studienplan Maschinenbau", latest version)

Conditions
look at Empfehlungen (en)

Recommendations
GTL/ESTL should be visited in advance, knowledge out of GTL/ESTL preconditioned

Learning Outcomes
Students are able to:

- Model the dynamic behaviour of material handling systems and based on this calculate the dynamical behaviour and
- Transfer this approach autonomous to further, different material handling installations and
- Discuss the knowledge with subject related persons.

Content
design and dimension of machines from intralogistics // static and dynamic behaviour // operation properties and specifics // visit of real intralogistic system
Inside practical lectures: sample applications and calculations in addition to the lectures

Media
supplementary sheets,projector, blackboard

Literature
Recommendations during lessons

Remarks
-

Course: Selected Topics in Manufacturing Technologies [2118092]

Coordinators: V. Schulze
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are capable to specify different manufacturing processes and to differentiate against each other.
- are able to classify the manufacturing processes by their structure and functionality according to the specific main groups.
- are able to explain the characteristics, function and field of application of different manufacturing processes.
- are qualified to evaluate different processes regarding specific applications based on technical aspects.

Content
The objective of the lecture is to look at manufacturing technology within the wider context of production engineering, to provide an overview of the different manufacturing processes and to impart process knowledge of the common processes. The lecture covers the basic principles of manufacturing technology and deals with the manufacturing processes according to their classification into main groups regarding technical and economic aspects.
The following topics will be covered:

- Quality control
- Primary processing (casting, plastics engineering, sintering, additive manufacturing processes)
- Forming (sheet-metal forming, massive forming, plastics engineering)
- Cutting (machining with geometrically defined and geometrically undefined cutting edges, separating, abrading)
- Joining
- Coating
- Heat treatment and surface treatment

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Selected Topics in Aeronautics and Astronautics I [2170454]

Coordinators: S. Wittig
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral
Duration: approximately 30 minutes

Supporting material: none

Conditions
Basic principles of mathematics, thermodynamics, fluid mechanics, mechanics

Learning Outcomes
The students are able to:

- analyse space systems
- comment on the integration of air traffic in the transport system due to the mobility requirements
- explain the physical-technical basics and judge the design and application of space vehicles and air transport concerning ecomnomic and ecological issues
- name the main components of various systems and application fields (e.g. earth observation, communication, space exploration, manned spaceflight) and explain their funtion
- define and analyse the requirements and design principles for aircrafts / aircraft fleets

Content
Central topics are the analysis of space systems and of the air traffic with its impact on modern mobility requirements. The unterstanding of the fundamentals - physical and technological - is essential fo the design and application of space vehicles as well as of an economically and ecologically efficient air transport. Based on recent developments the main components of the various systems and their design principles are introduced.
In the fall/winter semester an additional lecture course is offered.
I. Space Systems
Applications
Space Programms
Economical Aspects
Main Components
Influence Parameters
Space Missions
Launches
Satellites

II. Air Transport
Development: State of the art
Economical Aspects
Aircraft Design and Development
Aerodynamics
New Materials
Future Developments

Literature
Messerschmidt, Ernst: Raumfahrt-systeme, Springer-Verlag 2005

Griffin, Michael D.: Space Vehicle Design; AIAA Education Series 2004

Hünecke, Klaus: Die Technik des modernen Verkehrsflugzeuges, Motorbuch-Verlag 2004

Course: Selected Topics in Aeronautics and Astronautics II [2169486]

Coordinators: S. Wittig
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
Duration: approximately 30 minutes

Supporting material: none

Conditions
Basic Principles of Mathematics, Fluid Mechanics, Thermodynamics, Mechanics

Learning Outcomes
The students posses the ability to:

- explain and evaluate the desiogn principles of civil aircrafts
- analyse the requirements for civil aircrafts
- derive design and construction principles for aircraft fuselage and engines
- discuss discuss (transient) loads during operation
- describe and apply the basic principles of orbital mechanic and maneuverability of satellites in space
- discuss launcher desgin and re-entry problems with ground and space segments

Content
The main topics in the first half of the course is the civil aircraft design. Based on the analysis of the general requirements, design principles for aircraft fuselage and the engines are introduced. Various - including unsteady - loads during operation are discussed. The second part is directed towards the basic principles of orbital mechanic and maneuverability of satellites in space . Launcher design and re-entry problems with ground and space segments are introduced. In the spring/summer semester an additional lecture-course is offered.
I. Aircraft Design
Mission Envelope
Aircraft Engines
Design Concepts
Aerodynamic Loads

II. Space Systems and
Satellites
Orbital Mechanics
Orbital Transfer
Rocket Systems
Ground- and Space Segements
Re-entry
Future Missions

Literature
Hünecke, Klaus: Die Technik des modernen Verkehrsflugzeuges, Motorbuch-Verlag, 2004

Hull, David, G.:Fundamentals of air-plane flight mechanics; Springer 2007

Messerschmid, Ernst: Raumfahrt-systeme, Springer-Verlag 2005

Griffin, Michael D.: Space Vehicle Design, AIAA Education Series 2004

Course: Selected Topics on Optics and Microoptics for Mechanical Engineers [2143892]

Coordinators: T. Mappes
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Selected chapters of the combustion fundamentals [2167541]

Coordinators: U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Oral
Duration: 30 min

Conditions
None

Recommendations
None

Learning Outcomes
The attendance of this course enables students to gain a deeper understanding of the mechanisms involved in the chemistry of combustion, droplet and spray combustion and the statistical modelling of turbulent combustion.

Content
Depending on the lecture: Fundamentals of chemical kinetics, of statistical modeling of turbulent flames or of droplet and spray combustion.

Media
Blackboard and Powerpoint presentation

Literature
Lecture notes
Combustion - Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, authors: U. Maas, J. Warnatz, R.W. Dibble, Springer-Lehrbuch, Heidelberg 1996

Course: Selected Problems of Applied Reactor Physics and Exercises [2190411]

Coordinators: R. Dagan
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam, 30 min.

Conditions
none

Recommendations
none

Learning Outcomes
The students

- have solid understanding of the basic reactor physics
- are able to estimate processes of growth and decay of radionuclides; out of it, they can preform dose calculation and introduce their biological hazards
- can calculate the relationship of basic parameters which are needed for a stable reactor operation
- understand important dynamical processes of nuclear reactors.

Content

- Nuclear energy and forces
- Radioactive decay
- Nuclear processes
- Fission and the importance of delayed neutrons
- Basics of nuclear cross sections
- Principles of chain reaction
- Static theory of mono energetic reactors
- Introduction to reactor kinetic
- student laboratory

Literature
K. Wirtz Basics of Reactor technic Par I, II, Technic School Karlsruhe 1966 (in German)
D. Emendorfer. K.H. Höcker Theory of nuclear reactions, BI- Hochschultaschenbücher 1969 (in German)
J. Duderstadt and L. Hamilton, Nuclear reactor Analysis, J. Wiley $ Sons, Inc. 1975.

Course: Design of highly stresses components [2181745]

Coordinators: J. Aktaa
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam: 30 minutes

Conditions
material science
solid mechanics II

Learning Outcomes
The students know about the rules of established design codes for the assessment of components which under operation are subjected to high thermo-mechanical and/or irradiation loadings. They understnd which constitutive equations are used according to state-of-the-art of technology and research to estimate deformation and damage appearing under these loadings and to predict expected lifetime. They gained insight into the application of these generally non-linear constitutive equations in finite element codes and can judge the major issues which shall be thereby taken into account.

Content
Contents of the lecture:

- rules of common design codes
- classical models for elasto-plasticity and creep
- lifetime rules for creep, fatigue and creep-fatigue interaction
- unified constitutive models for thermo-elasto-viscoplasticity
- continuum mechanical models for damage at high temperatures
- application of advanced material models in FE-codes

Literature

- R. Viswanathan, Damage Mechanisms and Life Assessment of High-Temperature Components, ASM International, 1989.
- Lemaitre, J.; Chaboche J.L.: Mechanics of Solid Materials, Cambridge University Press, Cambridge, 1990.

Course: Design and Development of Mobile Machines [2113079]

Coordinators: M. Geimer, J. Siebert
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
homework in small groups during the semester + oral examination

Conditions
None.

Recommendations
Knowledge in Fluid Technology (SoSe, LV 21093)

Learning Outcomes
Students will learn:
1. How to develop a mobile working machine
2. How to apply existing knowledge on a specific problem
3. How to break down and structure a complex task
4. How knowledge of different courses can be brought together

Content
Wheel loaders and excavators are highly specialized mobile machines. Their function is to detach, pick up and deposit materials near by. Significant size for dimensioning of the machines is the content of their standard shovel. In this lecture the main steps in dimensioning a wheel loader or excavator are beeing thought. This includes among others:

-
- Defining the size and dimensions,
- the dimensioning of the drive train,
- Determining the kinematics of the equipment,
- the dimension of the working hydraulics and
- Calculations of strength

The entire design process of these machines is strongly influenced by the use of standards and guidelines (ISO/DIN-EN). Even this aspect is dealt with.

The lecture is based on the knowledge from the fields of mechanics, strength of materials, machine elements, propulsion and fluid technique. The lecture requires active participation and continued collaboration.

Literature
None.

Course: Dimensioning and Optimization of Power Train System [2146208]

Coordinators: E. Kirchner
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral Examination

Conditions
none

Learning Outcomes
The students gain the knowledge about ...

- functionality of conventional vehicle drive systems and design load for components.
- design- and functional principals of the main components of manual transmission, dual-clutch systems and automatic transmissions.
- comfort relevant interactions and corrective measures.
- requirements of hybridization and electrification of vehicles.
- evaluation on system level.

Content

1. Architectures: conventional, hybrid and electrical transmissions
2. The gear as system in a vehicle
3. Components and power flow ofsynchromesh gears
4. Spur gears
5. Synchronization
6. Switching systems for vehicles with manual transmission
7. Actuators
8. Comfort aspects for manual transmissions
9. Torque converter
10. Planetary sets
11. Power conversion in automatic transmissions
12. Continuously variable transmission systems
13. Differentials and components for power split
14. Drive train for commercial vehicles
15. Gears and electrical machines for electro mobility

Course: Automation of Power Grids [23396]

Coordinators: R. Eichler
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at the beginning of the recess period (according to Section 4 (2), 2 of the examination regulation). The exam takes place in every summer semester. Re-examinations are offered at every ordinary examination date.

Conditions
Basic knowledge of power transmission and distribution; basic knowledge of IT

Learning Outcomes
The students understand methods, equipment, standards, current and future technology, state-of-the-art and trends of power systems control from a global (i.e. worldwide) perspective. They are able to identify problems related to power system control and to develop solution approaches. They have acquired an understanding of interrelationships from both physical and IT points of view, and they are able to describe power system control problems using the subject-specific terminology.

Content
The lecture conveys the bases of power systems control, whereby special value is attached to the application in the practice. Thus both current technologies are covered as well as technologies already applied in the field for some time. After a short introduction to the electrical energy supply as well as to the operation of electrical grids, i.e. to the environment of power systems control, the operational data dealt with in power systems control are analyzed. The lecture deals with the concepts and technologies of remote control and substation automation as well as technology applied in network control centers; the communication technology is non-specific for the power systems control and therefore gets only striped. A main emphasis of the lecture is on the software technical solutions for network control centers, i.e. on data models, data management as well as the architecture of software systems in control centers. The basic functionality of a network control center (SCADA = Supervisory Control And Data Acquisition) as well as its man-machine interface are treated among others with the help of a demo control system as well as an excursion to a network control center. The discussion of Advanced Applications and their underlying mathematical algorithms complete the lecture.

Media
Slides of the lecture presentation.

Literature
Elective literature:

- Dieter Rumpel, Ji R. Sun: Netzleittechnik. Informationstechnik für den Betrieb elektrischer Netze Springer; Berlin (Januar 1989)
- Ernst-Günther Tietze: Netzleittechnik 1. Grundlagen; VWEW Energieverlag GmbH
- Ernst-Günther Tietze: Netzleittechnik Teil 2: Systemtechnik; VDE-Verlag
- Allen J. Wood, Bruce F. Wollenberg: Power Generation, Operation, and Control; Wiley-Interscience; 2nd edition (January 1996)
- Stuart A. Boyer: SCADA: Supervisory Control and Data Acquisition; ISA 3rd edition (June 2004)

Course: Automated Manufacturing Systems [2150904]

Coordinators: J. Fleischer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	6	Summer term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are able to analyze implemented automated manufacturing systems and describe their components.
- are capable to assess the implemented examples of implemented automated manufacturing systems and apply them to new problems.
- are able to name automation tasks in manufacturing plants and name the components which are necessary for the implementation of each automation task.
- are capable with respect to a given task to plan the configuration of an automated manufacturing system and to determine the necessary components to its realization.
- are able to design and select components for a given use case of the categories: “Handling Technology”, “Industrial Robotics”, “Sensory” and “Controls”.
- are capable to compare different concepts for multi-machine systems and select a suitable concept for a given use case.

Content
The lecture provides an overview of the structure and functioning of automated manufacturing systems. In the introduction chapter the basic elements for the realization of automated manufacturing systems are given. This includes:

- Drive and control technology
- Handling technology for handling work pieces and tools
- Industrial Robotics
- Quality assurance in automated manufacturing
- automatic machines, cells, centers and systems for manufacturing and assembly
- structures of multi-machine systems
- planning of automated manufacturing systems

In the second part of the lecture, the basics are illustrated using implemented manufacturing processes for the production of automotive components (chassis and drive technology).The analysis of automated manufacturing systems for manufacturing of defined components is also included.
In the field of vehicle power train both, the automated manufacturing process for the production of the conventional internal-combustion engine and the automated manufacturing process for the production of the prospective electric power train (electric motor and battery) are considered. In the field of car body, the focus is on the analysis of the

process chain for the automated manufacturing of conventional sheet metal body parts, as well as for automated manufacturing of body components made out of fiber-reinforced plastics.
Within tutorials, the contents from the lecture are advanced and applied to specific problems and tasks.

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Automation of Discrete Event and Hybrid Systems [23160]

Coordinators: M. Kluwe
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) according to §4(2), 2 of the examination regulation. The exam takes place at several dates in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
In the lecture the students get familiar with the basics of the modelling, simulation, analysis and control of discrete event and hybrid systems.
The course trains students in basic topics on discrete event systems. It qualifies students to develop different discrete event process models and to select the appropriate model for a given problem. It also familiarizes students with simulation and analysis of presented model concepts. A major topic of the course is discrete event controller design, including specification as well as implementation issues. An introduction to hybrid systems provides self-studying ability on this topic of increasing importance in control engineering.

Content
In the lecture the students get familiar with the basics of the modelling, simulation, analyses and control of discrete event and hybrid systems:

- *Introduction*
  system classification, definition, example: controlled charging process
- *Model classification and modeling formalisms*
  automata and formal languages, petri nets, net condition/event systems
- *Discrete process modeling*
  state-oriented modeling, resource-oriented modeling
- *Analysis of discrete event systems*
  characteristics of petri nets, analyzing petri nets, analyzing timed event graphs via Max-plus algebra
- *Specification and Design of discrete controllers*
  classification of control objectives and control, control specification, control design, implementation, control of a lifting table, control of a production line
- *Hybrid Systems*
  hybrid phenomena, simulation, analyzing and control of hybrid systems, example

Media
Supplemental sheets
Demonstration with Matlab/Simulink

Literature

- Cassandras, C. G., Lafortune, S.: Introduction to Discrete Event Systems, Springer, Netherlands, 2008

Elective literature:

- Abel, D.: Petri-Netze für Ingenieure, Springer Verlag Berlin, 1990

Remarks
Current information can be found on the IRS webpage (http://www.irs.kit.edu/).

Course: Automation Systems [2106005]

Coordinators: M. Kaufmann
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Fundamentals of measuring and control engineering

Learning Outcomes
Students have fundamental knowledge about functionality, composition, components and development of industrial automation systems.

Content

- Introduction: Terms and definitions, examples, requirements
- Industrial processes: classification, process conditions
- Automation tasks
- Components of industrial automation systems: control functions, data acquisition, data output equipment, Programmable Logic Controllers, PC-based control
- Industrial communication, classification, topology, protocols, bus systems for automation systems
- Engineering: plant engineering, composition of control systems, programming
- Requirements on equipment, documentation, identification
- Dependability and safety
- Diagnosis
- Application examples

Literature

- Gevatter, H.-J., Grünhaupt, U.: Handbuch der Mess- und Regelungstechnik in der Produktion. 2. Auflage, Berlin, Heidelberg: Springer-Verlag, 2006.
- Langmann, R.: Taschenbuch der Automatisierung. München: Fachbuchverlag Leipzig, 2010.
- Strohrmann, G.: Automatisierung verfahrenstechnischer Prozesse: eine Einführung für Ingenieure und Techniker. München, Wien: Oldenbourg-Industrieverlag, 2002.
- Wellenreuther, G., Zastrow, D.: Automatisieren mit SPS: Theorie und Praxis. 4. Auflage, Wiesbaden: Vieweg+Teubner, 2009.

Course: Automotive Engineering I [2113809]

Coordinators: F. Gauterin, M. Gießler
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter term	en

Learning Control / Examinations
Written examination

Duration: 120 minutes

Auxiliary means: none

Conditions
Examination in English
Can not be combined with lecture [2113805] Grundlagen der Fahrzeugtechnik I.

Recommendations
none

Learning Outcomes
The students know the movements and the forces at the vehicle and are familiar with active and passive security. They have proper knowledge about operation of engines and alternative drives, the necessary transmission between engine and drive wheels and the power distribution. They have an overview of the components necessary for the drive and have the basic knowledge, to analyze, to judge and to develop the complex system “vehicle”.

Content
1. History and future of the automobile

2. Driving mechanics: driving resistances and driving performances, mechanics of the longitudinal and transverse forces, passive safety

3. Engines: combustion engine, alternative drives (e.g. electric motor, fuel cell)

4. Transmission: clutches (e.g. friction clutch, visco clutch), transmission (e.g. mechanical transmission, hydraulic fluid transmission)

5.Power transmission and distribution: drive shafts, cardon joints, differentials

Literature
1. Mitschke, M./ Wallentowitz, H.: Dynamik der Kraftfahrzeuge, Springer-Verlag, Berlin, 2004

2. Braes, H.-H.; Seiffert, U.: Handbuch Kraftfahrzeugtechnik, Vieweg&Sohn Verlag, 2005

3. Gnadler, R.: Script to the lecture ’Automotive Engineering I’

Course: Rail System Technology [2115919]

Coordinators: P. Gratzfeld
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
The students understand relations and interdependencies between rail vehicles, infrastructure and operation in a rail system.
They can assess the suitability of existing elements in the overall system.
They deduct the fundamental requirements for rail vehicles out of it.

Content
Introduction: railyway as system, history, networks, traffic development, economic impact
Vehicle dynamics: driving resistance, tractive effort diagram, load cycles
Wheel-rail-contact: carrying of vehicle mass, adhesion, wheel guidance
Train protection: succession of trains, guideway
Traction power supply: power networks, power distribution, substations
Vehicles: definitions, compositions
Enviromental aspekt: energy consumption, traffic area, noise

Media
All slides are available for download (Ilias-platform).

Literature
A bibliography is available for download (Ilias-platform).

Remarks
none

Course: Battery- and Fuel Cell Systems [23214]

Coordinators: A. Weber
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Learning Outcomes
The participants will gather the knowledge required for the technological development and economic evaluation of battery and fuel cell systems by means of selected examples.
In the lecture Battery- and Fuel Cell Systems, the topics of the first lecture (23207) will be deepened, current technology developments will be discussed and system-relevant aspects will be covered.

Content
The various cell concepts, the design of stacks and the components required for systems are treated in detail for the most common low- and high-temperature fuel cells. This lecture especially emphasizes the electrical operating behaviour of systems. Here, the aspects of power, long-term stability and the loss mechanisms associated with degradation phenomena are discussed on the basis of own research projects.
The treatment of systems for electrotraction focuses on the lithium-ion battery. Its operating behaviour, failure mechanisms, and the development status of high-energy batteries are presented.
Knowledge on electrochemical characterization methods and modeling of batteries and fuel cells is furthered.

Literature
Copies of the slides are available on http://www.iwe.kit.edu/.

Course: Production Operations Management [2110085]

Coordinators: K. Furmans, G. Lanza, F. Schultmann, B. Deml
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH], Mechatronics and Products (p. 20)[BSc-MIT - B8]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Summer term	de

Learning Control / Examinations
The assessment is carried out as a written exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are able to describe the connections between production science work scheduling and –design, material flow and basics of economics,
- are able to differentiate between production systems and rate their characteristics,
- are capable of designing workplaces according to the requirements,
- can create material flow systems depending on the production system to ensure supply,
- are able to evaluate systems financially by having the economical knowledge.

Content
The lecture is given in cooperation by the Institute for Conveying Technologies and Logistics (IFL), the Institute of Human and Industrial Engineering (ifab), the Institute of Production Science (wbk) and the Institute for Industrial Production (IIP). Basic knowledge about the planning and operation of a production business is provided. Subject areas are production science (production techniques, manufacturing and assembly systems), work scheduling, work control, work design, material flow as well as basics of economics (accounting, reinvestment analyses, legal forms).

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Fuels and Lubricants for Combustion Engines [2133108]

Coordinators: B. Kehrwald
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination, Duration: ca. 25 min., no auxiliary means

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can name and explain composition and meaning of fuels, lubricants and coolants as important components in the system of todays Otto and Diesel engines as well as definition and chemical composition of fuels and lubricants, the meanig of crude oil as basic primary product, production processes, major properties, standards and specifications, testing methods.
They can point out future worldwide trends in the field of conventional and alternative fuels regarding emission standards and energy conservation

Content
Introduction and basics

Fuels for Gasoline and Diesel engines

Hydrogen

Lubricants for Gasoline and Diesel engines

Coolants for combustion engines

Literature
Lecturer notes

Course: Operating Systems [24009]

Coordinators: F. Bellosa
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
Knowledge of C/C++ programming is required.

Recommendations
The successful completion of the module *Programming* [IN1INPROG] is recommended.

Learning Outcomes
The students describe the basic mechanisms and policies of operating systems. They show the flow of execution in the kernel components and trace the interaction via defined system interfaces.The students use the system call interface to request operating system services. They design and implement small applications (utilities) using the system call interface.

Content
Students describe mechanisms, policies and control structures in the follow components of an operating system:

- Process management
- Synchronization
- Memory management
- File system
- I/O management

Media
Lecture slides in English.

Literature
Operating System Concepts by Abraham Silberschatz, 8th Edition
Elective literature:
Modern Operating Systems by Andrew S. Tanenbaum, 3rd Edition

Course: Business Administration: Finance and Accounting [2610026]

Coordinators: M. Ruckes, M. Uhrig-Homburg
Part of the modules: Betriebswirtschaft (Wirtschaftswissenschaften) (p. 30)[BSc-MIT - B-PW1], Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	2/0/2	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes
Students

- are able to valuate bonds and cash flows in general,
- can valuate stocks,
- can make investment decisions,
- can analyse portfolios,
- are able to recognise business events in financial reports,
- can determine depreciation expenses,
- are able to valuate inventories,
- can analyse costs,
- knows the difference between financial and management accounting,
- knows cost center accounting,
- can estimate product costs.

Content

- **Investment and Finance:**
  - Valuation of Bonds and Stocks
  - Capital Budgeting
  - Portfolio Theory
- **Financial Accounting**
- **Management Accounting**

Literature
Extensive bibliographic information will be given in the materials to the lecture.

Remarks
Key qualifications can be shown in an active participation through presentations of solutions and discussions in the tutorials which accompany the course. Each part of the course is taught by instructors specialised in the field of that part.

Course: Business Administration: Production Economics and Marketing [2600024]

Coordinators: M. Ruckes, W. Fichtner, M. Klarmann, Th. Lützkendorf, F. Schultmann
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	2/0/2	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam (90 minutes) according to Section 4(2), 1 of the examination regulation.

Conditions
None.

Learning Outcomes
Students

- are able to analyse and implement the marketing strategy and marketing measures (marketing mix: 4 Ps),
- can analyse, implement and manage procurement and production processes,
- are able to plan projects, and
- have skills about selected issues in energy economics.

Content
The course is made up of the following topics:
Marketing

- Foundations of marketing
- Strategic marketing
- Cosumer behaviour
- Product
- Price
- Promotion
- Sales
- Marketing Metrics

Production economics
In the part of production economics the student will learn basics in the field of production theory, procurement and resource aquisitions, production and operations management and industrial engineering.
Aspects of energy economics, technological foresights, construction industry and real estate markets will be treated.

Literature
Further literature references are announced in the materials to the lecture.

Remarks
Key qualifications can be shown in an active participation through presentations of solutions and discussions in the tutorials which accompany the course.
Each part of the course is taught by instructors specialised in the field of that part.

Course: Civil Law for Beginners [24012]

Coordinators: T. Dreier, O. Knöfel
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	4/0	Winter term	de

Learning Control / Examinations
The assessment consists of a written exam according to Section 4, (2), 1 of the examination regulation.

Conditions
None.

Learning Outcomes
The Students grasp the differences between civil law, public law and criminal law. In particular, students know the fundamental notions and constructions of Civil law as laid down in the German Civil Code (Bürgerliches Gesetzbuch, BGB), such as subjects and objects of law, legally binding declarations, the formation of contracts, standard terms and conditions, consumer protection, performance of contractual promises etc. Students are able to recognize the legal problems of a given factual situation and develop solutions to simple legal problems.

Content
The course starts with a general introduction into law. What is law, why are legal rules valid, and what is the role of law in conjunction with social behavior, technological and market developments? What is the relationship between law and justice? Moreover, the distinction between civil law, public law and criminal law will be highlighted. The basics of jurisdiction, international conflicts and alternative dispute settlement will be discussed. The main focus of the course is on the fundamental notions of civil law as defined and regulated in the German Civil Code (Bürgerliches Gesetzbuch, BGB), such as subjects and objects of law, legally binding declarations, agency, the formation of contracts, standard terms and conditions, consumer protection, performance of contractual promises. The course ends with an outlook to the law of contracts and property law.

Media
Transparencies/Slides

Literature
Tba at the beginning of the course,
Elective literature:
Tba at the beginning of the course,

Course: Advanced Civil Law [24504]

Coordinators: T. Dreier
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations
The assesment ist explained in the module description.

Conditions
The course *Civil law for beginners* [24012] is required.

Learning Outcomes
Following what the students have learned in the course *Civil law for beginners* about the basic notions of law and, in particular, the general part of the German Civil Code (Bürgerliches Gesetzbuch, BGB), in this course the students shall acquire knowledge of contract and of property law. They will learn about the statutory regulation of place, time and modalities of the performance of contractual duties, as well as the statutory rules governing defaults of performing contractual promises (impossibility of performance; non-performance; delayed performance, defective performance). In addition the students will be presented with the different types of contracts and with both liability for fault and strict liability. As far as property law is concerned, the students shall understand the different types of transfer of ownership and of securities the German Civil Code provides for.

Content
Following what the students have learned in the course Civil law for beginners about the basic notions of law and, in particular, the general part of the German Civil Code (Bürgerliches Gesetzbuch, BGB), in this course the students shall acquire knowledge of contract and of property law. On the one hand, this includes the statutory rules on place, time and modalities of performance, and the statutory rules governing defaults of performing contractual promises (impossibility of performance; non-performance; delayed performance, defective performance). On the other hand, the statutory types of contracts will be discussed (in particular, sale, lease, contract for work and contract for services, lending and borrowing) as well as new types of combined contracts (e.g., leasing, factoring, computer contracts). Moreover, legal liability will be discussed both with regard to liability for fault and with regard to strict liability. As regards property law, possession and ownership will be discussed as well as the different forms of transfer of ownership and the most important of the security rights.

Media
Transparencies/Slides

Literature
Tba at the beginning of the course.
Elective literature:
tba at the beginning of the course

Course: Image processing for Navigation [23090]

Coordinators: N. Link
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Verbal exam

Conditions
None.

Recommendations
Linear agebra, calculus

Learning Outcomes
Basics of image and image sequence analysis.
Abstract concepts of image analysis as an information source of autonomous systems (interpretation cycle for images and image sequences). Components for the extraction of information for the detection, recognition and analysis of objects and motion as well as spatial configuration.

Content
The importance and the application of imaging sensors is increasing at still growing speed. Industrial inspection, security, robotics and automotive technology rely on machine vision to capture and understand the situation under consideration. The applications range from recognising and measuring objects to autonomous navigation of aircraft and vehicles. This trend towards more and more complex applications is not only driven by demand but also by the rapid progress of mathematical techniques, computers, communication and sensors.
The course goal is to enable the students to create situation understanding solutions based on images and image sequences. The methodology of image and image sequence analysis is shown. The different components are presented in detail: Texture analysis, discontinuity (contours, edges, corners) detection, contour descriptions, shape analysis, motion analysis, imaging geometry, pose estimation, stereo imaging and sensor properties.
The presented concepts are illustrated with examples from applications and on-line demonstrations.

Literature

-
- Course slides can be downloaded from the internet.
- George Stockman, Linda G. Shapiro: Computer Vision, Addison Wesley Pub Co Inc, 2001
- Hartley, Richard and Zisserman, Andrew: Multiple View Geometry in Computer Vision, Second Edition., Cambridge University Press, 2004
- Jähne, B.: Digital Image Processing (third edition), Springer-Verlag London 1995

Course: Medical Imaging Techniques I [23261]

Coordinators: O. Dössel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Written Exam

Conditions
None.

Recommendations
23275

Learning Outcomes
Comprehensive understanding of all methods of medical imaging based on ionizing radiation
This course teaches students to understand theoretical aspects and engineering of x-ray imaging systems (incl. Computed Tomography) and imaging methods of Nuclear Medicine (SPECT and PET).

Content
X-ray Physics and technique of X-ray imaging
Digital radiography, x-ray image intensifier, flat x-ray detectors
Theory of imaging systems, Modulation-Transfer-Function and Detective Quantum Efficency
Computer Tomography CT
Ionizing radiation, dosimetry and radiation protection
SPECT and PET

Literature
Bildgebende Verfahren in der Medizin, Olaf Dössel, Springer Verlag

Remarks
Current information can be found on the ITIV (http://www.ibt.kit.edu/) webpage and within the eStudium-teachingplatform (www.estudium.org).

Course: Medical Imaging Techniques II [23262]

Coordinators: O. Dössel, O. Dössel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Written Exam

Conditions
None.

Recommendations
23270, Fourier Transformation

Learning Outcomes
Comprehensive understanding of all methods of medical imaging without ionizing radiation
This course teaches students to understand theoretical aspects and techniques of ultrasound-, Magnetic Resonance- and some unconventional imaging systems.

Content

Literature
Bildgebende Verfahren in der Medizin, Olaf Dössel, Springer Verlag

Remarks
Current information can be found on the ITIV (http://www.ibt.kit.edu/) webpage and within the eStudium-teachingplatform (www.estudium.org).

Course: Bioelectric Signals [23264]

Coordinators: G. Seemann, G. Seemann
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
oral exam

Conditions
None.

Learning Outcomes
Bioelectricity and mathematical modelling of the underlying processes
The students learn how bioelectrical signals are generated in the human body and how these signals can be measured and interpreted. The content is explained both on the biological level and based mathematical modelling.

Content
Cell membrane and ion channels
Cell physiology
Conduction of action potentials
Numerical field calculation in the human body
Measurement of bioelectrical signals
Electrocardiography and electrography, electromyography and -neurography
Electroencephalogram, evoked potentials and magnetic measurement techniques
Imaging of bioelectrical sources

Literature
Bioelectromagnetism: J. Malmivuo

Course: Biomedical Measurement Techniques I [23269]

Coordinators: W. Stork, A. Bolz
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
oral exam

Conditions
None.

Recommendations
23281, 23261

Learning Outcomes
This course teaches students to understand physiological systems and biomedical measuring techniques. It provides knowledge of how physiological parameters can be measured applying electrical engineering measuring techniques to the human body.

Content
Origin of Biopotentials: Anatomy and Physiology of the Nerv Cell and the Nervous System, Resting State of the Cell, Electrical Activity of Excitable Cells, Recording Technique of Resting and Action Potentials.
Biopotential Electrodes: Electrode-Electrolyte-Interface, Polarisation, Polarizable and Nonpolarizable Electrodes, Electrode Behaviour and Circuit Models, Electrode Skin Interface. Biopotential Amplifiers:
- Basic Requirements, Differential Amplifier, Biopotential Pre-Amplifier.
Interference:
- Interference in the Lead System, External Interference, Galvanic Coupled Interference, Capacitive Coupled Interference, Inductive Coupled Interference, Measuring Techniques
of Electric and Magnetic Fields, Methodes of Interference Reduction.
Biopotentials of Nervesystem and Muscles: Anatomy and Function, Electroneurogram (ENG), Electromyogram (EMG), Nerve Conduction Velocity, Diagnosis, Recording-Technique.
Biopotentials of the Brain: Anatomy and Function of the Central Nervous System. Electro Corticogram (ECoG), Electroencephalogram (EEG), Recording-Technique, Diagnosis.
Electrocardiogram (ECG): Anatomy and Function of the Heart, Ventricular Cell, Ventricular Activation, Body Surface Potentials.
Electrical Safety: Physiological Effects of Electricity, Shock-Hazards, Electrical Safety Codes and Standards, Approaches to Protection against Shocks, Testing of Electric Systems.

Literature
Bolz, Urbaszek: Technik in der Kardiologie (Springer 2002)

Remarks
Current information can be found on the IBT (http://www.ibt.kit.edu/) webpage and within the eStudium-teachingplatform (www.estudium.org).

Course: Biomedical Measurement Techniques II [23270]

Coordinators: W. Stork, A. Bolz
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
oral exam

Conditions
None.

Recommendations
23261, 23263, 23282

Learning Outcomes
This course extends the knowledge acquired from course 23275. It teaches students to understand physiological systems and biomedical measuring techniques. It provides knowledge of how physiological parameters can be measured applying electrical engineering measuring techniques to the human body.

Content
Blood Pressure Measurement: Physical and Physiological Fundamentals, Analysis of Blood-Pressure Waveforms. Non-invasive Methods: Korotkow-and Oscillation Method. Invasive Methods: Dynamic Properties of Measurement Systems, Transfer-Function, Measurement of System Response, Effect of System Parameters on Response, Effects on Pressure Measurements, Catheter-tip Transducers.
Blood Flow Measurement: Physical and Physiological Fundamentals, Electromagnetic Flowmeter: DC-, AC-Excitation, Ultrasonic Flowmeters: Transit-Time-, Doppler-Shift Flowmeters.
Measurement of Cardiac Output: Physical and Physiological Fundamentals, Fick Method, Indicator-Dilution Method, Electric Impedance Pletysmography, Diagnosis.
Electrostimulation: Physical and Physiological Fundamentals: DC-, Low - and Middle Frequency Currents, Local and System Compatibility, Physiological Thresholds, Voltage Source, Current Source, Analysis of Different Current Shapes.
Heart-Defibrillation: Electrophysical Fundamentals, Normal and Abnormal Cardiac Rhythms, Technical Realization: External and Implantable Defibrillators - Semi-Automatic and Automatic Systems, Safety Considerations.
Heart-Pacemaker: Electrophysical Fundamentals, Indications, Single-Chamber-, Dual-Chamber-Systems: V00...DDDR, Pacemaker Technology: Electrodes, Case, Energy, Electronics.

Remarks
Current information can be found on the IBT (http://www.ibt.kit.edu/) webpage and within the eStudium-teachingplatform (www.estudium.org).

Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II [2142883]

Coordinators: A. Guber
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral: Elective Course (Duration: 30 minutes) or Main Course in combination with other lectures (Duration: 60 minutes)

Aids: none

Conditions
None.

Learning Outcomes
The lecture will first shortly address some relevant microtechnical manufacturing methods. Then, selected biomedical applications will be presented, as the increasing use of microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical products, instruments, and operation and analysis systems.

Content
Examples of use in Life-Sciences and biomedicine: Microfluidic Systems:
LabCD, Protein Cristallisation
Microarrys
Tissue Engineering
Cell Chip Systems
Drug Delivery Systems
Micro reaction technology
Microfluidic Cells for FTIR-Spectroscopy
Microsystem Technology for Anesthesia, Intensive Care and Infusion
Analysis Systems of Person´s Breath
Neurobionics and Neuroprosthesis
Nano Surgery

Media
Lecture script

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II;
Springer-Verlag, 1994
M. Madou
Fundamentals of Microfabrication

Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III [2142879]

Coordinators: A. Guber
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral: Elective Course (Duration: 30 minutes) or Main Course in combination with other lectures (Duration: 60 minutes)

Aids: None

Conditions
None.

Learning Outcomes
The lecture will first shortly address some relevant microtechnical manufacturing methods. Then, selected biomedical applications will be presented, as the increasing use of microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical products, instruments, and operation and analysis systems.

Content
Examples of use in minimally invasive therapy
Minimally invasive surgery (MIS)
Endoscopic neurosurgery
Interventional cardiology
NOTES
OP-robots and Endosystems
License of Medical Products and Quality Management

Media
Lecture script

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005
Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II;
Springer-Verlag, 1994
M. Madou
Fundamentals of Microfabrication

Course: BioMEMS-Microsystems Technologies for Life-Sciences and Medicine I [2141864]

Coordinators: A. Guber
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination: Elective Course (Duration: 30 minutes) or Main Course in combination with other lectures (Duration: 60 minutes)

Aids: none

Conditions
None.

Learning Outcomes
The lecture will first address relevant microtechnical manufacturing methods. Then,
selected biomedical applications will be presented, as the increasing use of
microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical
products, instruments, and operation and analysis systems.

Content
Introduction into various microtechnical manufacturing methods: LIGA, Micro milling, Silicon Micromachining, Laser Microstructuring, µEDM, Metal-Etching
Biomaterials, Sterilisation.
Examples of use in the life science sector: basic micro fluidic strucutures: micro channels, micro filters, micromixers, micropumps, microvalves, Micro and nanotiter plates, Microanalysis systems (µTAS),
Lab-on-chip applications.

Media
Lecture script

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005
M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

Course: Bionics for Engineers and Natural Scientists [2142140]

Coordinators: H. Hölscher
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The successfull attandence of the lecture is controlled by a 30 minutes written examination, and a subsequent oral examination (20 min). Passing the written exam is mandantory for the participation of the oral examination. The grade result is the result of the oral exam.

Conditions
none

Recommendations
Basic knowledge in physics and chemistry

Learning Outcomes
The students should be able analyze, judge, plan and develop biomimetic strategies and products.

Content
Bionics focuses on the design of technical products following the example of nature. For this purpose we have to learn from nature and to understand its basic design rules. Therefore, the lecture focuses on the analysis of the fascinating effects used by many plants and animals. Possible implementations into technical products are discussed in the end.

Media
Slides of the lectures

Literature
Werner Nachtigall: Bionik – Grundlagen und Beispiele für Ingenieure und Naturwissenschaftler. Springer-Verlag Berlin (2002), 2. Aufl.

Course: Biosignals and User Interfaces [24105]

Coordinators: T. Schultz, C. Herff, D. Heger
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes
The students are introduced to the basics of biosignal processing, including the emergence of biosignals, recording mechanisms, and interpretation methodology, and get to know their potential in applications related to human-machine interfaces. They learn to analyze and describe the challenges and chances when using biosignals for user interfaces.
In order to achieve this, students are acquainted with the basic methods of biosignal acquisition, signal processing, and machine learning and classification. The current state-of-the-art in research and development is illustrated with many application examples. After having participated in this lecture, the students shall be able to transfer their knowledge to new requirements in modern biosignal processing.
The practical courses in biosignal processing (24905 and 24289) offer an opportunity to transfer the knowledge obtained in the lectures to a practical scenario.

Content
This module introduces into technologies which use different human biosignals for acquiring information and thereby revolutionize the design of user interfaces. The main focus is the interaction of humans and machines.
We first give an overview of the range of human biosignals, concentrating on those signals which may be recorded non-invasively, like the brain activity (electroencephalogram – EEG), which may be recorded from the head surface, the muscular activity (electromyogram – EMG), which may be recorded from the skin, eye activity (electrooculogram – EOG), and further signals like skin conductance, pulse and breathing frequency.
Subsequently we cover the basics of measuring, processing, and classifying and interpreting these signals. We illustrate these topics with multiple examples of how these methods are used both in literature as well as in our own research.
Further information is available at http://csl.anthropomatik.kit.edu.

Media
slides (online at http://csl.anthropomatik.kit.edu)

Literature
Elective literature:
Will be announced in the lecture.

Remarks
Language of the lecture: German (English by request)

Course: BUS-Controls [2114092]

Coordinators: M. Geimer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
Basic knowledge of electrical engineering is recommended. Programming skills are also helpful.

Learning Outcomes
The students will get an overview of the theoretic and practical functioning of different bus systems.

After the practical oriented lessons the students will be able to visualize the communication structure of different applications, design basic systems and evaluate the complexity of programming of the complete system.

Content

- Knowledge of the basics of data communication in networks
- Overview of the operating mode of current field buses
- Explicit observation of the operating mode and application areas of CAN buses
- Practical programming of an example application (hardware is provided)

Literature
Elective literature:

- Etschberger, K.: Controller Area Network, Grundlagen, Protokolle, Bausteine, Anwendungen; München, Wien: Carl Hanser Verlag, 2002.
- Engels, H.: CAN-Bus - CAN-Bus-Technik einfach, anschaulich und praxisnah dargestellt; Poing: Franzis Verlag, 2002.

Remarks
The course will be replenished by interesting lectures of professionals.

Course: CFD for Power Engineering [2130910]

Coordinators: I. Otic
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
Oral exam, length: 30 minutes

Conditions
None.

Learning Outcomes
After completing the course students are able:

- to understand the fundamentals of computational fluid dynamics (CFD)
- to simulate turbulent flow with heat transfer using CFD
- to present, analyse and evaluate the simulation results.

Content
This course is specified for both Bachelor and Master students, Power and Nuclear Engineering.
The course is aimed of giving the fundamental of Computational Fluid Dynamics (CFD) for energy technologies. Starting from the basic physical phenomena equations an overview on computational methods and turbulence modeling is given.

Course: Computational Intelligence [2105016]

Coordinators: R. Mikut, W. Jakob, M. Reischl
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination or written examination (for more than 40 participants),
Duration: 30min (oral) or 60 min (written)
Auxilary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are able to apply the fundamental methods of computational intelligence (fuzzy logic, artificial neural networks, evolutionary algorithms) efficiently. They know the basic mathematical foundations and are able to transfer these methods to practical applications.

Content

- Terms and definitions Computational Intelligence, application fields and examples
- Fuzzy logic: fuzzy sets; fuzzification and membership functions; inference: T-norms and -conorms, operators, aggregation, activation, accumulation; defuzzification methods, structures for fuzzy control
- Artificial Neural Nets: biology of neurons, Multi-Layer-Perceptrons, Radial-Basis-Function nets, Kohonen maps, training strategies (Backpropagation, Levenberg-Marquardt)
- Evolutionary Algorithms: Basic algorithm, Genetic Algorithms and Evolution Strategies, Evolutionary Algorithm GLEAM, integration of local search strategies, memetic algorithms, application examples

Literature
Lecture notes (ILIAS)
Kiendl, H.: Fuzzy Control. Methodenorientiert. Oldenbourg-Verlag, München, 1997
S. Haykin: Neural Networks: A Comprehensive Foundation. Prentice Hall, 1999
Kroll, A. Computational Intelligence: Eine Einführung in Probleme, Methoden und technische Anwendungen Oldenbourg Verlag, 2013
Blume, C, Jakob, W: GLEAM - General Learning Evolutionary Algorithm and Method: ein Evolutionärer Algorithmus und seine Anwendungen. KIT Scientific Publishing, 2009 (PDF frei im Internet)
H.-P. Schwefel: Evolution and Optimum Seeking. New York: John Wiley, 1995
Mikut, R.: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe; 2008 (PDF frei im Internet)

Course: Computer Graphics [24081]

Coordinators: C. Dachsbacher
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes
Fundamental concepts and algorithms of computer graphics and their application. The acquired knowledge is the basis for attending further specialized courses in computer graphics.

Content
Fundamental algorithms of computer graphics, color spaces and models, shading models, rendering techniques (ray tracing and rasterization), transformations and projections, texturing, graphic
hardware and APIs, geometric modeling, Bézier represenations and Bsplines, triangle meshes.

Literature
Will be announced in the lecture.

Course: Customer Relationship Management [2540508]

Coordinators: A. Geyer-Schulz
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	en

Learning Control / Examinations
Assessment consists of a written exam of 1 hour length following §4 (2), 1 of the examination regulation and by submitting written papers as part of the exercise following §4 (2), 3 of the examination regulation.
The course is considered successfully taken, if at least 50 out of 100 points are acquired in the written exam. In this case, all additional points (up to 10) from excersise work will be added. The grades of this lecture are assigned following the table below:

Grade	Minimum points
1.0	95
1.3	90
1.7	85
2.0	80
2.3	75
2.7	70
3.0	65
3.3	60
3.7	55
4.0	50
5.0	0

Conditions
None.

Learning Outcomes
The students

- understand service management as an economic basis for Customer Relationship Management and learn the resulting consequences for the management, the organisation itself and their departments,
- design and develop service concepts and service systems at a conceptual level,
- work on case studies in the CRM-area in small groups with limit time,
- learn English as the technical language in the area of CRM and consult internationale literature from this field for the case studies.

Content
The course begins with an introduction into Service Management as the strategic concept which also covers all CRM applications. The course is divided in the basics of Service Management as well as different topics within this concept like external and internal marketing, quality management and organizational requirements.

Media
Slides, Audio, Reader

Literature
Christian Grönroos. Service Management and Marketing : A Customer Relationship Management Approach. Wiley, Chichester, 2nd edition, 2000.
Elective literature:
Jill Dyché. The CRM Handbook: A Business Guide to Customer Relationship Management. Addison-Wesley, Boston, 2nd edition, 2002.
Ronald S. Swift. Accelerating Customer Relationships: Using CRM and RelationshipTechnologies. Prentice Hall, Upper Saddle River, 2001.

Stanley A. Brown. Customer Relationship Management: A Strategic Imperative in theWorld of E-Business. John Wiley, Toronto, 2000.

Course: Datenanalyse für Ingenieure [2106014]

Coordinators: R. Mikut, M. Reischl
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
Oral examination or written examination (for more than 40 participants),
Duration: 30min (oral) or 60 min (written)
Auxilary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are able to apply the methods of data analysis efficiently. They know the basic mathematical data mining foundations for the analysis of single features and time series using classifiers, clustering and regression approaches. They are able to use various relevant methods as Bayes classifiers, Support Vector Machines, decision trees, fuzzy rulebases and they can adapt application scenarios (with data preprocessing and validation techniques) to real-world applications.

Content

- Introduction and motivation
- Terms and definitions (types of multidimensional features - time series and images, problem classes)
- Scenario: Problem formulation, feature extraction, evaluation, selection and transformation, distance measures, Bayes classifiers, Support-Vector-Machines, decision trees, clustering, regression, validation
- Biweekly computer exercises (Software practice with Gait-CAD): Data import, benchmark datasets, control of hand prostheses, energy prediction
- 2 hours per week lectures, 1 hour per week computer training

Literature
Lecture notes (ILIAS)
Mikut, R.: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe.
2008 (free PDF in the Internet)
Backhaus, K.; Erichson, B.; Plinke, W.; Weiber, R.: Multivariate Analysemethoden: Eine anwendungsorientierte Einführung. Berlin u.a.: Springer. 2000
Burges, C.: A Tutorial on Support Vector Machines for Pattern Recognition. Knowledge Discovery and Data Mining 2(2) (1998), S. 121–167
Tatsuoka, M. M.: Multivariate Analysis. Macmillan. 1988
Mikut, R.; Loose, T.; Burmeister, O.; Braun, S.; Reischl, M.: Dokumentation der MATLAB-Toolbox Gait-CAD. Techn. Ber., Forschungszentrum Karlsruhe GmbH. 2006 (Internet)

Course: Database Systems [24516]

Coordinators: K. Böhm
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	2/1	Summer term	de

Learning Control / Examinations

Conditions
None.

Recommendations
It is recommended but not mandatory to attend lectures covering communication networks, system architecture and software engineering.

Learning Outcomes

Content

Media
Slides.

Literature

- Andreas Heuer, Kai-Uwe Sattler, Gunther Saake: Datenbanken - Konzepte und Sprachen, 3. Aufl., mitp-Verlag, Bonn, 2007
- Alfons Kemper, André Eickler: Datenbanksysteme. Eine Einführung, 7. Aufl., Oldenbourg Verlag, 2009

Elective literature:

- S. Abeck, P. C. Lockemann, J. Seitz, J. Schiller: Verteilte Informationssysteme, dpunkt-Verlag, 1. Aulage,2002, ISBN-13: 978-3898641883
- R. Elmasri, S.B. Navathe: Fundamentals of Database Systems, 4. Auflage, Benjamin/Cummings, 2000.
- Gerhard Weikum, Gottfried Vossen: Transactional Information Systems, Morgan Kaufmann, 2002.
- C. J. Date: An Introduction to Database Systems, 8. Auflage, Addison-Wesley, Reading, 2003.

Course: Analog Circuit Design [23664 + 23666]

Coordinators: I. Peric
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
Lecture To understand the behaviour of integrated BJTs and FETs, analysing the large and small signal characteristics of the devices. To understand the design steps of analog amplifier stages. To understand the design of bias circuits; current sources, current mirrors, PTAT and CTAT circuits.To understand the frequency response of operational amplifiers and feedback circuits.To understand the noise sources of integrated devices and circuits. Exercises To understand the essential design rules for analog circuit design.To design an operational amplifier step by step using the CadenceÒ Virtuoso full custom design environment. To understand and use the CadenceÒ simulation tools To understand and use the CadenceÒ layout tools to do a cell layout of the designed operational amplifier.

Content
Lecture
Integrated Circuits (Bipolar, MOS)
Design of Integrated Operational Amplifiers
Structure and Design of Input Stages
Structure and Design of Amplifier Stages
Structure and Design of Output Stages
Structure and Design of Bias Circuits
Frequency Response and Compensation
Noise in integrated Circuits
Analog Design Layout Rules
Exercise
Getting familiar with the CadenceÒ Virtuoso full custom design environment.
Design and simulation of parts of an operational amplifier
Design of a temperature compensated bias circuit
Layout of the differential input stage of the amplifier

Literature

-
- Presentation slides
- Analysis and Design of Analog Integrated Circuits, Gray, Hurst, Lewis, Meyer, John Wiley & Sons, Inc
- Analog Integrated Circuit Design, David A. Jones, Ken Martin,John Wiley & Sons, Inc
- Analog Design Essentials, Willy M.C. Sansen, Springer

Remarks
Current information can be found on the IMS (www.ims.kit.edu) webpage.

Course: Digital Circuit Design [23683 + 23685]

Coordinators: I. Peric
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
To understand the electrical characteristics of digital integrated circuits To understand logic levels, noise margins, power consumption, and propagation delays of digital integrated circuits based on CMOS technologies To understand static and dynamic behaviour of basic logical gates To understand on chip interconnections and parasitics To understand combinatorial logic and sequential logic To understand on chip clock distribution and timing requirements To understand memory cell design, write and read cycles and readout amplifiers.
Fundamental lecture in design of digital core cells. Based on CMOS characteristics design rules for standard logical gates are discussed as well as the behaviour of static and dynamic logic cells, combinatorial and sequential logical devices, clock distribution strategies and considerations for layout under specified conditions and rules.
Supporting the lecture, assignments to the curriculum are distributed. Using Cadence™ tools, basic digital cells are designed, simulated and optimized.

Content
Lecture

-
- Operation and modelling of CMOS Devices, Device current-voltage characteristics
- MOS transistor capacitances, Propagation delay, capacitance / voltage dependence
- CMOS inverter: static voltage-transfer characteristics, Dynamic behaviour, equivalent resistances, propagation delay
- Logic gates: NAND, NOR: voltage-transfer characteristics
- Transmission Gates: voltage-transfer characteristics
- IC interconnect , Interconnect capacitance and resistance
- Standard complementary CMOS combinatorial logic gates
- Sequential logic: Flip-flops, latches, registers
- Clocking and timing , Clock distribution, timing analysis
- Memory design, SRAM, DRAM, readout amplifiers

Exercise

-
- Schematic entry, Cadence Analog Artist
- Layout design rules
- Layout editing, Cadence VirtuosoXL
- Circuit parasitics extraction, (DRC, ERC)
- Design and simulation (dc, transient) of logical gates, Flip flops, PLL (group design projects)

Literature

-
- Presentation Slides.
- Digital Integrated Circuits, Jan M. Rabaey, Prentice Hall

Remarks
Current information can be found on the IMS (www.ims.kit.edu) webpage.

Course: Design and Evaluation of innovative user interfaces [24103]

Coordinators: T. Schultz, F. Putze, M. Georgi
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
Knowledge in the area of biosignal processing or cognitive systems is helpful.

Learning Outcomes
Students have a general overview of the methods from design to evaluation of user interfaces which make use of technique for natural or implicit interaction. Students can classify systems according to the scientific state of the art, evaluate their abilities and limitations and they have basic knowledge for the design of new interfaces.

Content
The lecture centers on innovative user interfaces which make use of technique for biosignal- or speech processing. This comprises on the one hand systems which support natural explicit interaction like spoken dialog systems or systems with gesture input. On the other hand, this comprises also interfaces for implicit interaction, for example by employing biosignal based recognition of emotion or mental workload. The lecture begins with an introduction of the necessary theoretical foundation. Following lectures deal with the design and evaluation of end-to-end systems. A focus of the lecture are the advantages but also the new challenges of such systems, for example in the area of multimodality. Another key point is how real users deal with innovative interfaces and with which methods strengths and weaknesses of such interfaces can be investigated systematically.

Media
Slides.

Literature
Will be announced in the lecture.

Course: Detectors for Applications in Space and Astronomy [23678]

Coordinators: T. Scherer
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
Basics in electronics and physics

Learning Outcomes
To understand the frequency ranges covered by different sources in space; principles of detection of light, radiowaves, infrared and THz-Radiation, X-ray and gamma-radiation; modulations; To understand functionality and fabrication of radiation detectors; semiconducting detectors, heterodyne-mixers, bolometers Development of electronic read-out circuits for detectors To learn RF system integration on radio antennas and satellites; cryotechnology, low noise amplifiers, filters Knowledge of world wide instrumentation in large radioastronomy projects (on earth and in space)

Content

-
- Astrophysical sources in space, frequency ranges
- Semiconducting detectors
- SIS-mixers for radio telescopes
- Hot-Electron-Bolometer mixers (HEB)
- System integration / RF techniques (Read-out circuits, amplifiers, filters, etc. . .)
- RF filter MEMS
- Existing instruments and projects worldwide
- Recent large future projects (SOFIA, HERSCHEL, ALMA)
- Detectors for X-ray detection (TES/SQUID) and particle astrophysics
- Kinetic inductance detectors (KID)
- Neutrino and WIMP detectors

Literature
Online material is available on: www.ims.kit.edu

Remarks
Current information can be found on the IMS (www.ims.kit.edu) webpage.

Course: Railways in the Transportation Market [2114914]

Coordinators: P. Gratzfeld
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
The students learn about the entrepreneurial approach and viewpoint of railways. They comprehend key issues of the transport policy, regulatory as well as financial framework, and grasp strategic fields of action in international as well as intermodal market perspectives.

Content
The lecture gives an overview about perspective, challenges and chances of rail systems in the national and European market. Following items will be discussed:

- Introduction and basics
- Rail reform
- Overview of Deutsche Bahn
- Development of infrastructure
- Regulation of railways
- Intra- and intermodal competition
- Field of actions in transport policy
- Railways and enviroment
- Trends in the transportation market
- Future of Deutsche Bahn, DB 2020
- Integration of traffic carriers
- International passenger and freight transportation

Media
All material is available for download (Ilias-platform).

Literature
none

Remarks
For the dates please see special announcement on the website www.bahnsystemtechnik.de

Course: Finite Difference Methods for numerial solution of thermal and fluid dynamical problems [2153405]

Coordinators: C. Günther
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
Duration: 30 minutes
no auxiliary means

Conditions
None.

Learning Outcomes
The students can apply the most important difference schemes for the numerical solution of steady and transient problems which are typical for thermal and fluid flow problems. They are able to discuss the most relevant properties of difference schemes such as consistency, stability and convergence. Furthermore, they can estimate the order of the numerical error and non-appearance of numerical oscillations.

Content
The lecture initially presents an overview and then the most important difference schemes for the numerical solution of steady and transient problems which are typical for thermal and fluid flow problems. The most relevant properties of difference schemes at one side as consistency, stability and convergence, at the other side the order of the numerical error and non-appearance of numerical oscillations are described. Algorithms for the solution of coupled systems of equations, characteristic for fluid flow and thermal problems, are reviewed.

- Spatial and temporal discretization
- Properties of difference schemes
- Numerical stability, consistency, convergence
- Nonhomogeneous meshes
- Coupled and noninteracting calculation methods

Course: Digital Control [2137309]

Coordinators: M. Knoop
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination; duration: 30 minutes; no tools or reference materials may be used during the exam.

Conditions
Basic studies and preliminary examination; basic lectures in automatic control

Learning Outcomes
The lecture intoduces key methods for the analysis and design of digital feedback control systems. Starting point is the discretisation of linear, continuous-time models. State space based and z-transform based controller design techniques are presented for discrete-time, single-input single-output systems. Furthermore, plants with dead-time and deadbeat design are covered.

Content
1. Introduction into digital control:
Motivation for digital implementation of controllers Structure of digital feedback control loops Sample and hold units
2. State space analysis and design:
Discretisation of continuous-time systems Discrete-time state space equations Stability - definition and criteria State feedback design by eigenvalue assignment PI state feedback controller Luenberger observer, separation theorem Systems with dead-time Deadbeat design
3. Analysis and design based on z-transform: z-transform - definition and theorems Control loop description in the z domain
Stability criteria Root locus controller design Transfer of continuous-time controllers into discrete-time controllers

Literature

- Lunze, J.: Regelungstechnik 2, 3. Auflage, Springer Verlag, Berlin Heidelberg 2005
- Unbehauen, H.: Regelungstechnik, Band 2: Zustandsregelungen, digitale und nichtlineare Regelsysteme. 8. Auflage, Vieweg Verlag, Braunschweig 2000
- Föllinger, O.: Lineare Abtastsysteme. 4. Auflage, R. Oldenbourg Verlag, München Wien 1990
- Ogata, K.: Discrete-Time Control Systems. 2nd edition, Prentice-Hall, Englewood Cliffs 1994
- Ackermann, J.: Abtastregelung, Band I, Analyse und Synthese. 3. Auflage, Springer Verlag, Berlin Heidelberg 1988

Course: Digital System Design [23615]

Coordinators: J. Becker
Part of the modules: Basics of Information Technology (p. 16)[BSc-MIT - B4]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Digital Circuits Design [24007]

Coordinators: M. Tahoori, T. Asfour, J. Henkel, W. Karl, Ömer Terlemez
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1/2	Winter term	de

Learning Control / Examinations

Conditions
The course Digital Circuits Design (Technical Informatics II) can only be taken in combination with the course Computer Organization (Technical Informatics I).

Learning Outcomes
Students are to gain the following competences by this module:

- understanding the different representations of numbers and alphabets in computers,
- abilities of the formal specification of circuits, as well as by means of programming languages,
- knowledge of the technical implementation types of circuits,
- ability to analyse and understand unknown circuits as well as to develop own circuits, based on the understanding of the structure and function of all important basic circuits and arithmetic units,
- knowledge of relevant memory technologies,
- knowledge of different implementation types of complex circuits.

Content
This course deals with the fundamentals of the representation of information, number systems, binary representations of negative numbers, floating point numbers, alphabets, codes; computer technology: MOS transistors, CMOS circuits; formal circuit specifications, Boolean algebra, normal forms, circuit optimization; implementation types of digital circuits: gates, PLDs, FPGAs, ASICs; basic circuits: flip-flop types, multiplexer, half/full-adder; arithmetic units: adder variants, multiplier circuits, division circuits; microprogramming.

Media
Slides, practice sheets, script.

Course: Dynamics of the Automotive Drive Train [2163111]

Coordinators: A. Fidlin
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions
None.

Recommendations
Powertrain Systems Technology A: Automotive Systems
Machine Dynamics
Vibration theory

Learning Outcomes

- To obtain the basic skills in dynamic modelling of the vehicle powertrain including the most important components, driving situations and requirements

Content

- Main components of the vehicle powertrain and their modelling
- Typical driving situations
- Problemoriented models for particular driving situations
- System analysis and optimization with respect to dynamic behavior

Literature

- Dresig H. Schwingungen mechanischer Antriebssysteme, 2. Auflage, Springer, 2006
- Pfeiffer F., Mechanical System Dynamics, Springer, 2008
- Laschet A., Simulation von Antriebssystemen:Modellbildung der Schwingungssysteme und Beispiele aus der Antriebstechnik, Springer, 1988

Course: Real-Time Systems [24576]

Coordinators: B. Hein, T. Längle, H. Wörn
Part of the modules: Informatik (Technische Informatik) (p. 27)[BSc-MIT - B-PI1], Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Summer term	de

Learning Control / Examinations

Conditions
None.

Recommendations

- Successful completion of the module *Basic Notions of Computer Science* [IN1INGI]
- Successful completion of the module *Programming* [IN1INPROG]

Learning Outcomes
The student should understand and learn to use the basic methods, modellings, and architectures of real-time systems based on the example of automation technology with its forward and feedback control systems. He should be capable of analysing, structuring and designing real-time systems with respect to hardware and software. Furthermore, the student shall be introduced to the basic concepts of real-time systems, robot control, machine tool control and programmable logic controllers.

Content
The basic principles, operation modes and architectures of real-time systems are provided. As an introduction, basic methods for modelling and design of discrete controls and time-continuous and time-discrete feedback controls for the automation of technical processes are treated. Then, basic computer architectures (microprocessor, microcontroller, signal processors, parallel buses) as well as hardware interfaces between real-time system and process are shown. Real-time communication is introduced, taking industrial Ethernet and field buses as examples. Furthermore, the basic methods of real-time programming (synchronous and asynchronous programming), real-time operating systems (task concept, real-time scheduling, synchronisation, resource management) and real-time middleware are presented. The lecture will be closed by examples of the application of real-time systems from the area of factory automation such as programmable logic controllers, machine tool control and robot control

Media
PowerPoint-slides and online work sheets.

Literature
Heinz Wörn, Uwe Brinkschulte “Echtzeitsysteme”, Springer,
2005, ISBN: 3-540-20588-8

Course: eFinance: Information Engineering and Management for Securities Trading [2540454]

Coordinators: C. Weinhardt
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	en

Learning Control / Examinations
The assessment consists of a written exam (60 min) (according to §4(2), 1 of the examination regulation) and by submitting written essays as part of the exercise (according to §4(2), 3 of the examination regulation). 70% of the final grade is based on the written exam and 30% is based on assignments from the exercises. The points obtained in the exercises only apply to the first and second exam of the semester in which they were obtained.

Conditions
None.

Learning Outcomes
The students

- are able to understand the theoretical and pracitical aspects of securitites trading,
- are able to handle the relevant electronic tools for the evaluation of financial data,
- are able to identify the incentives of the traders for participation in different market plattforms,
- are able to analyse capital marketplaces concerning their efficiency, weaknesses and technical configuration,
- are able to apply theoretical methods of econometrics,
- are able to understand, criticize and present articles with a finance-scientific background,
- learn to elaborate solutions in a team.

Content
The theoretical part of the course examines the New Institutions Economics which provides a theoretically found explanation for the existence of markets and intermediaries. Building upon the foundations of the market micro structure, several key parameters and factors of electronic trading are examined. These insights gained along a structured securities trading process are complemented and verified by the analysis of prototypical trading systems developed at the institute as well as selected trading systems used by leading exchanges in the world. In the more practical-oriented second part of the lecture, speakers from practice will give talks about financial trading systems and link the theoretical findings to real-world systems and applications.

Media

- Powerpoint presentations
- recorded lecture available on the internet

Literature

- Picot, Arnold, Christine Bortenlänger, Heiner Röhrl (1996): “Börsen im Wandel”. Knapp, Frankfurt
- Harris, Larry (2003): “Trading and Exchanges - Market Microstructure for Practitioners””. Oxford University Press, New York

Elective literature:

- Gomber, Peter (2000): “Elektronische Handelssysteme - Innovative Konzepte und Technologien”. Physika Verlag, Heidelberg
- Schwartz, Robert A., Reto Francioni (2004): “Equity Markets in Action - The Fundamentals of Liquidity, Market Structure and Trading”. Wiley, Hoboken, NJ

Course: Introduction to Operations Research I [2550040]

Coordinators: S. Nickel, O. Stein, K. Waldmann
Part of the modules: Betriebswirtschaft (Wirtschaftswissenschaften) (p. 30)[BSc-MIT - B-PW1], Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/2/2	Summer term	de

Learning Control / Examinations
See module description.

Conditions
See module information.

Learning Outcomes
The student

- names and describes basic notions of the essential topics in Operations Research (Linear programming, graphs and networks, integer and combinatorial optimization, nonlinear programming, dynamic programming and stochastic models),
- knows the indispensable methods and models for quantitative analysis,
- models and classifies optimization problems and chooses the appropriate solution methods to solve optimization problems independently,
- validates, illustrates and interprets the obtained solutions.

Content
Examples for typical OR problems.
Linear Programming: Basic notions, simplex method, duality, special versions of the simplex method (dual simplex method, three phase method), sensitivity analysis, parametric optimization, multicriteria optimization.
Graphs and Networks: Basic notions of graph theory, shortest paths in networks, project scheduling, maximal flows in networks.

Media
Blackboard, slides, beamer presentations, lecture notes, OR software.

Literature

- Nickel, Stein, Waldmann: Operations Research, 2nd edition, Springer, 2014
- Hillier, Lieberman: Introduction to Operations Research, 8th edition. McGraw-Hill, 2005
- Murty: Operations Research. Prentice-Hall, 1995
- Neumann, Morlock: Operations Research, 2. Auflage. Hanser, 2006
- Winston: Operations Research - Applications and Algorithms, 4th edition. PWS-Kent, 2004

Course: Introduction to Operations Research II [2530043]

Coordinators: S. Nickel, O. Stein, K. Waldmann
Part of the modules: Betriebswirtschaft (Wirtschaftswissenschaften) (p. 30)[BSc-MIT - B-PW1], Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	4	Winter term	de

Learning Control / Examinations
See module description.

Conditions
See corresponding module information. Especially the course *Introduction to Operations Research I* [2550040] is assumed.

Learning Outcomes
The student

- names and describes basic notions of the essential topics in Operations Research (Linear programming, graphs and networks, integer and combinatorial optimization, nonlinear programming, dynamic programming and stochastic models),
- knows the indispensable methods and models for quantitative analysis,
- models and classifies optimization problems and chooses the appropriate solution methods to solve optimization problems independently,
- validates, illustrates and interprets the obtained solutions.

Content
Integer and Combinatorial Programming: Basic notions, cutting plane metehods, branch and bound methods, branch and cut methods, heuristics.
Nonlinear Programming: Basic notions, optimality conditions, solution methods for convex and nonconvex optimization problems.
Dynamic and stochastic models and methods: dynamical programming, Bellman method, lot sizing models, dyanical and stochastic inventory models, queuing theory.

Media
Blackboard, slides, beamer presentations, lecture notes, OR software

Literature

- Nickel, Stein, Waldmann: Operations Research, 2nd edition, Springer, 2014
- Hillier, Lieberman: Introduction to Operations Research, 8th edition. McGraw-Hill, 2005
- Murty: Operations Research. Prentice-Hall, 1995
- Neumann, Morlock: Operations Research, 2. Auflage. Hanser, 2006
- Winston: Operations Research - Applications and Algorithms, 4th edition. PWS-Kent, 2004

Course: Introduction to Energy Economics [2581010]

Coordinators: W. Fichtner
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
5,5	2/2	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam according to Section 4(2), 1 of the examination regulation.

Conditions
None.

Learning Outcomes
The student is able to

- characterize and judge the different energy carriers and their peculiarities,
- understand contexts related to energy economics.

Content
1. Introduction: terms, units, conversions
2. The energy carrier gas (reserves, resources, technologies)
3. The energy carrier oil (reserves, resources, technologies)
4. The energy carrier hard coal (reserves, resources, technologies)
5. The energy carrier lignite (reserves, resources, technologies)
6. The energy carrier uranium (reserves, resources, technologies)
7. The final carrier source electricity
8. The final carrier source heat
9. Other final energy carriers (cooling energy, hydrogen, compressed air)

Media
Media will be provided on the e-learning platform ILIAS.

Literature
Complementary literature:
Pfaffenberger, Wolfgang. Energiewirtschaft. ISBN 3-486-24315-2
Feess, Eberhard. Umweltökonomie und Umweltpolitik. ISBN 3-8006-2187-8
Müller, Leonhard. Handbuch der Elektrizitätswirtschaft. ISBN 3-540-67637-6
Stoft, Steven. Power System Economics. ISBN 0-471-15040-1
Erdmann, Georg. Energieökonomik. ISBN 3-7281-2135-5

Course: Introduction to Flight Physics, Guidance & Control [23062]

Coordinators: A. Schöttl
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Verbal Exam

Conditions
Correct solutions to the assignments

Learning Outcomes

Content
This lecture presents an introduction to important basics of flight physics, guidance & control and represents a course part of a masters' curriculum. Since no aeronautic prerequisites are required, the lecture is divided into two parts.
In the first part, the lectures shall include theoretical basics on aerodynamics such as potential flows and Navier-Stokes equations as well as the wing aerodynamics. The resulting forces and moments shall be modelled using flight physics; kinematic values – with respect to various coordinate systems – shall be calculated.
In the second part, the lectures shall include theoretical foundations of flight physics, guidance and control. Aerodynamic coefficients shall be derived via linearization. The coefficients shall be used to describe the characteristics (e. g. the stability) of the vehicle in the lateral and longitudinal planes.The aerodynamical behaviour of a vehicle can be altered by introducing actuators within the system. Flight control calculates the necessary commands to achieve desired flight states. Simple flight controllers and their design shall be presented and discussed. The task of the flight guidance is to determine appropriate flight path commands in order to achieve certain flight goals. Typical designs (waypoint guidance and/or proportional navigation) shall be presented. The lecture shall end with an excurse on mission planning.

Literature
Online material is available on the ITE web site. Further literature shall be presented in the lecture.

Remarks
Due to technical reasons, the number of available spaces is higher in the summer term than in the winter term.

Course: Introduction to Nuclear Energy [2189903]

Coordinators: X. Cheng
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Introduction into Mechatronics [2105011]

Coordinators: M. Lorch
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	de

Learning Control / Examinations
Written examination, oral examination or certification of participation depending on the "Studienplan" resp. "Prüfungs- und Studienordnung (SPO)".

Conditions
none

Learning Outcomes
The student has knowledge about the specific challenge of interdisciplinary collaboration within the framework of mechatronics. He is able to explain the origin, necessity and methodic implementation of interdisciplinary collaboration, to name the main difficulties as well as the special features within the development of mechatronic products from the point of view of development methodic.
The student has fundamental knowledge of modeling mechanical, hydraulically and electrically part systems and about suitable optimization methods.
The student knows the difference in use of the term "system" in mechatronic and mechanical use.

Content
Part I: Modeling and optimization

Introduction
Architecture of mechatronic systems
Modeling of mechatronic systems
Optimization of mechatronic systems
Perspective

Part II: Development and design

Introduction
Development method for mechatronic products
Examples

Literature
Heimann, B.; Gerth, W.; Popp, K.: Mechatronik. Leipzig: Hanser, 1998
Isermann, R.: Mechatronische Systeme - Grundlagen. Berlin: Springer, 1999
Roddeck, W.: Einführung in die Mechatronik. Stuttgart: B. G. Teubner, 1997
Töpfer, H.; Kriesel, W.: Funktionseinheiten der Automatisierungstechnik. Berlin: Verlag Technik, 1988
Föllinger, O.: Regelungstechnik. Einführung in die Methoden und ihre Anwendung. Heidelberg: Hüthig, 1994
Bretthauer, G.: Modellierung dynamischer Systeme. Vorlesungsskript. Freiberg: TU Bergakademie, 1997

Course: Introduction to modeling of aerospace systems [2154430]

Coordinators: G. Schlöffel, B. Frohnapfel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral
Duration: 30 min
no auxiliary means

Conditions
none

Recommendations
basic skills in mathematics, physics and fluid dynamics

Learning Outcomes
Students attending this lecture will be able to,

- give an outline of the common methods of modeling the flight of aerospace systems,
- describe the different phases of flight of an aerospace system launching from earth,
- handle and compute the physics and its particular impact on the aerospace system during the different phases of flight,
- discriminate and treat in particular the effects of gravitation, propulsion and aerodynamics,
- characterize and describe possible flight paths and orbits,
- implement in Matlab/Simulink the fundamental equations of motion with respect to the simulation of an aerospace system

Content
This lecture covers the following topics:

- Reference and coordinate systems and their transformations
- Newton-Euler-Equations of motion
- Gravitation
- Propulsion of aerospace systems
- Aerodynamics
- Trajectories and Orbits
- Re-entry
- Implementation of a Matlab/Simulink simulation

Literature

- P. H. Zipfel: Modeling and Simulation of Aerospace Vehicle Dynamics. American Institute of Aeronautics and Astronautics (AIAA), Reston 2007. ISBN 978-1563478758
- A. Tewari: Atmospheric and Space Flight Dynamics. Birkhäuser, Boston 2007. ISBN 978-0-8176-4373-7
- W. Ley, K. Wittmann, W. Hallmann (Hrsg.): Handbuch der Raumfahrttechnik. Hanser, München 2011. ISBN 978-3446424067
- W. Büdeler: Geschichte der Raumfahrt. Edition Helmut Sigloch, Künzelsau 1999. ISBN 978-3893931941

Course: Einführung in die Quantentheorie für Elektrotechniker mit Übungen [23474]

Coordinators: G. Grau
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Learning Outcomes
Introduction to theory including latest developments

Content
Duality wave/particle
Dirac´s bracket formalism
Probabilities, expectation values
Uncertainty relations, complementarity
Spooky action at a distance, entangled states
Quantization of systems

Literature
Script as pdf-file for download

Remarks
Current information can be found on the IPQ www.ipq.kit.edu webpage.

Course: Introduction to Nonlinear Vibrations [2162247]

Coordinators: A. Fidlin
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions
None.

Recommendations
Vibration theory, mathematical methods of vibration theory, dynamic stability

Learning Outcomes
The students

- know the most usual nonlinear effects
- know the minimal models for these effects
- are able to apply perturbation methods for the analysis of nonlinear systems
- know basics of the bifurcation theory
- are able to identify dynamic chaos

Content

- dynamic systems
- basic ideas of asymptotic methods
- perturbation methods: Linstedt-Poincare, averaging, multiple scales
- limit cycles
- nonlinear resonance
- basics of the bifurcation analysis, bifurcation diagrams
- types of bifurcations
- discontinuous systems
- dynamic chaos

Literature

- Hagedorn P. Nichtlineare Schwingungen. Akademische Verlagsgesellschaft, 1978.
- Nayfeh A.H., Mook D.T. Nonlinear Oscillation. Wiley, 1979.
- Thomsen J.J. Vibration and Stability, Order and Chaos. McGraw-Hill, 1997.

- Fidlin A. Nonlinear Oscillations in Mechanical Engigeering. Springer, 2005.
- Bogoliubov N.N., Mitropolskii Y.A. Asymptotic Methods in the Theory of Nonlinear Oscillations. Gordon and Breach, 1961.
- Nayfeh A.H. Perturbation Methods. Wiley, 1973.
- Sanders J.A., Verhulst F. Averaging methods in nonlinear dynamical systems. Springer-Verlag, 1985.
- Blekhman I.I. Vibrational Mechanics. World Scientific, 2000.
- Moon F.C. Chaotic Vibrations – an Introduction for applied Scientists and Engineers. John Wiley & Sons, 1987.

Course: Introduction in Computer Networks [24519]

Coordinators: M. Zitterbart
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	2/1	Summer term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
It is recommended but not mandatory to attend lectures covering system architecture and software engineering.

Learning Outcomes

Content
Today's Internet is arguably the most well-known and most complex artefact ever created by mankind: hundreds of millions connected
computers and connecting networks. Millions of users who connect at any time to the Internet via various devices such as mobile phones, PDAs or laptops. Given the large scale as well as the diversity of the Internet, the question arises to which extent it is possible to understand the complex structures behind. Here, this lecture tries to provide an introduction to the world of computer networks by presenting theoretical and practical aspects of computer networks. Therefore, it covers basics of telecommunications engineering, fundamental protocol mechanisms as well as the layers model of current computer networks. Hence, we present all layers starting with the physical medium layer up to the application layer.

Media
Slides.

Literature

- J.F. Kurose, K.W. Ross: Computer Networking - A Top-Down Approach featuring the Internet. Addison-Wesley, 2007.
- W. Stallings: Data and Computer Communications. Prentice Hall, 2006.

Elective literature:

- F. Halsall: Computer Networking and the Internet. Addison-Wesley, 2005.
- P. Lockemann, G. Krüger, H. Krumm: Telekommunikation und Datenhaltung. Hanser Verlag, 1993.
- S. Abeck, P.C. Lockemann, J. Schiller, J. Seitz: Verteilte Informationssysteme. dpunkt-Verlag, 2003

Remarks
This lecture replaces the communication part of the lecture *Kommunikation und Datenhaltung*.

Course: Electromagnetics and Numerical Calculation of Fields [23263]

Coordinators: O. Dössel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	en

Learning Control / Examinations
Written Exam

Conditions
None.

Recommendations
Fundamentals of Electromagnetic Field Theory

Learning Outcomes
This course is an introduction to modern methods of numerical field calculation
The course starts with a revision of Maxwell equations and the most important methods of analytical field calculation. Then the most important methods of numerical field calculation are presented.

Content
Maxwell's equations, materials equations, boundary conditions, fields in ferroelectric and ferromagnetic materials
electric potentials, electric dipole, Coulomb integral, Laplace and Poisson's equation, separation of variables in cartesian, cylindrical and spherical coordinates
Dirichlet Problem, Neumann Problem, Greens function,
Field energy density and Poynting vector,
electrostatic field energy, coefficients of capacitance
vector potential, Coulomb gauge, Biot-Savart-law
magnetic field energy, coefficients of inductance
magnetic flux and coefficients of mutual inductance,
fields problems in steady electric currents,
law of induction, displacement current
general wave equation for E and H, Helmholtz equation
skin effect, penetration depth, eddy currents
retarded potentials, Coulomb integral with retarded potentials
wave equation for ϕ and A, Lorentz gauge, plane waves
Hertzian dipole, near field solution, far field solution
transmission lines, fields in coaxial transmission lines
waveguides, TM-waves, TE-waves
finite difference method FDM
finite difference - time domain FDTD, Yee´s algorithm
finite difference - frequency domain
finite integration method FIM
finite element method FEM
boundary element method BEM
solving large systems of linear equations
basic rules for good numerical field calculation

Literature
Recommendation of several books, Figures of the lecture

Remarks
Current information can be found on the ITIV (http://www.ibt.kit.edu/) webpage and within the eStudium-teachingplatform (www.estudium.org).

Course: Power Network Analysis [23371/23373]

Coordinators: T. Leibfried
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Winter term	de

Learning Control / Examinations
The assessment consists of a written exam (120 min) taking place at the beginning of the recess period (according to Section 4 (2), 1 of the examination regulation). The exam takes place in every winter semester. Re-examinations are offered at every ordinary examination date.

Conditions
Linear electrical networks, Electric Energy Systems

Learning Outcomes
The students are able to do calculations of load flows and short-circuit current calculations in the electric power network. They know the equivalent electric circuit of the equipment and the mathematics of the calculation methods, be it for symmetrical or asymmetrical networks.

Content
In its first part, this lecture introduces the High-Voltage technology and its basics. Especially, the reasons for the necessity for the power transmission with high voltages are given. Basic electrical configurations and stresses occurring at multi dielectric systems are presented. Finally the first chapter deals with discharge phenomena.
The second chapter deals with the three phase system. Especially, the mathematical treatment of three phase systems
and the introduction of component systems are contained in this chapter.
The third and very comprehensive chapter deals with the transmission and distribution of electric energy. Firstly, the laws of power transmission via transmission lines are presented. Then, the stability of electric power systems and possibilities to increase the power transmission capacity are discussed. Finally, the physics of energy distribution in the medium and low voltage grid is shown.
The fourth chapter deals with the Calculation of electric power networks and systems. Firstly, the preparatory steps for the calculation of the power network are shown. After discussing the basic network analysis methods, the load flow
calculation are shown. Especially, the method of current iteration and the Newton Raphson method are presented and
the algorithms of the individual methods are shown using an example.
The fifth chapter deals with methods for the calculation of the 3 phase short circuit. Thereby, it is distinguished between the short circuit nearby the generator and far from the generator.
In the sixth chapter the unsymmetrical faults in power networks and their calculation are discussed. Therefore, the symmetrical components are introduced as a first step. Then, the circuits in symmetrical components of all important power network equipment are presented. The chapter closes with the mathematical treatment of unsymmetrical short circuits using the symmetrical component method.
To accompany the lecture, a collection of problems can be downloaded. During lecture hall exercises their solutions will
be discussed.

Media
Online material is available on: https://www.ieh.kit.edu/studium_und_lehre_bee.php and can be downloaded using a password.

Literature
Elective literature:
Will be announced in the lecture notes.

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the IEH webpage (www.ieh.kit.edu).

Course: Technique of Electrical Installation [23382]

Coordinators: A. Kühner
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam taking place at the beginning of the recess period (according to Section 4 (2), 1 of the examination regulation). The exam takes place in every summer semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
Students know the practical fundamentals of electrical installations.

Content

- Capture 1: Electrical Power Distribution and Networking
- Capture 2: Electrical Power Supply of Buildings
- Capture 3: Electrical Power Supply in Buildings
- Capture 4: Protective Equipments
- Capture 5: Electrical Energy Applications
- Capture 6: Electrical Automation and System Engineering of Buildings
- Capture 7: Powermanagement of Buildings

Media
Online material is available on:
https://www.ieh.kit.edu/studium_und_lehre_elektrische_installationstechnik.php

Course: Electrical Machines and Power Electronics [23307]

Coordinators: M. Braun
Part of the modules: Electronics Basics II (p. 17)[BSc-MIT - B5]

ECTS Credits	Hours per week	Term	Instruction language
6	2	Winter term	de

Learning Control / Examinations
Written exam (see current document "Studienplan" and notice of the examination office ETIT).
Grades result from the written examination.

Conditions
Basic study knowledge of mathematics, Linear electrical networks

Learning Outcomes

Content
This lecture presents an introduction to the fundamentals of electrical drive systems and power electronics. The mode of operation, operation behaviour, control and typical applications of the most important electrical drives and power converters will be imparted.
At first the requirements and components of a drive system will presented in the lecture. Typical speed-torque-characteristics of the driven machine and the electrical drive will be shown. After that physical basics of electro-magnetism and induction on which the function of most of the electrical drives depends will be explained.
After the basics the most important electrical drives will be discussed in detail: DC-machine, stepping motor, synchronous machine and induction machine. The basic configuration and mode of operation will be explained and the characteristic equations will be deduced. Additionally different variants of the machines and their typical applications will be shown.
A special kind of an electrical machine is the transformer. Configuration, mode of operation, operation behaviour of AC-transformers, three-phase transformers and autotransformers will be presented.
The second part deals with power electronics. At first characteristics, operation behaviour and common use of the most important power semiconductors will be described. After that fundamental power converter circuits will discussed in detail. To begin with line-commutated converters followed by self-commutated converters.
The final chapter about drive systems consisting o driven machine, electrical drive, power converter, control and measured-value acquisition should increase the understanding of the complete system. Furthermore typical applications of power electronics in energy transmission systems will be presented.

Literature
The lecture notes are available at the secretary's office of the ETI. Assignments will be given out and are available online.

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the webpage of the ETI (www.eti.uni-karlsruhe.de).

Course: Electric Rail Vehicles [2114346]

Coordinators: P. Gratzfeld
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
The students know the history of electric traction in railway transportation from the very beginning to modern vehicles with three-phase traction drives.
They know the basics of railway transportation, vehicle dynamics and wheel-rail-contact and can deduct the requirements for electric rail vehicles out of it.
They understand purpose, design and functionality of electric traction drives.
They learn about the different systems of traction power supply with its advantages and disadvantages.
They are informed about actual concepts and new developments in the field of electric railway vehicles.

Content
History of electric traction with railway vehicles, economic impact
Vehicle dynamics: running resistance, tractive effort diagram, running cycles
Wheel-rail-contact
Electric drives: traction motors, power conversion, drives for vehicles at dc and ac lines, dieselelectric vehicles, multi system vehicles, axle drives, transmission of tractive effort to the rails
Traction power supply: networks, substations, inductive power supply, energy management
Modern vehicle concepts for mass transit and main line

Media
All slides are available for download (Ilias-platform).

Literature
A bibliography is available for download (Ilias-platform).

Course: Systems for Electrical Energy [23391/23393]

Coordinators: T. Leibfried
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT], Energie- und Elektrische Antriebstechnik (ETIT) (p. 21)[BSc-MIT - B-PE1]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam (120 min) taking place at the beginning of the recess period (according to Section 4 (2), 1 of the examination regulation). The exam takes place in every summer semester. Re-examinations are offered at every ordinary examination date.

Conditions
Linear Electrical Networks

Learning Outcomes
The students are able to calculate electric circuits (be it with passive or with controlled sources) within the time- and frequency domain. Furthermore, the students also know the major means of mains operation, their physical mode of action and their electric equivalent electric circuit.

Content
In its first part, this lecture is a consequent continuation of the calculation of electrical networks as it is presented in the lecture “Linear electrical networks”. In the second part of this lecture, the basics of electric power network equipment are presented. This is the basis for all further lectures of power system technology.
The first chapter gives an introduction in the single phase and three phase AC system.
The second chapter deals with or is a repetition of electromagnetic basics. In a first step magnetic circuits and their calculation is treated. Subjects like main flux and stray flux are introduced, as well as self induction main inductance and stray inductance. The induction law leads directly to the transformer and the calculation of inductances and finally to the calculation of forces caused by a current flowing in a conduction which is located within a magnetic field.
The third and very comprehensive chapter deals with the mathematical description of electrical networks. Hereby, it is distinguished between networks with concentrated elements and networks with distributed elements. The calculation of networks with concentrated elements leads to differential equations with constant coefficients. Their solution as well as a special case, the sinusoidal excitation of such networks, is comprehensively demonstrated using examples. Finally, the description of electrical networks by a system of first order differential equations is shown and their solution is presented. Circuits with distributed elements are transmission lines. The transmission line theory for sinusoidal voltages and currents as well as for impulse voltages and currents is shown.
The fourth chapter deals with the Laplace Transform as a tool for electrical network analysis. First, the Duhamel integral (convolution integral) is presented. Then the Laplace Transform is derived out of the convolution integral and in a further sub-chapter the solution of differential equations using the Laplace Transform is demonstrated.
The fifth chapter deals with methods for network analysis. It demonstrates the mesh analysis, the nodal analysis, the superposition theorem, Norton’s theorem, Thevenin’s theorem and the Tellegen-Theorem. These formal methods are demonstrated using two examples circuits. These circuits are transistor amplifier with and without a transformer. This allows the calculation of networks with voltage or current dependent sources.
In the sixth chapter the structure of the electric power network is shown and explained.
The seventh chapter deals with power network equipment. Thereby, their steady state behaviour in the power network as well as their electrical and mechanical basic design is presented. The chapter contains synchronous generators, power transformers, reactors, capacitors, transmission lines and switch gear. For all of this power network equipment its steady state electrical circuit is derived. This gives the basis for all further lectures in the field of power network engineering.
To accompany the lecture, a collection of problems can be downloaded. During lecture hall exercises their solutions will be discussed.
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the IEH webpage.

Media
Online material is available on: www.ieh.kit.edu and can be downloaded using a password.

Literature
Elective literature:
Will be announced in the lecture notes.

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the IEH webpage (www.ieh.kit.edu).

Course: Electronic Devices and Circuits [23655]

Coordinators: M. Siegel
Part of the modules: Electronics Basics I (p. 15)[BSc-MIT - B3]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
Written exam (see actual document "Studienplan" and notice of the examination office ETIT).
Grades result from the written examination and form homework. 90% examination, 10% Homework

Conditions
None.

Recommendations
Attendance of the lecture Linear Electronic Networks

Learning Outcomes
To understand the function and operating principles of pn junctions, pn- and zener diodes, bipolar and field-effect devices, basic analog and digital circuit components including single stage and operational amplifiers. To understand device parameters and operating principles, analyze and calculate single-stage amplifiers, CMOS and multi stage amplifiers, differential amplifier and output stages as well as operational amplifier applications. To understand and apply dc and ac device and circuit models in circuit design and understand the constraints. To understand and apply all basic digital circuits (inverter, NAND, NOR, tri state inverter and transmission gates), sequential logic circuits RS-, D- and JK- flip flops at counters, frequency dividers and shift registers. To understand and apply digital-to-analog and analog-to-digital converters

Content

- Notions and basic numerical tools
- Passive circuits (R, C, L)
- Properties of diodes and transistors
- Transistor equivalent circuits for dc and ac
- Circuits with common emitter, base and collector
- Multistage amplifier circuits with and without feedback
- Basic characteristics of operational amplifiers
- Typical applications of operational amplifiers
- Introduction to digital electronics
- Considerations of integrated circuit engineering
- Basic logic circuits with bipolar and field-effect devices
- Detailed description of n-MOS-, p-MOS- and CMOS-circuits
- Flip-flops, counters and Schmitt-triggers
- Multiplexer and demultiplexer,
- Main principles of analog-to-digital and digital-to-analog conversion.

Literature
Online material is available on: www.ims.kit.edu Literature: a booklet is available for free to all students at the first lecture

Course: Electronic Circuits for Light Sources and Laser [23746]

Coordinators: R. Kling, W. Heering
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
Light Sources and operating systems
Operational modes and principle circuits for plasma radiation sources, LED and solid state lasers

Learning Outcomes

Content

Literature
The corresponding documents are avalible under https://studium.kit.edu/

Remarks
You will find the newest Information online on https://studium.kit.edu/

Course: Electronic Systems and EMC [23378]

Coordinators: M. Sack
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Learning Outcomes
The goal is to relay practical knowledge in the design of electronic circuitry and systems with reduced sensitivity to electromagnetic interference
Based on the coupling mechanisms for electromagnetic interference the lecture gives an overview over different coupling paths for disturbance, the influence of the electromagnetic interference on the function of the system and measures for a system design less sensitive to electromagnetic interference.

Content
Especially for electronic circuitry and systems in the industrial environment a high reliability and operational safety is required. For the design of such systems this means on one hand, that these systems need to be tolerant against electromagnetic interference and over-voltage, on the other hand, that electromagnetic noise emissions have to be limited to the allowed levels. Both is summarised under the generic term of electromagnetic compatibility (EMC). The lecture gives an introduction to different concepts for the design of electronic circuitry and systems according to the rules for an electromagnetic compatible design.
A basic element of analogue circuits is the operational amplifier. As an introduction the lecture deals with selected basic circuits and their calculation with reference to the individual characteristics of voltage feedback- and current feedback amplifiers.
For a subsequent digital processing an analogue signal has to be digitized. By the proper choice of the digitalisation technique in some cases a considerable noise cut-off can be achieved. Frequently sources for noise are placed next to noise-sensitive circuitry. One example are analogue-to-digital converters with the noise-sensitive analogue signals lying next to the fast rising digital signals. In the area of power electronics and high-voltage technique control- and measurement signals have to be led and processed next to high voltage and high current. The lecture describes different coupling mechanisms (galvanic, electric, magnetic, and radiation) for coupling noise between two circuits on different coupling paths. The typical coupling paths on printed circuit boards and measures for a reduction of noise emission and sensitivity to noise are explained.
When coupling single circuit boards or devices to complex systems the connection leads and cables for power supply and signals form coupling paths. The lecture deals with different concepts to reduce the noise coupled into such grids.
Especially when connecting devices to large grids or in the area of high-voltage technique and power electronics over-voltages caused by lightning or switching processes may occur. Based on the available devices for over-voltage protection the lecture presents different concepts for a protection against over-voltage.
Shielded housings reduce of noise emission and protect against disturbing noise from outside. The lecture describes the different shielding mechanisms for electric and magnetic fields and electromagnetic waves. Furthermore, it deals with the design of housings with shielded doors, cable connections, and more.
Filtering plays an important role in the reduction of noise emission over cables and in the noise cut-off. The lecture presents different passive and active filter designs and their application.
The measurement of noise emission enables testing devices with respect to their electromagnetic compatibility. The lecture describes common measurement methods and measurement environments.

Literature
Copies of the transparencies are distributed in the course of the lecture

Course: Elements of Technical Logistics [2117096]

Coordinators: M. Mittwollen, Madzharov
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
after each lesson period; oral / written (if necessary) => (look at "Studienplan Maschinenbau", latest version)

Conditions
None.

Recommendations
previous / parallel visit of LV 21177095 "Grundlagen der Technischen Logistik"

Learning Outcomes
Students are able to:

- Describe elements and systems of technical logistics,
- Model and calculate structures and functions of special conveying machines,
- Describe interdependence of material flow systems and technique quantitatively and qualitatively and
- Equip material flow systems with appropriate machines.

Content
material flow systems and their (conveying) technical components
mechanical behaviour of conveyors;
structure and function of conveyor machines; elements of intralogistics (belt conveyor, racks, automatic guided vehicles, fan-in, bifurcation, and etc.)
sample applications and calculations in addition to the lectures inside practical lectures

Media
supplementary sheets,projector, blackboard

Literature
recommendations during lectures

Course: Energy and Process Technology II [2170832]

Coordinators: C. Höfler, H. Wirbser
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
9	6	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes
The students are able to:

- discuss and evaluate energy resources and reserves and their utility
- review the use of energy carriers for electrical power generation
- explain the concepts and properties of power-heat cogeneration, renewable energy conversion and fuel cells and their fields of application
- comment on and compare centralized and decentralized supply concepts
- calculate the potentials, riskis and economic feasibility of different strategies aiming at the protection of resources and the reduction of CO2 emissions
- name and judge on the options for solar energy utilization
- discuss the potential of geothermal energy and its utilization

Content
Thermal Turbomaschinery - In the first part of the lecture deals with energy systems. Questions regarding global energy resources and their use, especially for the generation and provision of electrical energy, are addressed. Common fossile and nuclear power plants for the centralized supply with electrical power as well as concepts of power-heat cogeneration for the decentralized electrical power supply by means of block-unit heat and power plants, etc. are discussed. Moreover, the characteristics and the potential of renewable energy conversion concepts, such as wind and hydro-power, photovoltaics, solar heat, geothermal energy and fuel cells are compare and evaluated. The focus is on the description of the potentials, the risks and the economic feasibility of the different strategies aimed to protect resources and reduce CO2 emissions.

Course: Energy efficient intralogistic systems [2117500]

Coordinators: F. Schönung, M. Braun
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral,30 min, examination dates after the end of each lesson period

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe and choose basic measures to enhance energy efficency,
- Specify this measures considering material handling processes like
  - steady conveyors,
  - unsteady conveyors,
  - as well as the necassary drives,
- Model based on this material handling systems and calculate their energy efficiency and
- Choose ressource efficient material handling systems.

Content
The main focuses of the course are:

- green supply chain
- processes in Intralogistic systems
- evaluation of energy consumption of conveyors
- modeling of conveying systems
- methods for energy savings
- approaches for energy efficiency increasing of continuous and discontinuous conveyors
- dimensioning energy efficient drives
- new approaches for resource efficient conveying systems.

Media
presentations, black board

Literature
None.

Remarks
none

Course: Energy Policy [2581959]

Coordinators: M. Wietschel
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3,5	2/0	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes
See German version.

Content
The course deals with material and energy policy of policy makers and includes the effects of such policies on the economy as well as the involvement of industrial and other stakeholders in the policy design. At the beginning the neoclassical environment policy is discussed. Afterwards the Sustainable Development concept is presented and strategies how to translate the concept in policy decision follows. In the next part of the course an overview about the different environmental instruments classes, evaluation criteria for these instruments and examples of environmental instruments like taxes or certificates will be discussed. The final part deals with implementation strategies of material and energy policy.

Literature
Will be anounced in the lecture.

Course: Energy Systems I: Renewable Energy [2129901]

Coordinators: R. Dagan
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	de

Learning Control / Examinations
Oral examination – as an elective course 30 minutes, in combination with Energiesysteme II or other courses within the energy courses, as a major course 1 hour

Conditions
None.

Learning Outcomes
The student knows the principles of the feasibility of energy gain by means of renewable energies, in particular the solar energy.

Content
The course deals with fundamental aspects of renewable energies.

1. The first part deals with the basic concepts of absorbing solar beans, in an efficient manner accounting for the minimization of heat losses. In this context, selective topics on Thermodynamics as well as fluid dynamics are introduced. In the second part few applications are discussed and optimizations techniques of solar collectors construction and their heat transfer are presented.
2. The use of solar energy as a source for heat generation is followed by the idea of electricity generation. Introductive aspects of Photovoltaic technologies are illuminated.
3. The last part presents additional regenerative energy sources such as wind and geothermal energy.

Course: Energy Systems II: Nuclear Energy and Reactor Technology [2130921]

Coordinators: A. Badea
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
oral examination, 30 min.

Conditions
none

Recommendations
none

Learning Outcomes
The students are familiar with nuclear, cooling and control engineering calculation methods for the design of nuclear power plants with nuclear fission reactors and with the safety standards in the nuclear industry.

Content
nuclear fission & fusion,
chain reactions,
moderation,
light-water reactors,
reactor safety,
reactor dynamics,
design of nuclear reactors,
breeding processes,
nuclear power systems of generation IV

Literature
slides, lecture notes
Dieter Smidt, Reaktortechnik, 1971 by G. Braun, ISBN 3 7650 2003 6;
D.G. Cacuci, Handbook of Nuclear Engineering, Springer 2010, ISBN 978-0-387-98130-7

Course: Energy Economics [23383]

Coordinators: G. Weissmüller
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Learning Outcomes
The goal is to relay technical and economical interrelation in liberalised energy markets.
Advanced lecture combining the aspects of energy generation and transmission infrastructures and economics of energy supply: Based on the estimation of available primary energy resources technical and economical solutions for covering the long-term energy demand are discussed. The lecture deals with the structural change of markets from monopoly to competition and the mechanisms of the European electricity and natural gas market are explained. Market actors, products and pricing in a competitive environment as well as new strategic approaches for increase of energy efficiency and customer service are covered. Knowledge of interrelation and interactions within the global system of energy supply is imparted.

Content
Lecture
This lecture is scheduled for those students working on the diploma or masters degree in Electrical Engineering and focuses on interrelation and interdependency in the European energy market. Based on a statement of availability of fossil fuel resources the world energy consumption of the year 2030 is prognosticated as the result of a study by Exxon. Consequences in the manner and the extent of reasonable use of energy and energy production are deduced. Structure, legal framework and interrelation of the different market actors in the European energy market are described in detail. Basic understanding of complex procedures in these markets is achieved by the discussion of realistic examples.
First of all the actual energy demand of Germany and the world is illustrated. Possibilities of specific energy savings and their impact on energy production and environment are shown. The prognosticated energy demand of the world in 2030 is measure for the necessary volume of energy production. Renewable energy generation plants are introduced as the reasonable and necessary complement of the previous fossil energy plants in respect of environment and energy efficiency.
The European Union regulated the energy market by issuing a new legal framework. The lecture delves deeply with the change from monopoly to competition market structures. The changes for market actors especially for customers are presented and new structures and procedures as for example trading through energy stock exchanges are developed.
The market environment for energy trading and sales has changed fundamentally. Pricing for energy supply is more and more subjected to national and international influences. Costs of energy production, energy transport and mainly public dues and taxes are determining energy prices and reducing the sales benefits. New products shall gain additional business and turnover.
Essential basis for a competitive energy market is the deregulation of energy transport systems. In this lecture options for a further development of the infrastructure for energy transports are discussed with the objective of providing random network access to all market actors at the same price and service quality.
Competitive energy markets need a highly sophisticated provision of energy data. Energy data management as an essential basis for planning, forecast, production, transport as well as billing is illustrated and examples for technical realisations are shown.
Goals of the European legislation are increasing energy efficiency and quality of customer service. Meeting these requirements energy supply companies will have to create new solutions and possibly new systems. The previous energy supply system based on centralised structures may be expanded by decentralized supply structures for energy production and distribution. Delivery of electricity and natural gas may be more and more replaced by provision of energy services which are presented in this lecture as well.
Finally, company structures, business management and the statement of operations are shown under competitive energy market conditions.

Paper Presentations
Accompanying the lecture students are welcome to present a paper on a subject related to energy demand or supply which is in their interest. The subject of the presentation will be appointed in consultation with the lecturer. The power-point-presentation should preliminarily be sent to the lecturer. The speech presented in class should last about 20 minutes and questions should be answered in the following discussion. The results of such a voluntary presentation will be part of the final grades.
Field Trips
At least two field trips are offered to deepen the curriculum by experiencing subjects of energy economics in reality. Preferably field trips are organized to visit thermal and renewable power plants, network infrastructure for transport and distribution purposes as well as integrated power supply companies.

Literature
Lecture material will be provided directly by mail. At the beginning of the term accompanying literature will be recommended and a list of adjacent literature to deepen the knowledge and understanding of the curriculum will be delivered.

Remarks
The course comprises of eight interleaved lecture blocks amended with student presentations and at least two field trips visiting power supply facilities.
The additional voluntary presentation of a paper on an energy economical subject will be weighted by one third of the final grades.

Course: Design Project Machine Tools and Industrial Handling [2149903]

Coordinators: J. Fleischer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
The Design Project Machine Tools an Industrial Handling can only be combined with the lecture Machine Tools and Industrial Handling (Lecture-No. 2149902). The number of students is limited to five.

Recommendations
None

Learning Outcomes
The students . . .

- are able to solve a specified task in a team.
- have the ability to analyze a given work piece, to select the necessary manufacturing process and to deduce a suitable manufacturing strategy.
- are qualified to identify the required movements of work piece and tool.
- are enabled to select the essential components and assemblies as well as execute the necessary design and calculations of dimensions.
- have the ability to interpret and present their designs and calculations.
- are capable of performing FEA analysis regarding dynamic and static behavior of the machine tool.
- are qualified to perform the essential methods for design at optimal cost, detect potentials for cost reduction and solve the given task within target costs.
- are enabled to practice the learned knowledge and methods of Machine Tools and Industrial Handling on an actual example.

Content
The tutorial Design Project Machine Tools and Industrial Handling provides an inside view of machine tool development. Within the project the students are enabled to design a machine tool for a specified work piece selected by a corporate partner.
First a machining strategy is deduced. With this strategy the students are enabled to calculate the relevant technological specifications and to dimension the necessary components such as feed axes, frame, bed and main spindle. In the end the machine tool is designed and optimized with FEA methods. Aside a target costing approach is executed for remaining within the specified costs.
The Project is executed by the students under the instruction and in cooperation with the corporate partner.
It offers

- a unique opportunity to implement the learned knowledge interdisciplinary and creatively.
- inside views into manifold development and design work.
- Co-operation with first-grade cooperate partners.
- work within a student team and professional support by research associates.

Media
SharePoint, wiki, Siemens NX 9.0

Course: Design of electrical machines [23324]

Coordinators: M. Doppelbauer
Part of the modules: Energie- und Elektrische Antriebstechnik (ETIT) (p. 21)[BSc-MIT - B-PE1], Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4.5	3	Winter term	de

Learning Control / Examinations
Written exam (2 hours)

Conditions
None.

Learning Outcomes
The goal is to provide the knowledge for designing electrical machines.
The lecture provides the basics of the calculation and design of electrical machines. The focus is especially on the generation of the rotary field and forces, on different windings and on the magnetic circuit. The students are taught to design electrical machines for specific purposes from scratch.

Content
Introduction
Windings
Magnetic circuit
Numerial field calculation
System equations of rotary field machines
Operation of rotary field machines
(Stray) Inductances and skin effect
Losses
Forces and torque
Magnetic noise
Design and calculation procedure

Remarks
15 double periods of lectures, 8 double periods of exercises

Course: Design and architectures of embedded systems (ES2) [24106]

Coordinators: J. Henkel
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
The requirements are explained in the module description.

Learning Outcomes
The Students learns methods to control and manage complexity and is able to apply these methods to the design of embedded systems. He/She assesses and selects specific architectures for embedded systems. Furthermore he/she is introduced to current research topics.

Content
Nowadays it is possible to integrate billions of transistors on a single chip to realize complete SoCs (Systems-on-Chip). The trend of being able to use more and more transistors continues unabated, so that the complexity of these systems keeps increasing. Computers become more and more ubiquitous, that is, they will be integrated into the environment and are no longer perceived as a computer. Examples are sensor networks, "electronic textiles" and many more. The potential physical complexity is not easily accessible as efficient design methods which would be capable of dealing with this high complexity are currently not available. There is a need for powerful ESL (Electronic System Level) design tools, and novel architectures. The focus of this course is therefore on high-level design methods and architectures for embedded systems. As the power consumption of the (mostly mobile) embedded systems is of crucial importance, a focus of the presented methodologies will be put on low power design.

Media
Slides

Course: Organ support systems [2106008]

Coordinators: C. Pylatiuk
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
written examination

Conditions
None.

Recommendations
Fundamentals of medicine

Learning Outcomes
Students have fundamental knowledge about functionality of organ support systems and its components. An analysis of historical developments can be done and limitations of current systems can be found. The limits and possibilities of transplantations can be elaborated.

Content

- Introduction: Definitions and classification of organ support and replacement.
- Special topics: acoustic and visual prostheses, exoskeletons, neuroprostheses, tissue-engineering, hemodialysis, heart-lung machine, artificial hearts, biomaterials.

Literature

- Jürgen Werner: Kooperative und autonome Systeme der Medizintechnik: Funktionswiederherstellung und Organersatz. Oldenbourg Verlag.
- Rüdiger Kramme: Medizintechnik: Verfahren - Systeme – Informationsverarbeitung. Springer Verlag.
- E. Wintermantel, Suk-Woo Ha: Medizintechnik. Springer Verlag.

Course: Electric Power Generation & Power Grid [23356]

Coordinators: B. Hoferer
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at the beginning of the recess period (according to Section 4 (2), 2 of the examination regulation). The exam takes place in every winter semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
The goal is to relay theoretical fundamentals and solid understanding of electrical power engineering. The students are able to analyse problems in the field of power generation and power grid and to develop approaches to these problems.

Content

- Energy resources
- Energy consumption
- Types and use of power plants
- Conversion of primary energy in power plants
- Thermodynamical fundamental terms
- Process in steam power plants
- Steam power plants components
- Flue gas cleaning
- Thermal power plants
- Nuclear power plants
- Hydroelectric power plants
- Wind energy converters
- Solar energy plants

Media
Material is available at the beginning of the lecture.

Literature
Elective literature:
Schwab; Elektroenergiesysteme; 1. Auflage 2006.

Course: Experimental Fluid Mechanics [2154446]

Coordinators: J. Kriegseis
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary means

Conditions
None.

Recommendations
Fundamental Knowledge about Fluid Mechanics

Learning Outcomes
The students can describe the relevant physical principles of experimental fluid mechanics. They are qualified to comparatively discuss the introduced measurement techniques. Furthermore, they are able to distinguish (dis-)advantages of the respective approaches. The students can evaluate and discuss measurment signal and data obtained with the common fluid mechanical measuring techniques.

Content
This lecture focuses on experimental methods of fluid mechanics and their application to solve flow problems of practical relevance. In addition, measurement signals and data, obtained with the discussed measuring techniques, are evaluated, presented and discussed.
The lecture covers a selection of the following topics:

- measuring techniques and measureable quantities
- measurements in turbulent flows
- pressure measurements
- hot wire measurements
- optical measuring techniques
- error analysis
- scaling laws
- signal and data evaluation

Media
Slides, chalk board, overhead

Literature
Tropea, C., Yarin, A.L., Foss, J.F.: Springer Handbook of Experimental Fluid Mechanics, Springer 2007
Spurk, J.H.:Fluid Mechanics, Springer, 1997

Course: Experimentelles Praktikum in Werkstoffkunde für ciw, vt, phys, MIT [2174565]

Coordinators: M. Heilmaier, K. Weidenmann, A. Möslang
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral colloquium at the beginning of each topic; certificate of successful attendance.

Conditions
Materials Science and Engineering I & II (ciw/vt, MIT)

Learning Outcomes
The students are able to describe the relationship between atomic structure, microscopical observations, and properties of solid materials.

The students can name standard materials characterization methods and can describe the execution of the tests as well as the evaluation of the results. The students are able to asses materials on base of the data obtained by these methods.
The students are capable to select appropriate experiments to clarify probelms regarding the materials behaviour. They can describe the experimental procedures and can carry out experiments. They can derive material properties from data gained in experiments. They can interpret these properties regarding microstructure-propety-relations.

Content
Performing and evaluating of two laboratory experiments in each of the following topics:

Mechanical testing of materials
Nonmetallic materials
Microstructure and properties
Cyclic loading / fatigue
Influence of manufacturing technique on materials

Literature
Laboratory script;

Shackelford, J.F.
Werkstofftechnologie für Ingenieure
Verlag Pearson Studium, 2005

Course: Handling Characteristics of Motor Vehicles I [2113807]

Coordinators: H. Unrau
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Verbally

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students know the basic connections between drivers, vehicles and environment. They can build up a vehicle simulation model, with which forces of inertia, aerodynamic forces and tyre forces as well as the appropriate moments are considered. They have proper knowledge in the area of tyre characteristics, since a special meaning comes to the tire behavior during driving dynamics simulation. Consequently they are ready to analyze the most importent influencing factors on the driving behaviour and to contribute to the optimization of the handling characteristics.

Content
1. Problem definition: Control loop driver - vehicle - environment (e.g. coordinate systems, modes of motion of the car body and the wheels)

2. Simulation models: Creation from motion equations (method according to D'Alembert, method according to Lagrange, programme packages for automatically producing of simulation equations), model for handling characteristics (task, motion equations)

3. Tyre behavior: Basics, dry, wet and winter-smooth roadway

Literature
1. Willumeit, H.-P.: Modelle und Modellierungsverfahren in der Fahrzeugdynamik,
B. G. Teubner Verlag, 1998

2. Mitschke, M./Wallentowitz, H.: Dynamik von Kraftfahrzeugen, Springer-Verlag, Berlin, 2004

3. Gnadler, R.; Unrau, H.-J.: Reprint collection to the lecture Handling Characteristics of Motor Vehicles I

Course: Handling Characteristics of Motor Vehicles II [2114838]

Coordinators: H. Unrau
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of common test methods, with which the handling of vehicles is gauged. They are able to interpret results of different stationary and transient testing methods. Apart from the methods, with which e.g. the driveability in curves or the transient behaviour from vehicles can be registered, also the influences from cross-wind and from uneven roadways on the handling characteristics are well known. They are familiar with the stability behavior from single vehicles and from vehicles with trailer. Consequently they are ready to judge the driving behaviour of vehicles and to change it by specific vehicle modifications.

Content
1. Vehicle handling: Bases, steady state cornering, steering input step, single sine, double track switching, slalom, cross-wind behavior, uneven roadway

2. stability behavior: Basics, stability conditions for single vehicles and for vehicles with trailer

Literature
1. Zomotor, A.: Fahrwerktechnik: Fahrverhalten, Vogel Verlag, 1991
2. Mitschke, M./Wallentowitz, H.: Dynamik von Kraftfahrzeugen, Springer-Verlag, Berlin, 2004

3. Gnadler, R. Unrau, H.-J.: Reprint collection to the lecture Handling Characteristics of Motor Vehicles II

Course: Vehicle Comfort and Acoustics I [2113806]

Coordinators: F. Gauterin
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
Can not be combined with lecture [2114856]

Recommendations
None.

Learning Outcomes
The students know what noises and vibrations mean, how they are generated, and how they are perceived by human beings.
They have knowledge about the requirements given by users and the public. They know which components of the vehicle are participating in which way on noise and vibration phenomenon and how they could be improved. They are ready to apply different tools and methods to analyze relations and to judge them. They are able to develop the chasis regarding driving comfort and acoustic under consideration of goal conflicts.

Content
1. Perception of noise and vibrations

3. Fundamentals of acoustics and vibrations

3. Tools and methods for measurement, computing, simulation and analysis of noise and vibrations

4. The relevance of tire and chasis for the acoustic and mechanical driving comfort:
phenomena, influencing parameters, types of construction, optimization of components and systems, conflict of goals, methods of development

An excursion will give insights in the development practice of a car manufacturer or a system supplier.

Literature
1. Michael Möser, Technische Akustik, Springer, Berlin, 2005

2. Russel C. Hibbeler, Technische Mechanik 3, Dynamik, Pearson Studium, München, 2006

3. Manfred Mitschke, Dynamik der Kraftfahrzeuge, Band B: Schwingungen, Springer, Berlin, 1997

The script will be supplied in the lectures

Course: Vehicle Comfort and Acoustics II [2114825]

Coordinators: F. Gauterin
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
Can not be combined with lecture [2114857]

Recommendations
None.

Learning Outcomes
The students have knowledge about the noise and vibration properties of the chassis components and the drive train. They know what kind of noise and vibration phenomena do exist, what are the generation mechanisms behind, which components of the vehicle participate in which way and how could they be improved. They have knowledge in the subject area of noise emission of automobiles: Noise impact, legal requirements, sources and influencing parameters, component and system optimization, target conflicts and development methods. They are ready to analyze, to judge and to optimize the vehicle with its single components regarding acoustic and vibration phenomena. They are also able to contribute competently to the development of a vehicle regarding the noise emission.

Content
1. Summary of the fundamentals of acoustics and vibrations

2. The relevance of road surface, wheel imperfections, springs, dampers, brakes, bearings and bushings, suspensions, engines and drive train for the acoustic and mechanical driving comfort:
- phenomena
- influencing parameters
- types of construction
- optimization of components and systems
- conflicts of goals
- methods of development

3. Noise emission of motor vehicles
- noise stress
- sound sources and influencing parameters
- legal restraints
- optimization of components and systems
- conflict of goals
- methods of development

Literature
The script will be supplied in the lectures.

Course: Vehicle Lightweight design – Strategies, Concepts, Materials [2113102]

Coordinators: F. Henning
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
verbally
duration: 20 - 30 min
auxiliary means: none

Conditions
none

Recommendations
none

Learning Outcomes
Students learn that lightweight design is a process of realizing a demanded function by using the smallest possible mass. They understand lightweight construction as a complex optimization problem with multiple boundary conditions, involving competences from methods, materials and production.
Students learn the established lightweight strategies and ways of construction. They know the metallic materials used in lightweight construction and understand the relation between material and vehicle body.

Content
strategies in lightweight design
shape optimization, light weight materials, multi-materials and concepts for lightweight design
construction methods
differential, integral, sandwich, modular, bionic
body construction
shell, space frame, monocoque
metalic materials
steal, aluminium, magnesium, titan

Course: Vehicle Mechatronics I [2113816]

Coordinators: D. Ammon
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Written examination

Duration: 90 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of the system science field of mechatronics and its application in the area of vehicle conception, especially in the context of vehicle system dynamics. They know the tools and methods for a systematical analysis, conception, and design of mechatronic systems, focussing on mechatronically extended suspension systems. They are ready to analyze, to judge and to optimize mechatronic systems.

Content
1. Introduction: Mechatronics in vehicle technology
2. Vehicle Control systems
Brake- and traction controls (ABS, ASR, automated power train controls)
Active and semiactive suspension systems, active stabilizor bars
Vehicle dynamics controls, driver assistence systems
3. Modelling technology
Mechanics - multi body dynamics
Electrical and electronical systems, control systems
Hydraulics
Interdisciplinary coupled systems
4. Computer simulation technology
Numerical integration methods
Quality (validation, operating areas, accuracy, performance)
Simulator-coupling (hardware-in-the-loop, software-in-the-loop)
5. Systemdesign (example: brake control)
Demands, requirements (funktion, safety, robustness)
Problem setup (analysis - modelling - model reduction)
Solution approaches
Evaluation (quality, efficiency, validation area, concept ripeness)

Literature
1. Ammon, D., Modellbildung und Systementwicklung in der Fahrzeugdynamik, Teubner, Stuttgart, 1997
2. Mitschke, M., Dynamik der Kraftfahrzeuge, Bände A-C, Springer, Berlin, 1984ff
3. Miu, D.K., Mechatronics - Electromechanics and Contromechanics, Springer, New York, 1992
4. Popp, K. u. Schiehlen, W., Fahrzeugdynamik - Eine Einführung in die Dynamik des Systems Fahrzeug-Fahrweg, Teubner, Stuttgart, 1993
5. Roddeck, W., Einführung in die Mechatronik, Teubner, Stuttgart, 1997
6. Zomotor, A., Fahrwerktechnik: Fahrverhalten, Vogel, Würzburg, 1987

Course: Tires and Wheel Development for Passenger Cars [2114845]

Coordinators: G. Leister
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
Knowledge in automotive engineering

Learning Outcomes
The students are informed about the interactions of tires, wheels and chassis. They have an overview of the processes regarding the tire and wheel development. They have knowledge of the physical relationships.

Content

1. The role of the tires and wheels in a vehicle
2. Geometrie of Wheel and tire, Package, load capacity and endurance, Book of requirement
3. Mobility strategy, Minispare, runflat systems and repair kit.
4. Project management: Costs, weight, planning, documentation
5. Tire testing and tire properties
6. Wheel technology incuding Design and manifacturing methods, Wheeltesting
7. Tire presssure: Indirect and direct measuring systems
8. Tire testing subjective and objective

Literature
Manuscript to the lecture

Course: Automotive Vision [2138340]

Coordinators: C. Stiller, M. Lauer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

no reference materials

Conditions
None.

Recommendations
Fundamentals in measurement, system and control theory, e.g. from the lecture "Measurement and Control Systems"

Learning Outcomes
Machine perception and interpretation of the environment for the basis for the generation of intelligent behaviour. Especially visual perception opens the door to novel automotive applications. First driver assistance systems can already improve safety, comfort and efficiency in vehicles. Yet, several decades of research will be required to achieve an automated behaviour with a performance equivalent to a human operator. The lecture addresses students in mechanical engineering and related subjects who intend to get an interdisciplinary knowledge in a state-of-the-art technical domain. Machine vision, vehicle kinematics and advanced information processing techniques are presented to provide a broad overview on ßeeing vehicles'. Application examples from cutting-edge and future driver
assistance systems illustrate the discussed subjects.

Content
1. Driver assistance systems
2. Image acquisition and discretization
3. Image signal processing
4. Stochastic image models
5. Stereo vision and image sequence processing
6. Tracking
7. Lane recognition
8. Obstacle recognition

Literature
TBA

Course: Composite Manufacturing – Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies [2114053]

Coordinators: F. Henning
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
verbally
duration: 20 - 30 min
auxiliary means: none

Conditions
none

Recommendations
none

Learning Outcomes
Students know different polymer resin materials and fiber materials and can deduce their character and use.
They understand the reinforcing effect of fibers in a matrix surrounding as well as the tasks of the single components in a compound. They know about the influence of the length of fibers, their mechanical characters and performance in a polymer matrix compound.
Student know the important industrial production processes for continuous and discontinuous reinforced polymer matrix compounds.

Content
Physical connections of fiber reinforcement
Use and examples
automotive construction
transport
Energy and construction
sport and recreation
resins
thermoplastics
duromeres
mechanisms of reinforcements
glas fibers
carbon fibers
aramid fibers
natural fibers
semi-finished products - textiles
process technologies - prepregs
recycling of composites

Course: Electromagnetic Fields and Waves [23055]

Coordinators: G. Trommer
Part of the modules: Electronics Basics II (p. 17)[BSc-MIT - B5]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
Written exam (see actual document "Studienplan" and notice of the examination office ETIT).
Grades result from the written examination

Conditions
None.

Learning Outcomes

Content
This course provides an introduction to the major theoretical foundations of electric and magnetic fields for students of the 3rd semester. In addition, the lecture is intended to be the basis for other application-related lectures.
Basis of the lecture is the presentation of the electromagnetic field theory and the necessary mathematical methods. This is done on the basis of Maxwell's equation, which are presented and explained in detail in this lecture.
Using this equation, the basic phenomena of electric and magnetic phenomena are calculated and explained. This includes the electrostatics, the stationary flow fields, strictly stationary magnetic fields, the inductive effects, quasistationary fields, the energy and energy flux density of fields, wave phenomena of fast varying fields up and finally the basics of antenna theory of the Hertzian dipole.

Literature
The content of the lecture is distributed as a paper script. Online material on exercises is available on: www.ite.uni-karlsruhe.de/lehre There a most recent list of books is presented

Remarks
The course comprises of the interleaved lecture blocks, exercises, and tutorials. Current information can be found on the ITE (www.ite.uni-karlsruhe.de) webpage.

Course: FEM Workshop – constitutive laws [2183716]

Coordinators: K. Schulz, D. Weygand
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Oral examination in the elective module MSc, otherwise no grading
solving of a FEM problem
preparation of a report
preparation of a short presentation

Conditions
None.

Recommendations
Engineering Mechanics; Advanced Mathematics; Introduction to Theory of Materials

Learning Outcomes
The student

- has the basic understanding of the materials theory and the classification of materials
- is able to independently generate numerical models using ABAQUS and can choose and apply adequate constitutive equations

Content
The course repeats the fundamentals of the theory of materials. It leads to the characterization and classification of material behavior as well as the specification by adequate material models. Here we focus on elastic, viscoelastic, plastic, and viscoplastic deformation behavior. Introducing the finite element program ABAQUS, the students learn how to analyze the material models numerically. Therefore ABAQUS-own and continuative constitutive equations are chosen.

Literature
Peter Haupt: Continuum Mechanics and Theory of Materials, Springer; ABAQUS Manual; Lecture notes

Course: Fabrication Processes in Microsystem Technology [2143882]

Coordinators: K. Bade
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Oral examination, 20 minutes

Conditions
Bachelor mach., wing.

Recommendations
Lectures
Mikrosystemtechnik I [2141861] and/or II [2142874]

Learning Outcomes
The student

- collects advanced knowledge
- understands process conditions and process layout
- gains interdisciplinary knowledge (chemistry, manufacturing, physics)

Content
The lecture offers an advanced understanding of manufacturing processes in microsystem technology. Basic aspects of microtechnological processing will be introduced. With examples from semiconductor microfabrication and microsystem technology the base processing steps for conditioning and finishing, patterning, removal are imparted. Nano-patterning is covered is also included and the micro-nano interface is discussed. By the help of typical processing steps elementary mechanisms, process execution, and equipment are explained. Additionally quality control, process control and environmental topics are included

Media
pdf files of presentation sheets

Literature
M. Madou
Fundamentals of Microfabrication
CRC Press, Boca Raton, 1997
W. Menz, J. Mohr, O. Paul
Mikrosystemtechnik für Ingenieure
Dritte Auflage, Wiley-VCH, Weinheim 2005
L.F. Thompson, C.G. Willson, A.J. Bowden
Introduction to Microlithography
2nd Edition, ACS, Washington DC, 1994

Course: Manufacturing Technology [2149657]

Coordinators: V. Schulze, F. Zanger
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	6	Winter term	de

Learning Control / Examinations
The assessment is carried out as a written exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students ...

- are capable to specify the different manufacturing processes and to explain their functions.
- are able to classify the manufacturing processes by their general structure and functionality according to the specific main groups.
- have the ability to perform a process selection based on their specific characteristics.
- are enabled to identify correlations between different processes and to select a process regarding possible applications.
- are qualified to evaluate different processes regarding specific applications based on technical and economic aspects.
- are experienced to classify manufacturing processes in a process chain and to evaluate their specific influence on surface integrity of workpieces regarding the entire process chain.

Content
The objective of the lecture is to look at manufacturing technology within the wider context of production engineering, to provide an overview of the different manufacturing processes and to impart detailed process knowledge of the common processes. The lecture covers the basic principles of manufacturing technology and deals with the manufacturing processes according to their classification into main groups regarding technical and economic aspects. The lecture is completed with topics such as process chains in manufacturing.
The following topics will be covered:

- Quality control
- Primary processing (casting, plastics engineering, sintering, additive manufacturing processes)
- Forming (sheet-metal forming, massive forming, plastics engineering)
- Cutting (machining with geometrically defined and geometrically undefined cutting edges, separating, abrading)
- Joining
- Coating
- Heat treatment and surface treatment
- Process chains in manufacturing

This lucture provides an excursion to an industry company.

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Solid-State Electronics [23704]

Coordinators: U. Lemmer
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT], Bauelemente der Elektrotechnik (ETIT) (p. 22)[BSc-MIT - B-PE2]

ECTS Credits	Hours per week	Term	Instruction language
4.5	3	Summer term	de

Learning Control / Examinations
Written Exam (2 hours)

Conditions
None.

Learning Outcomes
The students know the fundamentals of quantum mechanics.

Content
fundamentals of quantum mechanics

Literature
The corresponding documents are avalible under https://studium.kit.edu/

Course: Field Propagation and Coherence [23466 + 23467]

Coordinators: W. Freude
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	en

Learning Control / Examinations
Oral Exam

Conditions
Fundamentals of wave propagation

Learning Outcomes
Propagation of optical fields in multimode fibres and in a homogeneous medium. Coherence properties of optical fields and measurement techniques.
Multimode fibres became increasingly important in recent times, if price matters and not the maximum transmission capacity. The description of multimode fibre transmission, the wave propagation in homogeneous media and the description and measurement of coherence of optical fields is the topic of this lecture.

Content
Lecture
Multimode waveguides (Introduction. Refractive index profile. Fibre data. Group delay dispersion) ¾ Waves and modes (LP_{nm}-modes. Parabolic profile) ¾ Rays and modes (Free-space longitudinal and transverse modes. Sampling theorem. Phase space. Ray optics. Asymptotic approximations. JWKB approximation. Types of rays. Ray equation. Counting of modes. Excitation of modes. Excitation with light rays. Radiation of modes. Practical pencil of rays. Graded-index lens) ¾ Near-field and far-field ¾ Group delay dispersion (Group delay. Profile optimization) ¾ Impulse response (Transfer function. Singlemode impulse response. Singlemode power impulse response. Multimode power impulse response. Group delay power transfer function) ¾ Fibre imperfections and mode coupling ¾ Bandwidth-length product ¾.Coupling devices (Light sources and fibres. Butt coupling. 70-%-excitation) ¾ Optical branches (Multimode interference (MMI) coupler. Directional coupler) ¾ Modal noise
Propagation of optical fields
Solution of wave equation (Rayleigh-Sommerfeld and Helmholtz-Kirchhoff integrals. Boundary field and field gradient impulse response and convolution. Fourier, Fresnel and Fraunhofer approximation) ¾ Uniqueness of Helmholtz equation ¾ Paraxial optics (Gauss-Laguerre fields. Gaussian beam and spherical resonators. ABCD matrix)
Coherence of optical fields
Analytic optical signals ¾ Coherence function and power spectrum (Ergodic signals. Principle of a measurement. Temporal and spatial coherence. Spectrally pure process. Propagation of mutual coherence. Coherence tensor. Higher-order coherence functions) ¾ Polarisation (Coherence matrix. Stokes parameter. Jones vectors and matrices. Poincaré sphere. Eigenstates and principal states. Polarisation mode dispersion and birefringence) ¾ Interference (Baseband spectrum, contrast and line shapes. Narrowband and broadband sources. Mach-Zehnder and Michelson interferometer. Source with a comb spectrum. Multipath interference with dispersive waveguides) ¾ Interference of waves with different frequencies (Photocurrent. Correlation analysis of photocurrent. Thermal light source. Laser light source. Influence of polarisation)
Exercises
The exercises apply the lecture's material to practical problems for providing a deeper understanding. The exercises may be electronically downloaded prior to the exercise.

Literature
Online material (a complete German compuscript with English captions as well as the English PowerPoint pages presented during the lecture) can be downloaded from http://www.ipq.kit.edu <Lectures>. Further material for the interested ones (in German): Grau, G.; Freude, W.: Optische Nachrichtentechnik (Optical communications), 3. Ed. Berlin: Springer Verlag 1991. Since 1997 out of print. Corrected reprint from University Karlsruhe 2005, available via W. F. (W.Freude@ipq.uni-karlsruhe.de). Freude, W.: Vielmodenfasern. 50 Seiten in: Voges, E.; Petermann, K. (Eds.), Handbuch der optischen Kommunikationstechnik (Handbook of optical communications). Springer-Verlag, Berlin 2002

Remarks
Current information are available on the IPQ webpage (www.ipq.kit.edu).

Course: Finite Volume Methods for Fluid Flow [2154431]

Coordinators: C. Günther
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary means

Conditions
None.

Recommendations
Fundamental Knowledge about Fluid Mechanics

Learning Outcomes
Students can describe all fundamental aspcets of the finite volume methods, which form the basis for a number of different commerical CFD codes.

Content
The Finite Volume Method (=FVM) is nowadays of great interest, as it guarantees conservation of all relevant variables and as it can be used on nearly arbitrary meshes. By this it is a fundamental tool for numerical simulation of flows, which plays an ever growing role for construction and engineering and is the basis of several commercial or research codes as CFX, STAR-CCM+, FLUENT or OpenFOAM. The lecture is concerned with all aspects of FVM, mesh generation is also included. Newer developments as CVFEM (control volume based FEM) are described.

- Introduction
- Conservative schemes
- Finite volume method
- Analysis of FVM
- CVFEM as conservative FEM
- FVM for Navier-Stokes Equations
- Basics of mesh generation

Remarks
The lecture is recommended for students of mechanical, chemical or electrical engineering and is also of interest for people which are interested in FVM in a context other than fluid flow problems.

Course: Fluid-Structure-Interaction [2154401]

Coordinators: M. Mühlhausen, B. Frohnapfel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam
Duration: 30 min
no auxiliary means

Conditions
none

Recommendations
Basic Knowledge about Fluid Mechanics

Learning Outcomes
The students are familiar with the numerical treatment of coupled problems. After completing this course students are able to describe a fluid-structure coupled problem and to derive its numerical formulation. They are familiar with the different coupling possibilities between the two regions and the corresponding advantages and disadvantages. Finally, the students are aware of the fact that not every result of a numerical simulation necessarily reflects reality and can thus critically judge the numerically obtained results.

Content
The lecture first introduces/recalls the fundamental governing equations that describe fluids and structures. After the characterization of the problem, the relevant equations are discussed and geometry and grid generation are treated. The resulting partial differential equations are transformed into an algebraic set of equations using different DFG and CSD methods and discretization schemes. Different methods for fluid structure coupling are introduced, where the resulting stability problem is treated in detail. Finally, the obtained result is critically examined in terms of errors and inaccuracy and verification and validation procedures are introduced.
The lecture includes an introduction to function of CFG-Programs and Matlab routines that are related to the theoretically discussed approaches.

Literature
will be introduced during the lecture

Remarks
Block course with limited number of participants, registration in the secretary's office required.
See details at www.istm.kit.edu

Course: Fluid Technology [2114093]

Coordinators: M. Geimer, M. Scherer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Winter term	de

Learning Control / Examinations
The assessment consists of a writen exam (2 hours) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
The students will be able to

- know and understand physical principles of fluid power systems
- know the current components and their operating mode
- know the advantages and disadvantages of different components
- dimension the components for a given purpose
- calculate simple systems

Content
In the range of hydrostatics the following topics will be introduced:

- Hydraulic fluids
- Pumps and motors
- Valves
- Accessories
- Hydraulic circuits.

In the range of pneumatics the following topics will be introduced:

- Compressors
- Motors
- Valves
- Pneumatic circuits.

Literature
Scritum for the lecture *Fluidtechnik*
Institute of Vehicle System Technology
downloadable

Course: Formal Systems [24086]

Coordinators: B. Beckert
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/2	Winter term	de

Learning Control / Examinations

Conditions
The requirements are explained in the module description.

Learning Outcomes
Students will be introduced to the basic concepts of formal modeling and verification of IT systems.
Students will learn to understand and apply the principal definitions and their mutual dependencies.
Students will find their own solutions for small examples of specification problems using appropriate software tools where applicable.
Students will solve on their own verification taks for small examples using appropriate software tool where applicable

Content
This course will on one hand introduce the students to the basics of formal modeling and verification and on the other hand convey how theoretical concepts can be transformed into practically useful methods.
We distinguish static from dynamic aspects of IT systems.
Static Modelling and Verification

Building on what the students already know about propositional logic calculi for propositional deduction will be presented together with proofs of their soundness and correctness. Students will learn that these cacluli all solve the saem problem but may show different characteristics. Examples of calculi could be: resolution caclulus, tableau calculus, sequent calculus or Hilber's calculus, Furthermore calculi for fragments of propositional logic will be treated, e.g., Horn formulas.
To bridge theory and practice programs for solving propositional satisfiability problems (SAT solvers) will be covered.
Extending the propositional case syntax and semantics of first-order predicate logic will be introduced. Two calculi will be treated out of resolution, sequent, tableau, or Hilbert's calculus. For one calculus soundness and completeness proofs will be given.
To bridge theory and practice specification languages based on predicate logic, like OCL, JML or similar languages, we will covered.
In addition automatic or interactive proving may be covered.
Dynamic Modelling and Verification
As a first introduction to logics formalising properties of dynamic systems the syntax and semantics (Kripke structures) of propositional modal logics will be considered. However, without considering proof their proof theory.
Building on the students' aquaintance with the concept of finite automata omega-automata as a model of non-terminating processes will be introduced, e.g., Buechi automata or Müller automata. In particular closure properties of Buechi automata will be covered.
As a special instance of modal logics a temporal modal logic will be treated in syntax and semantics, e.g., LTL of CTL.
The correspondence between behavioral description using omega automata and using formulas of temporal logic will be explained.
To bridge theory and practice model checking procedures be treated

Media
Slides, homepage, online discussion forum, lecture notes.

Literature
Lecture notes "Formale Systeme"
User manuals oder operating instructions of the used tools (SAT-solver, Theorembeweiser, Modellprüfungsverfahren (model checker)).
Elective literature:
Will be announced in the lecture.

Course: Foundations of Digital Services [2595466]

Coordinators: C. Weinhardt, H. Fromm
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Summer term	en

Learning Control / Examinations
The assessment consists of a written exam (60 min) (according to §4(2), 1 of the examination regulation). By successful completion of the exercises (according to §4(2), 3 of the examination regulation) a bonus can be obtained. If the grade of the written exam is at least 4.0 and at most 1.3, the bonus will improve it by one grade level (i.e. by 0.3 or 0.4). The bonus only applies to the first and second exam of the semester in which it was obtained.

Conditions
None.

Recommendations
None.

Learning Outcomes
The student:
• understands the different perspectives on services and the concept of value generation in service networks,
• is able to understand and apply concepts, methods and tools for the design, development and management of digital services,
• gains experience in group work such as in solving case studies and in the professional presentation of those results,
• practices the use of English language as a preparation for work in an international environment

Content
The world is moving more and more towards “service-led” economies: in developed countries services already account for around 70% of gross value added. In order to design, engineer, and manage services, traditional “goods-oriented” models are often inappropriate. In addition, the rapid development of information and communication technology (ICT) pushes the economic importance of services that are rendered electronically (eServices) and, thus, drives competitive changes: increased interaction and individualization open up new dimensions of “value co-creation” between providers and customers; dynamic and scalable service value networks replace static value chains; digital services can be globally delivered and exchanged across today’s geographic boundaries;

Building on a systematic categorization of (e)Services and on the general notion of “value co-creation”, we cover concepts and foundations for engineering and managing IT-based services, allowing for further specialization in subsequent KSRI courses. Topics include service innovation, service economics, service modeling as well as the transformation and coordination of service value networks.

In addition, case studies, hands-on exercises and guest lectures will illustrate the applicability of the concepts. English language is used throughout the course to acquaint students with international environments.

Media
lecture slides

Literature
Announced in the first session.

Remarks
This course was formerly named “eServices”.
The credits have been changed from 5 to 4,5.

Course: Fusion Technology A [2169483]

Coordinators: R. Stieglitz
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral: Acceptance for the oral test only by certification of attendance of excercises

Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
Basic knowledge in fluid mechanics, material sciences and physics

Recommendations
appreciated is knowldege in heat ans mass transfer as well as in electrical engineering

Learning Outcomes
The lecture describes the functional principle of a fusion reactor, starting from the plasma, the magnets, teh tritium and fuel cycle, the vacuum technology and the associated material sciences. The physical principles are discussed and scaling laws are formulated. One major emphasis is directed towards the interface between the individual fields of disciplines which to a large extend determines the technological scaling of a fusion facility.Here methods are communicated, which allow for an identification of central parameters and a corresponding technical analysis. Based on the elaborated acquisition skills appoaches to design solution strategies are transmitted. Also technical solutions are shown and the weaknesses are discussed and evaluated.

Content
Acutal energy situation and perspectives. Transfer of the fndamentals in structure of matter physics, fusion and nuclear fission, plasma. Ignition conditions of a plasma, plasma instabilities, control of a plasma and transport in plasmas. Magnet technology, super-conductivity, materials in super-conductivity, fabrication and design of magnets, trtium and fuel cycle, vacuum technology in fusion. The individual section describe additionally the task, the challenges and the design of state of the art technology. Also an introduction into design criteria and materials for fusion are given, which scopes the fundamentals of material science, characterization of fusion materials, material damage by irradiation and calculation methods for nuclear materials.Additionally hints for an adequate material selection are presented.

Literature
Within each subblock an adequate selection of literature is given. Additionally the students get the lecuture materials in printed and electronic version.

Course: Fusion Technology B [2190492]

Coordinators: R. Stieglitz
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral
Completed set of practical courses within lecture

Duration: approximately 25 minutes

no tools or reference materials may be used during the exam

Conditions
reliable capability to use fundamental knowledge communicated in the bachelor study in physics, heat. and mass transfer and engineering design

Recommendations
attendance of fusion technology A lecutre

Learning Outcomes
The lecture comprising two semesters is addressing students of engineering science and physics after a successfull intermediate diploma. It intends to give a introduction to current fusion research and development and to the long term target of fusion as a promising energy source. After a short insight into fusion physics the lecture concentrates on key technologies for future fusion reactors. The lectures are complemented by exercises at different insitutes located at the campus north (two to three afternoons per subject).

Content
Die Fusionstechnologie B beinhaltet
Fusion neutronics, plasma facing components and plasma heating-and current drive methods. The section fusion neutronics scopes the fundamentals and calculation methods, which allows for a physical design of a nuclear fusion reactor and the corresponding components (such as blankets, divertors, shielding, activation and dose rate). Fusion reactors produce fuel their "self". The necessary blankets are complex structures whose foundations and concept options, design criteria and methods are discussed. Also the divertor is a plasma facing component. Its tasks, constraints, and design concepts are explained. The arrangement of the plasma facing components in a fusion power plant means changing demands on the system integration and energy conversion. To ignite the plasma extreme temperatures of several million degrees are required. For this purpose, special plasma heating techniques are used such as electron cyclotron resonance heating (ECRH), ion-cyclotron resonance heating (ICRH), the current drive at the lower hybrid frequency, and the neutral particle injection. Their basic mode of action, the design criteria, the transmission options and performance are presented and discussed. Additionally the heating method used also for plasma stabilization. Here are some considerations and limitations are presented.

Literature
Lecture notes

McCracken, Peter Scott, Fusion, The Energy of Universe, Elsevier Academic Press, ISBN: 0-12-481851-X

Course: Gasdynamics [2154200]

Coordinators: F. Magagnato
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral
Duration: 30 min
no auxiliary means

Conditions
none

Recommendations
basic skills in mathematics, physics and fluid dynamics

Learning Outcomes
The students can describe the governing equations of Gas Dynamics in integral form und the associated basics in Thermodynamics. They can calculate compressible flows analytically. The students are familiar with the Rankine-Hugoniot curve and the Rayleigh line and can name those. They can derive the continuity-, the momentum- and the energy equations in differential form. With the help of the stationary flow filament theory they can calculate the normal shock wave and the associated increase of entropy.
They are able to determine the stagnation values of the gas dynamic variables and to determine their critical values. The students can apply the flow filament theory for variable cross-sectional areas and can distinguish the related different flow states inside the Laval nozzle.

Content
This lecture covers the following topics:

- Introduction, basics of Thermodynamics
- Governing equations of gas dynamics
- Application of the conservation equations
- The transport equations in differential form
- Stationary flow filament theory with and without shock waves
- Discussion of the energy equation: Stagnation and critical values
- Flow filament theory for variable cross-sectional areas. Flow inside a Laval nozzle

Literature
John, J., and Keith T. Gas Dynamics. 3rd ed.
Harlow: Prentice Hall, 2006
Rathakrishnan, E. *Gas Dynamics*. Prentice Hall of India Pvt. Ltd, 2006

Course: Gas Engines [2134141]

Coordinators: R. Golloch
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	

Learning Control / Examinations
Oral examination, duration 25 min., no auxillary means

Conditions
none

Recommendations
Knowledge about „Verbrennungsmotoren A und B“ or “Fundamentals of Combustion Engines I and II”

Learning Outcomes
The student can name and explain the function, characteristics and application areas of gas and dual fuel engines. He is able to distinguish from engines using liquid fuels. The student describe and explain gaseous fuels, engine subsystems, combustion processes and exhaust gas aftertreatment technologies. He is capable to analyse and evaluate current development areas and technical challenges.

Content
Based on the basics of internal combustion engines the students learn about functions of modern gas and dual fuel engines. Core learning areas are gaseous fuels, combustion processes including abnormal combustion characteristics, subsystems like gas admission, ignition, safety and control systems. Further knowledge will be teached on emissions, exhaust gas aftertreatment, applications and operation characteristics.

Media
Lecture with PowerPoint slides

Literature
Lecture Script, prepared by the lecturer. Obtainable at the Institut für Kolbenmaschinen
Recommended:
- Merker, Schwarz, Teichmann: Grundlagen Verbrennungsmotoren, Vieweg + Teubner Verlag 2011;
- Zacharias: Gasmotoren, Vogel Fachbuch 2001

Course: Geometric Optimzation [2400026]

Coordinators: H. Prautzsch
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes

Content
Method of least squares, Levenberg-Marquardt-algorithm, best fitting planes, iterated closed point algorithm, FEM, animation trandfer, approximation with developable surfaces, smoothing of surfaces, parametrizations with minimal distortion, numerical stability, exact arithmetic, smallest enclosing spheres etc.

Media
Blackboard, slides.

Literature
Various papers and textbook chapters as announced during the course.

Course: Global vehicle evaluation within virtual road test [2114850]

Coordinators: B. Schick
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: CarMaker Simulation Environment

Conditions
none

Learning Outcomes
The students have an overview of the vehicle dynamics simulation, the model parametrization and the related data sources. They have good knowledge about vehicle dynamics test methods and related execution of virtual test driving (open loop, closed loop). They are able to evaluate driving behavior based on self-created results. They have achieved knowledge about influences and interactions of components such as tires, suspension, kinematics and compliance, roll bars, steering, brakes, mass distribution and powertrain and they have the qualification to analyze, to judge and to optimize components with regard to global vehicle behavior.

Content
1. Testing and evaluation methods
2. Fundamentals of vehicle dynamics simulation
3. Execution of virtual test driving and evaluation of the results
4. Influence of several components and optimization of global driving behavior

Literature
1. Reimpell, J.: Fahrwerktechnik: Grundlagen, Vogel Verlag, 1995
2. Unrau, H.-J.: Scriptum zur Vorlesung “Fahreigenschaften I”
3. Unrau, H.-J.: Scriptum zur Vorlesung “Fahreigenschaften II”
4. IPG: User Guide CarMaker

Course: Foundry Technology [2174575]

Coordinators: C. Wilhelm
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral

duration: 20 - 30 minutes

no notes

Conditions
Required: WK 1+2

Learning Outcomes
The students know the specific moulding and casting techniques and are able to describe them in detail. The students know the application of moulding and casting techniques concerning castings and metals, their advantages and disadvantages in comparision, their application limits and are able to describe these in detail.
The students know the applied metals and are able to describe advantages and disadvantages as well as the specific range of use.
The students are able, to describe detailled mould and core materials, technologies, their application focus and mould-affected casting defects.
The students know the basics of casting process of any casting parts concerning the above mentioned criteria and are able to desvcribe detailled.

Content
Moulding and casting processes
Solidifying of melts
Castability
Fe-Alloys
Non-Fe-Alloys
Moulding and additive materials
Core production
Sand reclamation
Feeding technology
Design in casting technology
Casting simulation
Foundry Processes

Literature
Reference to literature, documentation and partial lecture notes given in lecture

Course: Global Production and Logistics - Part 1: Global Production [2149610]

Coordinators: G. Lanza
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination date can be defined individually.

Conditions
None

Recommendations
Combination with Global Production and Logistics – Part 2

Learning Outcomes
The students . . .

- can explain the general conditions and influencing factors of global production.
- are capable to apply defined procedures for site selection and to evaluate site decisions with the help of different methods.
- are able to select the adequate scope of design for site-appropriate production and product construction case-specifically.
- can state the central elements in the planning process of establishing a new production site.
- are capable to make use of the methods to design and scale global production networks for company-individual problems.
- are able to show up the challenges and potentials of the departments sales, procurement as well as research and development on global basis.

Content
Target of the lecture is to depict the challenges and fields of action of global operating companies and to give an overview of central aspects in global production networks as well as establishing a deepening knowledge of established methods and procedures for design and scale. Within the course methods for site selection, procedures for site specific adjustment of product construction and product technology as well as planning approaches to establish a new production site are imparted. The course is rounded off by showing the characteristics of the departments sale, procurement as well as research and development under global aspects.
The topics are:

- Basic conditions and influencing factors of global production (historical development, targets, chances and threats)
- Global sales
- Site selection
- Site specific producion adjustment
- Establishing of new production sites
- Global procurement
- Design and management of global production networks
- Global research and development

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes
recommended secondary literature:
Abele, E. et al: Global Production – A Handbook for Strategy and Implementation, Springer 2008 (english)

Remarks
None

Course: Global Production and Logistics - Part 2: Global Logistics [2149600]

Coordinators: K. Furmans
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", current version)

Conditions
none

Recommendations
We recommend the course "Logistics - organisation, design and control of logistic systems " (2118078) beforehand.

Learning Outcomes
Students are able to:

- assign basic problems of planning and operation of global supply chains and plan them with apropriate methods,
- describe requirements and characteristics of global trade and transport, and
- evaluate characteristics of the design from logistic chains regarding their suitability.

Content
Characteristics of global trade

- Incoterms
- Customs clearance, documents and export control

Global transport and shipping

- Maritime transport, esp. container handling
- Air transport

Modeling of supply chains

- SCOR model
- Value stream analysis

Location planning in cross-border-networks

- Application of the Warehouse Location Problem
- Transport Planning

Inventory Management in global supply chains

- Stock keeping policies

Inventory management considering lead time and shipping costs

Media
presentations, black board

Literature
Elective literature:

- Arnold/Isermann/Kuhn/Tempelmeier. HandbuchLogistik, Springer Verlag, 2002 (Neuauflage in Arbeit)

- Domschke. Logistik, Rundreisen und Touren,Oldenbourg Verlag, 1982
- Domschke/Drexl. Logistik, Standorte, OldenbourgVerlag, 1996
- Gudehus. Logistik, Springer Verlag, 2007
- Neumann-Morlock. Operations-Research,Hanser-Verlag, 1993
- Tempelmeier. Bestandsmanagement in SupplyChains, Books on Demand 2006
- Schönsleben. IntegralesLogistikmanagement, Springer, 1998

Course: Size effects in micro and nanostructures materials [2181744]

Coordinators: P. Gumbsch, D. Weygand, P. Gruber, M. Dienwiebel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
compulsory preconditions: none

Recommendations
preliminary knowlegde in materials science

Learning Outcomes
The student can

- describe the mechanical behavior of nano and micrometer sized structured materials and analyse and explain the origin for the differences compared to classical materials behavior.
- explain processing routes, experimetal characterization methods and adequate modelling schems for nano- and microstructred maetrials.

Content
Modern topics in the mechanics of materials are presented.

1. Nanotubes
* production routes, properties
* application
2. cermics
* defect statistics
3. size effect in metallic structures
* thin film mechanics
* micro pillar
* modelling:
discrete dislocation dynamic
4. nanocontact:
* gecko
* hierachical structures
5. nanotribology
* contact, friction: simple and multiple contacts
* radio nucleid technique

Literature
lecture slides

Course: Basic Notions of Computer Science [24001]

Coordinators: T. Worsch
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	2/1/2	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

- Students know the most important techniques for definitions and are able to read and understand such definitions.
- Students know the difference between syntax and semantics.
- Students know the most important notions from discrete mathematics and computer science and are able to use them for the description of problems and in proofs.

Content

- informal notion of algorithm, basics of correctness proofs
- computational complexity measures, hard problems
- big O notation, master theorem
- alphabets, words, formal languages
- finite acceptors, contextfree grammars
- inductive/recursive definitions, proofs by induction, closure
- relations and functions
- graphs

Media
lecture notes, slides (pdf).

Literature
Elective literature:

- Goos: Vorlesungen über Informatik, Band 1, Springer, 2005
- Abeck: Kursbuch Informatik I, Universitätsverlag Karlsruhe, 2005

Course: Fundamentals of Energy Technology [2130927]

Coordinators: A. Badea
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	5	Summer term	de

Learning Control / Examinations

Conditions
none

Learning Outcomes
The students will receive state of the art knowledge about the very challenging field of energy industry and the permanent competition between the economical profitability and the long-term sustainability.

Content
The following relevant fields of the energy industry are covered:
- Energy forms
- Thermodynamics relevant to energy industry
- Energy sources: fossil fuels, nuclear energy, renewable sources
- Energy industry in Germany, Europe and worldwide
- Power generation and environment
- Evaluation of energy conversion processes
- Thermal/electrical power plants and processes
- Transport of energy / energy carriers
- Energy storage
- Systems utilizing renewable energy sources
- Basics of economic efficiency and calculus / Optimisation
- Future of the energy industry

Course: Automotive Engineering I [2113805]

Coordinators: F. Gauterin, H. Unrau
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter term	de

Learning Control / Examinations
Written examination

Duration: 120 minutes

Auxiliary means: none

Conditions
Can not be combined with lecture [2113809]

Recommendations
None.

Learning Outcomes
The students know the movements and the forces at the vehicle and are familiar with active and passive security. They have proper knowledge about operation of engines and alternative drives, the necessary transmission between engine and drive wheels and the power distribution. They have an overview of the components necessary for the drive and have the basic knowledge, to analyze, to judge and to develop the complex system "vehicle".

Content
1. History and future of the automobile
2. Driving mechanics: driving resistances and driving performances, mechanics of the longitudinal and transverse forces, passive safety

3. Engines: combustion engine, alternative drives (e.g. electric motor, fuel cell)

4. Transmission: clutches (e.g. friction clutch, visco clutch), transmission (e.g. mechanical transmission, hydraulic fluid transmission)

5. Power transmission and distribution: drive shafts, cardon joints, differentials

Literature
1. Mitschke, M./ Wallentowitz, H.: Dynamik der Kraftfahrzeuge, Springer-Verlag, Berlin, 2004

2. Braes, H.-H.; Seiffert, U.: Handbuch Kraftfahrzeugtechnik, Vieweg&Sohn Verlag, 2005

3. Gnadler, R.: Script to the lecture 'Automotive Engineering I'

Course: Automotive Engineering II [2114835]

Coordinators: F. Gauterin, H. Unrau
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Written Examination

Duration: 90 minutes

Auxiliary means: none

Conditions
Can not be combined with lecture [2114855]

Recommendations
None.

Learning Outcomes
The students have an overview of the modules, which are necessary for the road holding of a motor vehicle and the power transmission between vehicle bodywork and roadway. They have knowledge of different wheel suspensions, the tyres, the steering elements and the brakes. They know different execution forms, the function and the influence on the driving or brake behavior. They are able to develop the appropriate components correctly. They are ready to analyze, to judge and to optimize the complex relationship of the different components under consideration of boundary conditions.

Content
1. Chassis: Wheel suspensions (rear axles, front axles, kinematics of axles), tyres, springs, damping devices
2. Steering elements: Manual steering, servo steering, steer by wire
3. Brakes: Disc brake, drum brake, retarder, comparison of the designs

Literature
1. Heißing, B./Ersoy, M.: Fahrwerkhandbuch: Grundlagen, Fahrdynamik, Komponenten, Systeme, Mechatronik, Perspektiven, Vieweg-Verlag, Wiesbaden, 2011

2. Breuer, B./Bill, K.-H.: Bremsenhandbuch: Grundlagen - Komponenten - Systeme - Fahrdynamik, Vieweg-Verlag, Wiesbaden, 2012

3. Gnadler, R.: Script to the lecture 'Automotive Engineering II'

Course: Basic principles of powder metallurgical and ceramic processing [2193010]

Coordinators: R. Oberacker
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (20-30 min) taking place at the agreed date. The re-examination is offered upon agreement.

Conditions
None.

Recommendations
Knowledge of basic material science is assumed

Learning Outcomes
The students know the basics of characterization of powders, pastes and suspensions. They have a fundamental understanding of the process technology for shaping of particulate systems. They are able to use these fundamentals to design selected wet- and dry forming processes.

Content
The course covers fundamentals of the process technology for shaping of ceramic or metal particle systems. Important shaping methods are reviewed. The focus is on characterization and properties of particulate systems, and, in particular, on process technology for shaping of powders, pastes, and suspensions.

Media
Slides for the lecture:
available under http://ilias.studium.kit.edu

Literature

- R.J. Brook: Processing of Ceramics I+II, VCH Weinheim, 1996
- M.N. Rahaman: Cermamic Processing and Sintering, 2nd Ed., Marcel Dekker, 2003
- W. Schatt ; K.-P. Wieters ; B. Kieback. „Pulvermetallurgie: Technologien und Werkstoffe“, Springer, 2007
- R.M. German. “Powder metallurgy and particulate materials processing. Metal Powder Industries Federation, 2005
- F. Thümmler, R. Oberacker. “Introduction to Powder Metallurgy”, Institute of Materials, 1993

Course: Fundamentals of Microwave Engineering [23406]

Coordinators: T. Zwick
Part of the modules: Kommunikationstechnik (ETIT) (p. 23)[BSc-MIT - B-PE3], Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4.5	3	Winter term	de

Learning Control / Examinations
Written exam (see actual document "Studienplan" and notice of the examination office ETIT).
Grades result from the written examination.

Conditions
None.

Recommendations
Basic knowledge of higher mathematics, of linear electrical networks, of fields and waves and of electric circuits.

Learning Outcomes
The lecture covers theoretical basics together with a first overview of microwave components and systems.

Content
This lecture is an introduction to the fundamentals of microwave engineering scheduled for Bachelor students of electrical engineering in the 5th semester. Having already prerequisites in the area of fields and waves, circuit theory as well as higher mathematics, the students are taught methods and mathematical basics for the design of microwave systems. Furthermore, the lecture will communicate the fundamentals, which are necessary for all other lectures in the area of microwave engineering.
At the beginning of the lecture the behaviour of passive devices (e.g. resistors, capacitors, inductors) at higher frequencies is analysed and the limits of reasonable usage are determined using equivalent circuits. In this context also optimum configurations for devices at higher frequencies are discussed. The various circuits for compensation of parasitic blind elements are the task of a further chapter.
One of the main fundamentals of microwave engineering is the circuit theory. After introducing the equivalent circuit and the derivation of the telegraph equation the propagation of waves on transmission lines is discussed in detail. This includes also approximations for lossy transmission lines. Starting from the transmission line theory the diverse applications of transmission lines at higher frequencies for transformation and matching as well as a blind element are given in the following. In this context the Smith diagram is introduced and discussed in detail. The description of the most important transmission line types of microwave engineering (coax line, waveguide, microstrip line) together with their characteristic parameters closes these considerations.
In the following chapter the fundamentals of microwave network analysis are treated. First, the different matrices (impedance, admittance, ABCD, scattering matrix etc.) are introduced and their application is demonstrated. The special properties of microwave networks as well as the connection of multi ports are further topics of this chapter.
After the fundamentals for a common comprehension of microwave engineering are available the next comprehensive chapter gives a first insight into the world of microwave systems. First, the most important components (antennas, propagation channel, amplifiers, mixers etc.) of microwave systems and their essential system parameters are introduced. Based on this an overview of modern microwave systems (e.g. radio wave propagation, radar) is given to grant a good first insight into microwave engineering.

Remarks
The lecture consists of the two closely intermeshed parts lecture and tutorial as well as an additional offer of Matlab based exercises. Current information is available on the webpage of the IHE (www.ihe.kit.edu).

Course: Fundamentals of catalytic exhaust gas aftertreatment [2134138]

Coordinators: E. Lox
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination, Duration: 25 min., no auxiliary means

Conditions
none

Recommendations
Combustion engines I helpful

Learning Outcomes
The students can name and explain the scientific fundamentals of the catalytic exhaust gas aftertreatment, as well as the technical, political and economical parameters of its application in engines for passenger cars and HD vehicles.

The students are able to point out and explain which emissions are formed in combustion engines, why these emissions are helth-related critical and which measures the legislator has established to reduce the emissions.

Content
1. kind and source of emissions
2. emission legislation
3. principal of catalytic exhaust gas aftertreatment (EGA)
4. EGA at stoichiometric gasoline engines
5. EGA at gasoline engines with lean mixtures
6. EGA at diesel engines
7. economical basic conditions for catalytic EGA

Literature
Lecture notes available in the lectures

1. ”Environmental Catalysis” Edited by G.Ertl, H. Knötzinger, J. Weitkamp Wiley-VCH Verlag GmbH, Weinheim, 1999 ISBN 3-527-29827-4
2. ”Cleaner Cars- the history and technology of emission control since the 1960s” J. R. Mondt Society of Automotive Engineers, Inc., USA, 2000 Publication R-226, ISBN 0-7680-0222-2
3. ”Catalytic Air Pollution Control - commercial technology” R. M. Heck, R. J. Farrauto John Wiley & Sons, Inc., USA, 1995 ISBN 0-471-28614-1
4. ”Automobiles and Pollution” P. Degobert Editions Technic, Paris, 1995 ISBN 2-7108-0676-2
5. ”Reduced Emissions and Fuel Consumption in Automobile Engines” F. Schaeder, R. van Basshuysen, Springer Verlag Wien New York, 1995 ISBN 3-211-82718-8
6. ”Autoabgaskatalysatoren : Grudlagen - Herstellung - Entwicklung - Recycling - Ökologie” Ch. Hagelüken und 11 Mitautoren, Expert Verlag, Renningen, 2001 ISBN 3-8169-1932-4

Course: Principles of Medicine for Engineers [2105992]

Coordinators: C. Pylatiuk
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
written examination

Conditions
None.

Recommendations
Organ support systems

Learning Outcomes
Students have fundamental knowledge about functionality and anatomy of organs within different medical disciplines. The students further know about technical methods in diagnosis and therapy, common diseases, their relevance and costs. Finally the students are able to communicate with medical doctors in a way, in which they prevent misunderstandings and achieve a more realistic idea of each others expectations.

Content

- Introduction: Definitions of “health” and “disease”. History of medicine and paradigm shift towards evidence based medicine and personalized medicine.
- Special topics: nervous system, saltatory conduction, musculoskeletal system, cardio-circulatory system, narcosis, pain, respiratory system, sensory organs, gynaecology, digestive organs, surgery, nephrology, orthopaedics, immune system, genetics.

Literature

- Adolf Faller, Michael Schünke: Der Körper des Menschen. Thieme Verlag.
- Renate Huch, Klaus D. Jürgens: Mensch Körper Krankheit. Elsevier Verlag.

Course: Measurement and Control Systems [2137301]

Coordinators: C. Stiller
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
7	3	Winter term	de

Learning Control / Examinations
written exam; duration 2,5 h; paper reference materials only (no calculator)

Conditions
Fundamentals in physics and electrical engineering; ordinary linear differential equations; Laplace transform

Learning Outcomes
Measurement and control of physical entities is a vital requirement in most technical applications. Such entities may comprise e.g. pressure, temperature, flow, rotational speed, power, voltage and electrical current, etc.. From a general perspective, the objective of measurement is to obtain information about the state of a system while control aims to influence the state of a system in a desired manner. This lecture provides an introduction to this field and general systems theory. The control part of the lecture presents classical linear control theory. The measurement part discusses electrical measurement of non-electrical entities.

Content
1 Dynamic systems
2 Properties of important systems and modeling
3 Transfer characteristics and stability
4 Controller design
5 Fundamentals of measurement
6 Estimation
7 Sensors
8 Introduction to digital measurement

Literature

- Measurement and Control Systems:

R.H. Cannon: Dynamics of Physical Systems, McGraw-Hill Book Comp., New York,1967
G.F. Franklin: Feedback Control of Dynamic Systems, Addison-Wesley Publishing Company, USA, 1988
R. Dorf and R. Bishop: Modern Control Systems, Addison-Wesley
C. Phillips and R. Harbor: Feedback Control Systems, Prentice-Hall

- Regelungstechnische Bücher:

J. Lunze: Regelungstechnik 1 & 2, Springer-Verlag
R. Unbehauen: Regelungstechnik 1 & 2, Vieweg-Verlag
O. Föllinger: Regelungstechnik, Hüthig-Verlag
W. Leonhard: Einführung in die Regelungstechnik, Teubner-Verlag
Schmidt, G.: Grundlagen der Regelungstechnik, Springer-Verlag, 2. Aufl., 1989

- Messtechnische Bücher:

E. Schrüfer: Elektrische Meßtechnik, Hanser-Verlag, München, 5. Aufl., 1992
U. Kiencke, H. Kronmüller, R. Eger: Meßtechnik, Springer-Verlag, 5. Aufl., 2001
H.-R. Tränkler: Taschenbuch der Messtechnik, Verlag Oldenbourg München, 1996
W. Pfeiffer: Elektrische Messtechnik, VDE Verlag Berlin 1999
Kronmüller, H.: Prinzipien der Prozeßmeßtechnik 2, Schnäcker-Verlag, Karlsruhe, 1. Aufl., 1980

Course: Introduction to Microsystem Technology I [2141861]

Coordinators: A. Guber, J. Korvink
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
written examination for implementation in a major field, 30 min oral exam for elective subject

Conditions
None.

Learning Outcomes
The lecture gives an introduction into the basics of microsystems technology. In analogy to processes employed in fabrication of microelectronics circuits the core technologies as well as materials for producing microstructures and components are presented. Finally, various techniques for Silicon micromachining are explained and illustrated with examples for micro-components and micro-systems.

Content
- Introduction in Nano- and Microtechnologies
- Silicon and processes for fabricating microelectronics circuits
- Basic physics background and crystal structure
- Materials for micromachining
- Processing technologies for microfabrication
- Silicon micromachining
- Examples

Literature
M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

Course: Introduction to Microsystem Technology II [2142874]

Coordinators: A. Guber, J. Korvink
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
written examination for major field, oral exam (30 min) for elective field

Conditions
None.

Learning Outcomes
The lecture gives an introduction into the basics of microsystems technology. In the first part, methods for lithographic pattern transfer are summarized. Then specific techniques such as the LIGA process, micro-machining, and laser-patterning are explained and examples are given. Finally assembly and packaging methods are presented leading into a discussion of entire microsystems.

Content
- Introduction in Nano- and Microtechnologies
- Lithography
- LIGA-technique
- Mechanical microfabrication
- Patterning with lasers
- Assembly and packaging
- Microsystems

Literature
M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

Course: Foundations of nonlinear continuum mechanics [2181720]

Coordinators: M. Kamlah
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
Engineering Mechanics - Advanced Mathematics

Learning Outcomes
The students understand the fundamental structure of a continuum theory consisting of kinematics, balance laws and constitutive model. In particular, they recognize non-linear continuum mechanics as a common structure including all continuum theories of thermomechanics, which are obtained by adding a corresponding constitutive model. The students understand in detail the kinematics of finite deformation and know the transition to the geometrically linear theory they are familiar with. The students know the spatial and material representation of the theory and the different related tensors. The students take the balance laws as physical postulates and understand their respective physical motivation.

Content
The lecture is organized in three parts. In the first part, the mathematical foundations of tensor algebra and tensor analysis are introduced, usually in cartesian representation. In the second part of the lecture, the kinematics, i.e. the geometry of deformation is presented. Besides finite deformation, geometric linearization is discussed. The thrid part of the lecture deals with the physical balance laws of thermomechanics. It is shown, how a special classical theory of continuum mechanics can be derived by adding a corresponding constitutive model. For the illustration of the theory, elementary examples are discussed repeatedly.

Literature
lecture notes

Course: Introduction into plasma technologies [23734]

Coordinators: R. Kling
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
Basic knowledge on plasma technologies for coatings, semiconductor production and lamps

Content

Literature
The corresponding documents are avalible under https://studium.kit.edu/

Remarks
You will find the newest Information online on https://studium.kit.edu/

Course: Fundamentals of Production Management [2581950]

Coordinators: F. Schultmann
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
5,5	2/2	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam (90 minutes) (following §4(2), 1 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes

- Students should describe the tasks of strategic corporate planning.
- Students should be able to use general approaches in order to solve these problems.

Content
This lecture focuses on strategic production management with respect to various economic aspects. Interdisciplinary approaches of systems theory will be used to describe the challenges of industrial production. This course will emphasize the importance of R&D as the central step in strategic corporate planning to ensure future long-term success.
In the field of site selection and planning for firms and factories, attention will be drawn upon individual aspects of existing and greenfield sites as well as existing distribution and supply centres. Students will obtain knowledge in solving internal and external transport and storage problems with respect to supply chain management and disposal logistics.

Media
Media will be provided on learning platform.

Literature
will be announced in the course

Course: Fundamentals of reactor safety for the operation and dismantling of nuclear power plants [2190465]

Coordinators: V. Sánchez-Espinoza
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
oral examination; duration: 20-30 minutes

Conditions
Nuclear Safety I: Fundamentals, Nuclear power plants, Nuclear thermal hydraulics

Recommendations
none

Learning Outcomes

- gain understanding for safety analysis and its methods
- get familiar with the mathematical-physical basis of numerical safety analysis codes used for the safety demonstration as well as with the role of code validation
- get familiar with the methodology to analyse design basis accidents of Light Water Reactors and with the step-by-step of the modelling of nuclear power plants with simulation tools

Content
The goal of this lecture is to impart the main elements and newest methods applied in the industry and by regulators that are needed to perform a safety assessment of nuclear power plants of generation 2 and 3 using numerical simulation tools. This lecture is focused on the deterministic safety analysis methodology; the mathematical and physical bases of numerical simulation tools used for safety demonstration and last but not least the safety criteria. The methodology and the prediction capability of Safety Analysis Tools (TRACE/PARCS, RELAP5/PARCS) widely used in industry, regulators and R&D institutions is exemplary demonstrated by analyzing selected transients and accidents of Light Water Reactors (LWR). The examples will describe the practical steps developing integral nuclear power plant models for the analysis of the normal and off-normal operation conditions. This lecture will be concentrated on the following topics:

- Safety analysis- an introduction
- Mathematical-physical basis of coupled neutronic-thermal hydraulic Best-Estimate codes
- Characterization of the plant conditions (start-up, operation, shutdown)
- Design basis accidents
- Methodologies fort he accident analysis of Pressurized and Boiling Water Reactors (PWR, BWR)
- Analysis of selected transients and accidents of PWR and BWR (RIA, LOCA, MSLB, TUSA)
- Beyond design basis accidents (physical phenomena and simulation tools)

Course: Basics of Technical Logistics [2117095]

Coordinators: M. Mittwollen, V. Madzharov
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
after each lesson period; oral / written (if necessary) => (look at "Studienplan Maschinenbau", latest version)

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe processes and machines of technical logistics,
- Model the fundamental structures and the impacts of material handling machines with mathematical models,
- Refer to industrially used machines and
- Model real machines applying knowledge from lessons and calculate their dimensions.

Content
Bases effect model of conveyor machines made for the change of position and orientation; conveyor processes; identification systems; drives; mechanical behaviour of conveyors; structure and function of conveyor machines; elements of intralogistics
sample applications and calculations in addition to the lectures inside practical lectures

Media
supplementary sheets,projector, blackboard

Literature
Recommendations during lessons

Course: Fundamentals of Combustion I [2165515]

Coordinators: U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Compulsory elective subject: Written exam.
In SP 45: oral exam.

Conditions
None

Recommendations
None

Learning Outcomes
After completing this course students are able to:

- explain the chemical and physical processes gorverning combustion.
- discuss diagnostic methods apllied in combustion science.
- describe laminar and turbulent flames in a mathematical way.
- analyse the working principle of various technical combustion systems (e. g. piston engines, gas turbines, furnaces).

Content

- Ignition processes
- Fundamental concepts ans phenomena
- Experimental analysis of flames
- Conservation equations for laminar flat flames
- Chemical reactions
- Chemical kinetics mechanisms
- Laminar premixed flames
- Laminar diffusion flames

Media
Blackboard and Powerpoint presentation

Literature
Lecture notes,
Combustion - Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, authors: U. Maas, J. Warnatz, R.W. Dibble, Springer-Lehrbuch, Heidelberg 1996

Remarks
Compulsory elective subject: 2+1 SWS and 5 LP.

Course: Fundamentals of Combustion II [2166538]

Coordinators: U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
After completing the course attendents are able to:

- explain the processes involved in ignition (auto-ignition and induced ignition).
- describe the governing mechanisms in combustion of liquid and solid fuels.
- understand the mechanisms governing pollutant formation.
- describe turbulent reacting flows by means of simple models.
- explain the occurence of engine knock.
- outline the basic numerical schemes applied in the simulation of reacting flows.

Content

- Three dimensional Navier-Stokes equations for reacting flows
- Tubulent reactive flows
- Turbulent non-premixed flames
- Turbulent premixed flames
- Combustion of liquid and solid fuels
- Engine knock
- NOx formation
- Formation of hydrocarbons and soot
- Thermodynamics of combustion processes
- Transport phenomena

Media
Blackboard and Powerpoint presentation

Literature
Lecture notes;
Combustion - Physical and Chemical Fundamentals, Modeling and Simulation,Experiments, Pollutant Formation; Authors: U. Maas, J. Warnatz, R.W. Dibble, Springer; Heidelberg, Karlsruhe, Berkley 2006

Course: Grundlagen der Wahrscheinlichkeitstheorie und Statistik für Studierende der Informatik [0133500]

Coordinators: N. Henze, D. Hug
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature
Elective literature:
Henze/Kadelka: Skript zur Vorlesung „Wahrscheinlichkeitstheorie und Statistik für Studierende der Informatik“

Course: Optical Flow Measurement: Fundamentals and Applications [2153410]

Coordinators: F. Seiler, B. Frohnapfel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary means

Conditions
none

Learning Outcomes
The students can thoroughly describe the introduced optical measurement techniques. From recently achieve results in shock tunnels, they are able to explain the working principle(s) of the most important registration and visualization methods working with either tracer scattering or with the information obtained with light passing directly the measuring regime. Particularly, the students are qualified to comparatively discuss the measurement techniques for velocity, density and gas temperature (listed below) and can furthermore illustrate their working principles with examples:

- shadowgraph techniques
- Schlieren method
- Mach/Zehnder- and Differential interferometer
- Particle Image Velocimetry (PIV)
- Doppler Global Velocimetry (DGV)
- Doppler picture velocimetry (DPV)
- classical single-beam
- cross-beam anemometry
- interference velocimetry
- CARS-method
- laser-induced fluorescence (LIF)

Content

- Visualisations techniques
- Techniques for local point-wise measurement
- Techniques using light scattering methods
- Laser-induced fluorescence

Literature
H. Oertel sen., H. Oertel jun.: Optische Strömungsmeßtechnik, G. Braun, Karlsruhe

F. Seiler: Skript zur Vorlesung über Optische Strömungsmeßtechnik

Course: Fundamentals for Design of Motor-Vehicles Bodies I [2113814]

Coordinators: H. Bardehle
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations
Oral group examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of the fundamental possibilities for design and manufacture of motor-vehicle bodies. They know the complete process, from the first idea, through the concept to the dimensioned drawings (e.g. with FE-methods). They have knowledge about the fundamentals and their correlations, to be able to analyze and to judge relating components as well as to develop them accordingly.

Content
1. History and design

2. Aerodynamics

3. Design methods (CAD/CAM, FEM)

4. Manufacturing methods of body parts

5. Fastening technologie

6. Body in white / body production, body surface

Literature
1. Automobiltechnische Zeitschrift ATZ, Friedr. Vieweg & Sohn Verlagsges. mbH, Wiesbaden
2. Automobil Revue, Bern (Schweiz)
3. Automobil Produktion, Verlag Moderne Industrie, Landsberg

Course: Fundamentals for Design of Motor-Vehicles Bodies II [2114840]

Coordinators: H. Bardehle
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Oral group examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students know that, often the design of seemingly simple detail components can result in the solution of complex problems. They have knowledge in testing procedures of body properties. They have an overview of body parts such as bumpers, window lift mechanism and seats. They understand, as well as, parallel to the normal electrical system, about the electronic side of a motor vehicle. Based on this they are ready to analyze and to judge the relation of these single components. They are also able to contribute competently to complex development tasks by imparted knowledge in project management.

Content
1. Body properties/testing procedures

2. External body-parts

3. Interior trim

4. Compartment air conditioning

5. Electric and electronic features

6. Crash tests

7. Project management aspects, future prospects

Literature
1. Automobiltechnische Zeitschrift ATZ, Friedr. Vieweg & Sohn Verlagsges. mbH, Wiesbaden
2. Automobil Revue, Bern (Schweiz)
3. Automobil Produktion, Verlag Moderne Industrie, Landsberg

Course: Fundamentals in the Development of Commercial Vehicles I [2113812]

Coordinators: J. Zürn
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations
Oral group examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have proper knowledge about the process of commercial vehicle development starting from the concept and the underlying original idea to the real design. They know that the customer requirements, the technical realisability, the functionality and the economy are important drivers.
The students are able to develop parts and components. Furthermore they have knowledge about different cab concepts, the interior and the interior design process. Consequently they are ready to analyze and to judge concepts of commercial vehicles as well as to participate competently in the commercial vehicle development.

Content
1. Introduction, definitions, history
2. Development tools
3. Complete vehicle
4. Cab, bodyshell work
5. Cab, interior fitting
6. Alternative drive systems
7. Drive train
8. Drive system diesel engine
9. Intercooled diesel engines

Literature
1. Marwitz, H., Zittel, S.: ACTROS – die neue schwere Lastwagenbaureihe von Mercedes-Benz, ATZ 98, 1996, Nr. 9

2. Alber, P., McKellip, S.: ACTROS – Optimierte passive Sicherheit, ATZ 98, 1996

3. Morschheuser, K.: Airbag im Rahmenfahrzeug, ATZ 97, 1995, S. 450 ff.

Course: Fundamentals in the Development of Commercial Vehicles II [2114844]

Coordinators: J. Zürn
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Oral group examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students know the advantages and disadvantages of different drives. Furthermore they are familiar with components, such as transfer box, propeller shaft, powered and non-powered frontaxle etc. Beside other mechanical components, such as chassis, axle suspension and braking system, also electric and electronic systems are known. Consequently the student are able to analyze and to judge the general concepts as well as to adjust them precisely with the area of application.

Content
1. Gear boxes of commercial vehicles
2. Intermediate elements of the drive train
3. Axle systems
4. Front axles and driving dynamics
5. Chassis and axle suspension
6. Braking System
7. Systems
8. Excursion

Literature
1. Schittler, M., Heinrich, R., Kerschbaum, W.: Mercedes-Benz Baureihe 500 – neue V-Motorengeneration für schwere Nutzfahrzeuge, MTZ 57 Nr. 9, S. 460 ff., 1996

2. Robert Bosch GmbH (Hrsg.): Bremsanlagen für Kraftfahrzeuge, VDI-Verlag, Düsseldorf, 1. Auflage, 1994

3. Rubi, V., Strifler, P. (Hrsg. Institut für Kraftfahrwesen RWTH Aachen): Industrielle Nutzfahrzeugentwicklung, Schriftenreihe Automobiltechnik, 1993

Course: Fundamentals of Automobile Development I [2113810]

Coordinators: R. Frech
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations
Written examination

Duration: 90 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of the fundamentals of the development of automobiles. They know the development process, the national and the international legal requirements that are to be met. They have knowledge about the thermo-management, aerodynamics and the design of an automobile. They are ready to judge goal conflicts in the field of automobile development and to work out approaches to solving a problem.

Content
1. Process of automobile development
2. Conceptual dimensioning and design of an automobile
3. Laws and regulations – National and international boundary conditions
4. Aero dynamical dimensioning and design of an automobile I
5. Aero dynamical dimensioning and design of an automobile II
6. Thermo-management in the conflict of objectives between styling, aerodynamic and packaging guidelines I
7. Thermo-management in the conflict of objectives between styling, aerodynamic and packaging guidelines II

Literature
The scriptum will be provided during the first lessons

Course: Fundamentals of Automobile Development II [2114842]

Coordinators: R. Frech
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Written examination

Duration: 90 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are familiar with the selection of appropriate materials and the choice of adequate production technology. They have knowledge of the acoustical properties of the automobiles, covering both the interior sound and exterior noise. They have an overview of the testing procedures of the automobiles. They know in detail the evaluation of the properties of the complete automobile. They are ready to participate competently in the development process of the complete vehicle.

Content
1. Application-oriented material and production technology I
2. Application-oriented material and production technology II
3. Overall vehicle acoustics in the automobile development
4. Drive train acoustics in the automobile development
5. Testing of the complete vehicle
6. Properties of the complete automobile

Literature
The scriptum will be provided during the first lessons.

Course: Semiconductor Components [23456]

Coordinators: C. Koos
Part of the modules: Bauelemente der Elektrotechnik (ETIT) (p. 22)[BSc-MIT - B-PE2], Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2+1	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Quantum Functional Devices and Semiconductor Technology [23476]

Coordinators: M. Walther
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment will consist of a oral exam (20 min) (following §4 (2), 2 of the examination regulation).

Conditions
None.

Learning Outcomes
Students

- will be proficient in the basics of optical and electrical devices with carrier confinement
- will understand carrier confinement effects in low-dimensional systems for optical and electrical devices
- acquire knowledge in the technology for realization of modern semiconductor devices
- will deal with future trends and scaling limits in micro- and opto-electronics.

Content
Fundamental properties of quantum functional devices
Heterostructures and band gap engineering
Carrier confinement in 2-, 1- and 0-dim structures
Quantum functional compound semiconductor devices
High electron mobility transistors
Quantum well, quantum dot and quantum cascade lasers
Infrared detectors
Compound semiconductor technology
Epitaxy, lithography, etching and deposition
Future trends in microelectronics
Scaling limits, Moore's law, devices beyond Moore

Media
script

Remarks
Current information can be found on the IPQ www.ipq.kit.edu webpage.

Course: Commercial and Corporate Law [24011]

Coordinators: Z. (ZAR), O. Knöfel
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Winter term	de

Learning Control / Examinations
The assesment ist explained in the module description

Conditions
None.

Recommendations
It is recommended to attend the lecture *BGB for Advanced* [24504] in advance.

Learning Outcomes
the student is able to overview the specifics of commercial transactions, commercial agency and the law of merchants. Moreover, he knows the forms of organization available in German company law.

Content
The lecture begins with an introduction into the different terms of merchants of the German Commercial Code. Subsequently, the rules governing trade names, commercial registries and commercial agency are dealt with. This is followed by a presentation of the general rules of commercial transactions and of the specific commercial transactions. In company law, first of all, the basics of partnerships are explained. Thereafter, the focus will be on corporate law which is most important in practice.

Media
Slides.

Literature
Klunzinger, Eugen

- Grundzüge des Handelsrechts, Verlag Vahlen, latest edition
- Grundzüge des Gesellschaftsrechts, Verlag Vahlen, latest edition

Elective literature:
tba at the beginning of the course.

Course: Hardware Modeling and Simulation [23608 + 23610]

Coordinators: E. Sax
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	en

Learning Control / Examinations
Written Exam

Conditions
Lecture „Systems and Software Engineering“ (23605)

Learning Outcomes
By the end of this course students understand hardware description languages for different levels of abstraction (circuit, logic, algorithmic, system level) and different views (behavioural, structural, geometrical). Students understand the function of simulation kernels for logic simulators, circuit simulators and system simulators with multi-level, mixed mode modelling. Students understand sequential and concurrent statements of the hardware description language VHDL, they can apply VHDL to write models for novel designs of digital circuits. In using simulation they can interpret and predict the behaviour of a design with respect to specified functions, given timing constraints and tolerances due to variation of loads, power supply voltage, ambient temperature and manufacturing tolerances. Thus they can analyze, plan and design novel digital systems, they can optimize these circuits and systems with respect to performance, energy consumption, layout area and costs. Another aim of this lecture is to provide the students with knowledge about CAE tools and their backgrounds. To establish a more practical view, the lecture is supported by a demonstration of the tools. For better practical understanding the Design Automation Laboratory (course 23645) complements this lecture and is highly recommended.

Content
Lecture
At the beginning of the lecture the design process for integrated circuits and embedded systems is introduced. Solution strategies are given to cope with the challenges of designing complex systems. The different approaches are presented and illustrated by examples. Finally, the use of hardware description languages is motivated.
In the second part of the lecture the hardware description language VHDL presented. First, the principle structure is explained and examples for the application are given. The concepts and syntax are explained on the basis of examples. With the help of the Y-diagram the different levels of abstraction in VHDL are explained as well as the modeling of behavioral and structural descriptions. Then the representation of sequential and parallel statements and the different delay models are described in detail. Furthermore, the methodology for testing VHDL models and the use of context commands is explained. Finally, the nine-value logic system as well as the design of final state machines is explained by example. explain
The third part of the lecture deals with verification, validation and simulation. Following the system-level simulation, the logic simulation is introduced. Therefore the modeling of logical and timing behavior is clarified. The simulation process is explained on basis of the different VHDL timing models. Finally, fault-simulation with the presentation of error classes as well as the appropriate test methods are introduced. The area of circuit simulation deals with the modeling of analog circuits as well as the simulation steps. The modeling of mixed-signal systems is supported by the introduction of the VHDL-AMS extension. In the area of the physical level simulation, semiconductor process simulation methods and the finite element method are explained. The areas of rule checking and formal verification deal with the plausibility criteria and the compliance of implementation and specification.
In the last part of the lecture, the modeling language Verilog is being compared to VHDL and an overview of system modeling in System C is given.

Literature
Online material is available on: ILIAS. Literature references are given in lecture slides.

Remarks
The course comprises of the blocks lecture and exercises. Current information can be found on the ITIV (www.itiv.kit.edu) webpage and within ILIAS.

Course: Hardware-Synthesis-Optimization [23619 + 23621]

Coordinators: J. Becker
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
The students shall be able to demonstrate the capabilities for the optimized design of electronic systems.
Focus of the lecture Hardware-Synthesis-Optimization is on the transfer of formal and methodological basics for design of electronic systems. The selection of the algorithms discussed in the lecture is driven by their practical application and their importance for the industry.
The accompanying exercises intend to consolidate the knowledge from the lectures. Selected topics will be repeated and by working on theoretical and practical examples the students will learn to apply the methods in modern system design.

Content
This lecture presents fundamental and advanced algorithmic methods which are used at the automated synthesis of microelectronic circuits inside modern CAD-tools. Besides theoretical discussions the presented methods will be elaborated by the means of numerous examples and a relationship to practical applications will be established. In this connection the spectrum of system and circuit realization starting from the behavioral description of an hardware description language up to the synthesis and optimization of a gate netlist and the generation of the of physical layouts of today's standard cell technology are expatiated. The presented methods are organized in high-level synthesis, register transfer synthesis, logic synthesis and the physical design as well.
The following themes are treated:

-
- Design process using computer-aided design
- Relevant graph algorithms and complexity
- Various design methods
- for gate arrays, standard cells, macro cells, reconfigurable hardware
- High-level-synthesis
- Scheduling methods, algorithms for allocation and binding
- Register-transfer-synthesis
- Optimization of Controllers, Retiming of datapathes
- Logic-synthesis
- Two-stage and multi-stage logic optimization
- Technology-mapping of an optimized gate netlist
- Physical design methods
- Various algorithms for partitioning, simulated annealing, genetical optimization
- Floorplanning-, routing- and placement methods
- Global and detailed wiring mechanisms

- Rapid-Prototyping
- Emulation/simulation, technology and ascertained prototyping-systems,
- Application examples

Literature
Online material is available on: ILIAS

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the ITIV (www.itiv.kit.edu) webpage and within ILIAS.

Course: Hardware/Software Codesign [23620 + 23623]

Coordinators: O. Sander
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
The lecture intends to relay the knowledge about fundamentals and first principles of HW/SW Codesign. The attendance at the lecture affords the comprehension and classification of target architectures, estimation methods of design quality in early phases of system design as well as partitioning strategies of HW/SW based systems.
The lecture presents theoretical fundamentals for the concurrent and interlocked design of a system's hardware and software components. The practical application of these principles is shown on several examples of actual hardware and software components.
The accompanying exercises intend to consolidate the knowledge from the lectures. Selected topics will be repeated and, by working on theoretical and practical examples, the students will learn to apply the methods in modern system design.

Content
Hardware/Software Co-design is the denomination of the concurrent and interlocked design of a system's hardware and software components. The most modern embedded systems (for example mobile phones, automotive and industrial controller devices, game consoles, home cinema systems, network routers) are composed of cooperating hardware and software components. Enabled by the rapid progress in microelectronics, embedded systems are becoming increasingly more complex with manifold application specific criteria. The deployment of computer aided design tools is not only necessary for handling the increasing complexity, but also for reducing the design costs and time-to-market. The lecture Hardware/Software Codesign discusses the needed criteria & methods and possible hardware/software target architectures on following topics:

-
- Target architectures of HW/SW-systems
- DSP, microcontrollers, ASIPs, FPGAs, ASIC, System-on-Chip
- Processor design: Pipelining, superscalar, cache, VLIW
- Estimation of design quality
- Hardware- and software-performance
- Methods for hardware/software partitioning
- Iterative and constructive heuristics
- Interface and communications synthesis

Literature

-
- J. Teich, C. Haubelt: „Digitale Hardware/Software-Systeme-Synthese und Optimierung“, Springer-Verlag, 2007 (2. Auflage)
- D.D. Gajski, F. Vahid, S. Narayan, J. Gong: „Specification and Design of Embedded Systems“, Prentice Hall, 1994

- Online material is available on: ILIAS

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the ITIV (www.itiv.kit.edu) webpage and within ILIAS.

Course: Heterogeneous Parallel Computing Systems [24117]

Coordinators: W. Karl
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes

Content

Media
Slides

Course: Semiconductor Circuits for microwave and millimeter-wave application [23419 + 23421]

Coordinators: T. Zwick
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Recommendations
Fundamentals of Microwave Engineering (recommended)

Learning Outcomes
To convey the theory and implementation of linear millimeter-wave monolithic integrated circuits.
This lecture conveys the theory and implementation of millimeter-wave monolithic integrated circuits (MMICs). The focus is on active linear circuits for applications up to and beyond 300 GHz as well as oscillators. The components and building blocks MMICs and their operating principle are covered.
Using a modern CAD design environment, actual circuit examples from the lecture will be implemented. Besides the circuit design and analysis, the physical layout of the MMIC will be carried out.

Content
Lecture
The advances in speed and efficiency of modern transistor technologies enable the availability of the entire millimeter wave frequency range for compact, cost-effective, active electronics.
Based on the lecture "Fundamentals of Microwave Engineering", the building blocks of active, linear circuits for the microwave and millimeter-wave frequency range are treated. The key components are passive linear elements, such as transmission lines, capacitors and inductors, and active elements such as transistors.
The working principle of the passive elements and their application in MMICs is covered. The transistor technologies that are suitable for the frequency ranges are introduced and their advantages and disadvantages are discussed.
The second part of the course introduces design concepts and implementation of an analogue front end in the millimeter wave range. The focus lies on linear components including low noise amplifiers, broadband traveling wave amplifiers. In the design of nonlinear circuits concepts for power amplifiers and oscillator are discussed.
Beyond the principles of circuit design and layout each chapter also covers aspects of circuit-oriented modeling and analysis of relevant characteristics.
In addition to the latest III-V compound semiconductor-based technologies, the lecture also deals with recent developments in the field of silicon transistor technology and develops an understanding of the respective advantages and limitations.
The lecturer reserves the right to alter the contents of the course without prior notification.
Exercises
Accompanying the lecture the treated circuit are evaluated in a Simulation with recent CAD tools during the tutorials. Additionally necessary techniques and procedures during the development of processable MMICs are covered.

Media
Lecture, CAD design hands-on

Literature
Material to the lecture can be found online at www.ihe.kit.edu.

Remarks
Current information can be found at the internet page of the IHE (www.ihe.kit.edu).

Course: High Power Converters [23319]

Coordinators: M. Braun
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral Exam

Conditions
Basics of electrical Engineering

Learning Outcomes
Function and performance of power electronic circuits
Specialized lecture. The main topic is the treatment of mains controlled converters with diodes and thyristors: AC-DC converter, cycloconverter and phase controlled AC converter. Further, the application aspects and the protection of power semiconductors are treated.

Content
Lecture
The content of the lecture are power electronic circuits using diodes and thyristors. The circuits are presented and analyzed.
Firstly, the basic performance under ideal conditions is given. Secondly, the influence of real conditions is added.
Following topics are trated in detail:
Mains commutated Power converters under idealized conditions, transformers for power electronic power circuits, mains commutated power converters under real conditions, 12-pulse power converters, cycloconverter, High Voltage DC Transmission systems, 1 phase and 3 phase ac voltage controller, influence on the mains power quality, Power semiconductors for mains commutated converters, snubbers and protection.

Literature
Printed lecture material is available at secretary of ETI. Proposals for literature are listed there, for example: Heumann;K.:Grundlagen der Leistungselektronik, Teubner Studienbücher Elektrotechnik, B.G. Teubner Stuttgart 1996

Remarks
The lecture is considered as first part of the topic Power Electronics.

Course: High-Voltage Test Technique [23392/23394]

Coordinators: R. Badent
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam according to Section 4 (2), 2 of the examination regulation.

Conditions
None.

Recommendations
High-Voltage-Technology I and II

Learning Outcomes
The student can measure partial discharges, can conduct On-site testings and is able to check cables and accessories. Furthermore he can use and design computer aided test systems and create the necessary conditions for the accreditation of test
laboratories.

Content

- High voltage test technique
- PD-measurement
- Transformer testing
- Cable and garniture
- Switchyard
- Insulators and overhead pipeline fittings
- Computer based test systems in the area of high voltage testing
- Accreditation of test laboratories

Literature
Elective literature:
Küchler, A.; Hochspannungstechnik, Springer Verlag 2005

Course: High-Voltage Technology I [23360/23362]

Coordinators: R. Badent
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	de

Learning Control / Examinations
See German version.

Conditions
Basic Network and Field Theory

Learning Outcomes
The students know how to calculate electric fields with the help of numeric or graphical methods.

Content

- Electric potential fields
- Maxwell's equations
- Calculation of static electric fields, charge simulation method
- Difference method, Finite-Element method, Monte-Carlo method, Boundary-element method
- Graphical field evaluation
- Measurement of electric fields, field energy and field forces
- Polarization, boundary layers, inclusions, DC and AC voltage distribution in imperfect dielectrics
- Frequency and temperature dependency of the dissipation factor
- Generation of high DC/AC and impulse voltages and high impulse currents for testing

Literature
Küchler, Andreas; Hochspannungstechnik, Springer Verlag 2. Auflage 2005, ISBN 3-540-21411-9

Course: High-Voltage Technology II [23361/23363]

Coordinators: R. Badent
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam according to Section 4 (2), 1 of the examination regulation.

Conditions
High-Voltage Technology I

Learning Outcomes
The students can dimension, design and calculate high-voltage generators for the generation of high direct current, AC voltage and pulse voltage.

Content
Gas discharges, gaseous electronics, atomic energy niveaus, self-sustained and nonselfsustained discharges
Townsend mechanisms, channel mechanism, similarity laws, Paschen's law
Glow discharges, sparks, arcs, partial discharges, breakdown of liquid and solid dielectrics Statistics of electrical breakdown
Insulation coordination, roots of overvoltage's, trans-mission line equations, travelling wave theory

Literature
Elective literature:
Küchler, A. Hochspannungstechnik; Springer Verlag, 2005

Course: Advanced Mathematics I [0131000]

Coordinators: A. Kirsch, T. Arens, F. Hettlich
Part of the modules: Advanced Mathematics (p. 13)[BSc-Modul 01, HM]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Winter term	de

Learning Control / Examinations
non graded (precondition for the admission to the examination): certificate of homeworks graded: written examination

Conditions
Homework is mandatory and a precondition to take part at the exam "AM I".

Learning Outcomes
The students know the basic facts and tools of one dimensional analysis.

Content
Basic concepts, sequences and convergence, functions and continuity, series, differntial calculus of one variable, integral calculus

Literature
Burg, Haf, Wille: Höhere Mathematik für Ingenieure,
Merziger, Wirth: Repetitorium der höheren Mathematik,
Arens, Hettlich et al: Mathematik

Course: Advanced Mathematics II [0180800]

Coordinators: A. Kirsch, T. Arens, F. Hettlich
Part of the modules: Advanced Mathematics (p. 13)[BSc-Modul 01, HM]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Summer term	de

Learning Control / Examinations
precondition for the admission to the examination: certificate of homeworks (non graded)
written examination (graded)

Conditions
Homework is mandatory and a precondition to take part at the exam "AM 2".

Recommendations
cours of 1st semester

Learning Outcomes
The students know the basics on vector spaces and multi-dimensional calculus and the basic techniques to solve differential equations.

Content
vector spaces, differential equations, Laplace transform, vector-valued functions of several variables

Literature
Burg, Haf, Wille: Höhere Mathematik für Ingenieure,
Merziger, Wirth: Repetitorium der höheren Mathematik,
Arens, Hettlich et al: Mathematik

Course: Advanced Mathematics III [0131400]

Coordinators: A. Kirsch, T. Arens, F. Hettlich
Part of the modules: Advanced Mathematics (p. 13)[BSc-Modul 01, HM]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Winter term	de

Learning Control / Examinations
precondition for the admission to the examination: certificate for homeworks (non graded)
written examination (graded)

Conditions
Homework is mandatory and a precondition to take part at the exam “AM 3”.

Recommendations
courses of 1st and 2nd semester

Learning Outcomes
The students know techniques and applications of the multi-dimensional calculus (vector calculus) and have basic knowledge on partial differential equations and stochastics.

Content
Applications of multi-dimensional calculus, domain integral, vector analysis, partial differential equations, Fourier theory, stochastics

Literature
Burg, Haf, Wille: Höhere Mathematik für Ingenieure,
Merziger, Wirth: Repetitorium der höheren Mathematik,
Arens, Hettlich et al: Mathematik

Course: Hybrid and Electric Vehicles [23321]

Coordinators: M. Doppelbauer, M. Schiefer
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
written exam (2 h)

Conditions
none

Recommendations
none

Learning Outcomes
The students are able to understand the technical functionality of all drive components of hybrid and electric vehicles and their interaction in the drive train. They possess detailed knowledge about all drive components, in particular batteries and fuel cells, power electronics and electric machines including gears. Moreover they know the different drive train topologies and theirs specific advantages and disadvantages. The students can evaluate the technical, economical and ecological impact of alternative automotive drive technologies.

Content
Starting with the mobility needs of the modern industrialized society and the political goals concerning climate protection, the different drive and charge concepts of battery-electric and hybrid-electric vehicles are introduced and evaluated. The lecture gives a wide overview on all needed components such as electric drive trains, especially batteries, chargers, DC/DC-converters, DC/AC-converters, electrical machines and gear drives.
Structure:
Hybrid automotive drive trains
Electric automotive drive trains
Driving resistance and energy consumption
Control strategies
Energy storage systems
Fundamentals of electric machines
Induction machines
Synchronous machines
Special machines
Power electronics
Charging
Enviroment
Automotive examples
Requirements and specifications

Media
Slides

Literature

-
- Peter Hofmann: Hybridfahrzeuge – Ein alternatives Antriebskonzept für die Zukunft, Springer-Verlag, 2010
- L. Guzzella, A. Sciarretta: Vehicle Propulsion Systems – Introduction to Modeling and Optimization, Springer Verlag, 2010
- Konrad Reif: Konventioneller Antriebsstrang und Hybridantriebe – Bosch Fachinformation Automobil, Vieweg+Teubner Verlag, 2010
- Rolf Fischer: Elektrische Maschinen, Carl Hanser Verlag München, 2009
- Joachim Specovius: Grundkurs Leistungselektronik, Vieweg+Teubner Verlag, 2010

Remarks

The lecture slides can be downloaded from the institute's homepage at the beginning of the semester. Due to organizational reasons a certificate of attendance cannot be issued.

Course: Hydraulic Fluid Machinery I (Basics) [2157432]

Coordinators: M. Gabi
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter term	de

Learning Control / Examinations
Oral or written examination (see anouncement)
No tools or reference materials may be used during the exam.

Conditions
2157432 (Hydraulic Machinery) can not be combined with the event 2157451 (Wind and Hydropower)

Recommendations
2153412 Fluid mechanics

Learning Outcomes
Students get to know the basics of hydraulic fluid machinery (pumps, fans, hydroturbines, windturbines, hydrodynamic transmissions) in general. Application of the knowledge in different fields of engineering.
The lecture introduces the basics of Hydraulic Fluid Machinery. The different types and shapes are presented. The basic equations for the preservation of mass, momentum and energy are discussed. Velocity schemes in typical cascades are shown, the Euler equation of fluid machinery and performance characteristics are deduced.
Similarities and dimensionless parameters are discussed. Fundamental aspects of operation and cavitation are shown.
Students are able to understand the working principle of Hydraulic Fluid Machinery as well as the interaction with typical systems, in which they are integrated.

Content

1. Introduction
2. Basic equations
3. System analysis
4. Elementary Theory (Euler's equation of Fluid Machinery)
5. Operation and Performance Characteristics
6. Similarities, Specific Values
7. Control technics
8. Wind Turbines, Propellers
9. Cavitation
10. Hydrodynamic transmissions and converters

Literature

1. Fister, W.: Fluidenergiemaschinen I & II, Springer-Verlag
2. Bohl, W.: Strömungsmaschinen I & II . Vogel-Verlag
3. Gülich, J.F.: Kreiselpumpen, Springer-Verlag
4. Pfleiderer, C.: Die Kreiselpumpen. Springer-Verlag
5. Carolus, T.: Ventilatoren. Teubner-Verlag
6. Kreiselpumpenlexikon. KSB Aktiengesellschaft
7. Zierep, J., Bühler, K.: Grundzüge der Strömungslehre. Teubner-Verlag

Course: Hydraulic Fluid Machinery II [2158105]

Coordinators: S. Caglar, M. Gabi
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: ca. 30 minutes
No tools or reference materials may be used during the exam.

Conditions
Hydraulic Fluid Machinery I (Basics)

Recommendations
2153412 Fluid mechanics

Learning Outcomes
Students get to know advanced basics of hydraulic fluid machinery (pumps, fans, hydroturbines, windturbines, hydrodynamic transmissions). Application of the knowledge in different fields of engineering.
The lecture introduces, based on the lecture Hydraulic Fluid Machinery I, advanced knowledge in the field of design and operation. The different types and shapes are discussed.
Students are able to understand the working and design principle of Hydraulic Fluid Machinery as well as the interaction with typical systems, in which they are integrated.

Content
Rotodynamic pumps and fans of different types of construction
Hydro turbines
Wind turbines
Hydrodynamic transmissions

Literature

1. Fister, W.: Fluidenergiemaschinen I & II, Springer-Verlag
2. Siegloch, H.: Strömungsmaschinen, Hanser-Verlag
3. Pfleiderer, C.: Kreiselpumpen, Springer-Verlag
4. Carolus, T.: Ventilatoren, Teubner-Verlag
5. Bohl, W.: Ventilatoren, Vogel-Verlag
6. Raabe, J.: Hydraulische Maschinen, VDI-Verlag
7. Wolf, M.: Strömungskupplungen, Springer-Verlag
8. Hau, E.: Windkraftanlagen, Springer-Verlag

Course: Hydrodynamic Stability: From Order to Chaos [2154437]

Coordinators: A. Class
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral
Duration: 30 minutes
Auxiliary means: none

Conditions
Mathematics

Learning Outcomes
The studends can apply the analytic and numerical methods for an evaluation of stability properties of hydrodynamic systems. The are qualified to discuss the characteristic influence of parameter changes (e.g. Renolds number) on the calculated results with respect to the flow character and properties (e.g. transition laminar/turbulent flow).

Content
Increasing a control parameter of a thermohydraulic system, e.g. the Reynolds number, the initial flow pattern (e.g. stationary flow) can be replaced by a different pattern (e.g. turbulent flow).
Typical hydrodynamic instabilities are summarized in the lecture.
The systematic analysis of thermohydraulic stability problems is developed for the case of Rayleigh-Bernard convection (fluid layer heated from below) and selected examples from fluid dynamics.
Covered is:

- linear stability analysis: determine limiting control parameter value up to which the basic flow pattern is stable against small perturbations.
- nonlinear reduced order modeling, capable to characterize more complex flow patterns
- Lorenz system: a generic system exhibiting chaotic behavior

Media
Black board

Literature
Script

Remarks
Lecture also offered as a block-lecture within the AREVA Nuclear Professional School (www.anps.kit.edu)

Course: Industrial aerodynamics [2153425]

Coordinators: T. Breitling, B. Frohnapfel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary means

Conditions
None.

Learning Outcomes
Students can describe the different challenges of aerdynamical flow that occur in vehicles. They are qualified to analyze external flows around the vehicles, flows in the passenger compartments (thermal comfort), as well as cooling flows, charge motion, mixing and combustion processes in the engine.

Content
This compact lecture deals with flow, mixing and combustion phenomena with significance in vehicle development. A special focus is set on the optimization of external car and truck aerodynamics, thermal comfort in passenger compartments, analyses of cooling flows and improvement of charge motion, mixing and combustion in piston engines. These fields are explained in their phenomenology, the corresponding theories are discussed and the tools for measurement and simulation are introduced and demonstrated. The focus of this lecture is on industry relevant methods for analyses and description of forces, flow structures, turbulence, flows with heat transfer and phase transition and reactive flows. In addition an introduction to modern methods in accuracy control and efficiency improvement of numerical methods for industrial use is given. The integration and interconnection of the methods in the development processes are discussed examplary.
An excursion to the Daimler AG wind tunnel and the research and development centers is planned.

- Industrial flow measurement techniques
- Flow simulation and control of numerical errors, turbulence modeling
- Cooling flows
- Flow mixing and combustation at direct injected Diesel engines
- Flow mixing and combustation at gasoline engine
- Vehicle aerodynamics
- HVAC-Systems and thermal comfort
- Aeroacoustics

Literature
Script

Remarks
Block course with limited number of participants, registration in the secretary's office required. See details at www.istm.kit.edu

Course: Introduction to Industrial Production Economics [2109042]

Coordinators: S. Dürrschnabel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Elective Subject: oral exam (approx. 30 min)
Optional Subject: oral exam (approx. 30 min)
The exam is offered in German only!

Conditions
Registration for the lecture via ILIAS is required.

Learning Outcomes

- The students know the possible organisational structures for enterprises.
- The students learn about the importance of process data as basis for efficient work structuring.
- The students are able to execute and evaluate time studies in industry (e. g. REFA).
- The students know different methods for the evaluation of workplaces.
- The students know basic techniques for the determination of wages.
- The students are able to make a cost calculation for a specific product.

Content

- Design of structural and process organisation
- Execution and evaluation of time studies
- Actual tools for time studies, e.g. Work Sampling, Methods-Time Measurement, Planned times,
- Evaluation of workplaces and determination of wages
- Cost accounting (including process costs)

Literature
Handout and literature are available on ILIAS for download.

Course: Industrial Microwave and Materials Processing Technology [23445]

Coordinators: L. Feher
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral Exam

Conditions
Basic lectures on Electrical Engineering and HF-technology

Learning Outcomes
The goal is to relay theoretical and applied fundamentals with industrial background
Focuses of the lecture are formal, methodical, mathematical and electrotechnical fundamentals for the design and built up of energy efficient microwave systems. Detailed themes in materials science connecting the electromagnetic action by exposition to microwaves from the microscopic level to the thermal equilibrium are pointed out. Model extensions of Maxwell´s equations with basic methods of quantum theory are opposed. In the main focus of material science relevant materials and their fields of application for aerospace, automotive and chemical industry as well their manufacturing processes are conveyed.

Content
Lecture
The lecture gives at first an introduction on the special field "Industrial Microwave Technology". By this the fundamentals of electromagnetic waves, technical frequency bands and power levels as well as the related microwave measurement technology are presented.
Afterwards industrial applications are treated for aerospace, automotive, CFRP lightweight structural design and processing, food preparation, wood processing, conventional thermal processing and industrial ovens as the novel HEPHAISTOS-technology that is based on microwaves. The unique advantages of microwave processes can be clearly relayed on these examples. To describe the important material science fundamentals and their regularities the structure of technical materials for industrial processing like ceramics and sintering, metals and alloys, organic materials (polymers and laminates) and their synthesis are considered individually. Thereby also relevant themes like reaction kinetics, laws for ideal and non-ideal gases, polymerization, plastics and composites, as well as their mechanical material properties and related testing procedures are described. Another chapter considers the coupling of microwaves as the centre topic of dielectric heating. By this the Debye theory, classical polarization methods, fundamentals of quantum theory, biological action of electromagnetic waves and hazards, radiation and exposure limits and the physics of microwave heating of water are described. To get a consolidation on the theoretical methods, electromagnetic wave propagation is derived from Maxwell´s equations as well the advantageous treatment by vector potential notation. Optical methods and their generalization are derived by Helmholtz equations. Numerical methods are discussed by means of the calculations and commercial simulation packages for different fields of application are presented for their use. In another chapter, the generation of microwaves, microwave sources, magnetrons, klystrons, gyrotrons are considered as well as the fundamentals of applicators and oven systems, monomode and multimode systems. The topic transmission devices, waveguides, radiation coupling by slots and their calculation procedures represent an important methodical focal point for the student electrical engineers. The measurement of dielectric constants/parameters as well as an overview of dielectric constants for different frequencies and temperatures is declared in theory, as well as their experimental and technical realization. In another chapter about the automation of processes and systems, the fundamentals of signal theory for controlling and measuring, programming of SPS devices as well power supplies and their related components are discussed.
The lecturer reserves the right to alter the contents of the course without prior notification.

Literature
The lecture is accompanied by the book published in Springer Verlag „Energy efficient Microwave Systems“ (ISBN: 978-3-540-92121-9).
Material to the lecture can be found online at www.ihe.kit.edu.

Remarks
Current information can be found at the internet page of the IHE (www.ihe.kit.edu).

Course: Occupational Safety and Environmental Protection (in German) [2110037]

Coordinators: R. von Kiparski
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Elective Subject: oral exam (approx. 30 min)
Optional Subject: oral exam (approx. 30 min)
The exam is offered in German only!

Conditions

- Compact course (one week full-time)
- Limited number of participants; seats are assigned according the date of registration
- Registration via ILIAS is required
- Compulsory attendance during the whole lecture

Recommendations

- Knowledge of Human Factors Engineering is helpful

Learning Outcomes
The participant can

- explain the importance of occupational safety and environmental protection as well as their connection to each other.
- describe the influence of human behaviour in this context.
- explain the possibilities and limits for an engineer in this context.
- realise, wether the professional assistance of an expert of other faculties is needed.
- work through the case studies in small groups.
- evaluate and present the results of his/her work.

Content
The participants have to solve a specific case study within the field of occupational safety and environmental protection. Therefore, they work in a team. The course work covers the information research as well as the presentation of the results.

Content:

- Occupational Safety and Safety Engineering
- Environmental Protection within a Production Enterprise
- Health Management

Structure:

- Terminology
- Basics of Occupational Safety and Environmental Protection

- Case Study
- Moderated Processing of a Case Stuy within a Small Group

Literature
Handout and literature are available on ILIAS for download.

Course: Computer Science for Engineers [2121390]

Coordinators: J. Ovtcharova, S. Rogalski
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	2	Winter term	de

Learning Control / Examinations
Written examination

Duration: 3 hours (compulsory subject)

Auxiliary means: none

Conditions
Examination prerequisite: passed Lab Course [2121392]

Recommendations
None.

Learning Outcomes
The students can identify, explain and assign the repective context to the fundamental terms of information technology, such as data, signals, information, numeral systems, propositional logic, computer architectures, data structures, algorithms, database managements systems as well as the related concepts and theories.
In addition, they can efficiently implement the underlying theorys and concepts in form of procedural and object-oriented (Java) programs as well as analyze the source code and its corresponding function.

Content
Basics: Information representation- and processing, terms and definitions: alphabet, data, signals, information, numeral systems, propositional logic and Boolean algebra, computer architectures, programming paradigms.
Object Orientation: Definition and important characteristics of object orientation, Object-oriented modeling with UML.
Data Structures: Definition, properties and application of graphs, trees, linked lists, queues and stacks.
Algorithms: Characteristics of algorithms, complexity analysis, design methods, important examples.
Database management systems: Relational data model, relational algebra, declarative language SQL

Literature
Lecture notes
Robert Sedgewick: Algorithms in Java, Part 1-4, 3. Auflage, Addison Wesley, 2002, ISBN 0201361205.
Robert Sedgewick: Algorithms in Java, Part 5, 3. Auflage. Addison Wesley, 2003, ISBN 0201361213.
Gerhard Goos: Informatik 1. Eine einführende Übersicht, 4. Auflage, Springer Lehrbuch, 1992, ISBN 3540527907
Gerhard Goos: Informatik 2. Eine einführende Übersicht, 4. Auflage, Springer Lehrbuch, 1992, ISBN 3540555676
Sebastian Abeck: Kursbuch Informatik (Broschiert), Universitätsverlag Karlsruhe, 2005, ISBN-10: 3937300686
Russ Miles, Kim Hamilton: Learning UML 2.0, 1. Auflage, O'Reilly, 2006, ISBN 0596009828
Craig Larman: Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, 3. Auflage. Prentice Hall, 2004, ISBN 0131489062
Peter Drake: Data Structures and Algorithms in Java. 1. Auflage. Prentice Hall, 2005, ISBN 0131469142
Thomas Rießinger: Informatik für Ingenieure und Naturwissenschaftler: Eine anschauliche Einführung in das Programmieren mit C und Java, Springer, 2005, ISBN-10: 3540262431
Raghu Ramakrishnan, Johannes Gehrke: Database Management Systems, 3. Auflage, McGraw-Hill, 2003, ISBN 0072465638

Course: Information Systems in Logistics and Supply Chain Management [2118094]

Coordinators: C. Kilger
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)
examination aids: none

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to:

- Describe requirements of logistical processes regarding IT systems,
- Choose information systems to support logistical processes and use them according to the requirements of a supply chain.

Content
1) Overview of logistics systems and processes
2) Basic concepts of information systems and information technology
3) Introduction to IS in logistics: Overview and applications
4) Detailed discussion of selected SAP modules for logistics support

Media
presentations

Literature
Stadtler, Kilger: Supply Chain Management and Advanced Planning, Springer, 4. Auflage 2008

Remarks
none

Course: Information Technology [23622]

Coordinators: K. Müller-Glaser
Part of the modules: Basics of Information Technology (p. 16)[BSc-MIT - B4]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Written exam (see actual document "Studienplan" and notice of the examination office ETIT). Prerequisite: passed lab information technology (23626).
Grades result from the written examination.

Conditions
None.

Learning Outcomes
At the end of the lecture, the students should be able to describe different computer architectures, their structure and functions. Furthermore, the students should understand programming paradigms and compare them. In this context appropriate data structures should be selected. Besides, they can distinguish and evaluate different algorithms based on specific quality features in order determine the appropriate one when conceiving their own programs. At the end of the exercise, students can solve a given algorithmic problem, describing it in different representation forms and implementing it in a structured, executable and efficient C++ program. For this purpose, the main features of C++ programming language should be understood and applied. Another objective is the evaluation of algorithms and programs with respect to certain quality criteria.

Content
The course provides an introduction to major theoretical fundamentals of information technology. This course is specific to the students of the 2nd semester of Electrical Engineering and Information Technology. Since the students have not yet acquired basic knowledge in computer science, the fundamentals of computer architecture, software development, data structures and algorithms need to be in the main focus. In addition the lecture will also communicate basics, which are needed in other lectures.
In the beginning, the lecture describes the basic terms and shows the areas of information technology to solve complicated problems. Then, basic computer architectures and their relation to the design and execution of programs are discussed. On this basis, the construction and use of programming languages are presented, as well as the basic programming paradigms.
The software development process starting from the analysis of problems concerning the design and implementation up to testing and quality evaluation are shown. In this context, appropriate tools, such as integrated development environments, and the process from source code to an autonomously running program is discussed.
For the description of programs, different representation forms are compared. Furthermore, the principles of object orientated programming are shown. In the next step, the various data structures and their characteristics are presented.
Based on the principles of software development and data structures, different algorithms - their construction and application - are explained. In this context the focus is on the basic algorithms for searching, sorting and optimization. Also their runtime, efficiency and applicability are analyzed. Even more complex and optimized algorithms are addressed and their use in solving current technical problems is shown.

Literature
Online material is available on: www.estudium.org; Literature: Kirch-Prinz, U.; Prinz, P.: C++ lernen und professionell anwenden; 4. Auflage 2007; Cormen T. H., Leiserson C. E., Rivest R. L., and Stein C.: Introduction to Algorithms, Second Edition. 2001.

Remarks
The course comprises the interleaved blocks: lecture, exercises and lab. Current information can be found on the ITIV (www.itiv.kit.edu) webpage.

Course: Informationstechnik in der industriellen Automation [23144]

Coordinators: P. Bort
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Written Exam (see current document “Studienplan” and notice of the examination office ETIT).
Grades result from the written examination.

Conditions
None.

Learning Outcomes
The goal is to relay theoretical fundamentals.

Content
The lecture provides an introduction to modern automation systems. Starting from simple PLC systems, complex Control and Manufacturing Execution Systems (MES) up to Enterprise Resource Planning (ERP) Systems. The lecture examines different industries, technologies and standards which are used in such complicated systems..
Another focus of the lecutre is plant engineering and system integration. Different modelling approaches and tools for plant engineering are introduced and the specific features of the system integration in plant automation are examined, as for example the high number by different interfaces, the different life cycles of single components, subsystems and plant components or the extreme requirements for the safety and availability of the plants.
Economic aspects play a central role in all cases of the lecture. On the basis of numerous practical examples the student should develop a feeling for the economic effects of engineer’s decisions from developer view and from operating authority view by themselves. In this context subjects are treated like asset management and strategies for plant engineering and plant operation.

Course: Information Processing in Mechatronic Systems [2105022]

Coordinators: M. Kaufmann
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Basic knowledge of computer science and programming

Learning Outcomes
Students have fundamental knowledge about selection, conceptual design and development of information processing components in mechatronic systems.

Content
Information processing components – consisting of sensors, actors, hardware and software – are of essential importance for the implementation of mechatronic functions.
Based on requirements on information processing in mechatronic systems typical hardware and software solutions are examined. Characteristics, advantages, disadvantages and application areas are discussed. Solutions are examined regarding real-time capabilities, dependability, safety and fault tolerance. Bus communication in mechatronic systems is examined. Description methods and several approaches of functional description are considered. An approach on the development of information processing components is developed. Lecture topics are complemented by practical examples.
Outline:

- Requirements on information processing components,
- Characteristics of information processing components
- Real-time capabilities, dependability, safety and fault tolerance
- Architectures of information processing components
- Communication in mechatronic systems
- Descriptive models und functional description
- Development of information processing components

Software quality

Literature

- Marwedel, P.: Eingebettete Systeme. Springer: 2007.
- Teich, J: Digitale Hard-, Software-Systeme. Springer: 2007.
- Wörn, H., Brinkschulte, U.: Echtzeitsysteme: Grundlagen, Funktionsweisen, Anwendungen. Springer, 2005.
- Zöbel, D.: Echtzeitsysteme: Grundlagen der Planung. Springer, 2008.

Course: Innovation Workshop: Mobility concepts for the year 2050 [2115916]

Coordinators: P. Gratzfeld
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Written report and oral exam

Conditions
Attendance is mandatory during the whole seminar.

Recommendations
none

Learning Outcomes

- The students get aware of the mega and industry trends and learn about the innovationprocess of an international company in rail industry.
- They exercise advanced creativity techniques.
- They learn and deepen key qualifications like communication skills, presentation skills, moderation techniques and team work.
- They learn the appliance of a business plan as well as the usage of project management by practical examples.

Content

- Presentation of the company and the industry.
- Long term development of society and environment (megatrends), impact on railways and rail industry.
- Creating, elaborating and discussing innovative ideas by using the innovation tool "Zukunftswerkstatt".
- Different methods (Card Technique, Flash Light, Mind Map, Feedback, Elevator pitch, Business Plan, Project Management)
- Training and coaching of the individual presentation skills with final presentations in front of company representatives.

Media
All material is available for download (Ilias-platform).

Literature
Literature will be provided in advance and during the course.

Remarks

- This seminar is a 5-day block course.
- Number of participants is limited.
- Registration is necessary.
- For further information please look at the website www.bahnsystemtechnik.de.

Course: Innovative Nuclear Systems [2130973]

Coordinators: X. Cheng
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations

- oral examination
- duration 20min

Conditions

None.

Learning Outcomes

This lecture is addressed to students of mechanical engineering, chemical engineering and physics. Goal of the lecture is the explanation of state-of-the-art development of nuclear systems. Nuclear systems, that are from todays point of view promising will be presented and explained. The main characteristics of such systems and the associated challenges are also part of the lecture.

Content

1. state of the art and development tendencies in nuclear systems
2. advanced concepts in light water cooled systems
3. new developments in fast reactors
4. development tendencies in gas-cooled plants
5. transmutation systems for waste management
6. fusionsystems

Course: Integrated production planning [2150660]

Coordinators: G. Lanza
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	6	Summer term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
Attendance of the lecture 'Manufacturing Engineering' [21657] prior to attending this lecture is recommended.

Learning Outcomes
The students . . .

- can discuss basic questions of production technology.
- are able to apply the methods of integrated production planning they have learned about to new problems.
- are able to analyze and evaluate the suitability of the methods, procedures and techniques they have learned about for a specific problem.
- can apply the learned methods of integrated production planning to new problems.
- can use their knowledge targeted for efficient production technology.

Content
As part of this lecture further engineering aspects of production technology are taught. This includes content from the manufacturing technology, machine tools and handling techniques as well as the organization and planning.
Planning factories within the context of value networks and integrated production systems (Toyota etc.) requires an integrated perspective for the consideration of all functions included in the "factory" system. This includes the planning of manufacturing systems including the product, the value network and factory production, and the examination of SOPs, the running of a factory and maintenance. Content and theory covered by this lecture are completed with many examples from industry and exercises based on real-life situations and conditions.
Main topics covered by the lecture:

- The basic principles of production planning
- Links between product planning and production planning
- Integrating a production site into a production network
- Steps and methods of factory planning
- Approach to the integrated planning of manufacturing and assembly plants
- Layout of production sites
- Maintenance
- Material flow
- Digital factory
- Process simulation for material flow optimisation
- Start-up

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Course: Integrated Systems and Circuits [23688 + 23690]

Coordinators: M. Siegel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
23655 (Electronic Devices and Circuits)

Learning Outcomes
To understand the entire signal path of a mixed signal integrated circuit for analog and digital signal processing To understand signal conditioning of analog sensor signals Filters and sample & hold techniques Analog to digital converters Digital to analog converters Control of actuators Signal processing with microcontrollers and DSP's Signal processing with FPGA's Integrated circuits for analog and digital signal processing
The lecture contains the knowledge for the development and the implementation of modern mixed-signal circuits for sensor signals, digital signal processing and output signals for actuators. The lecture is focused on modern analog circuit design for signal conditioning before analog-digitals conversion. Further filter amplifiers and Sample&Hold circuits will be described. Analog-digital converters are introduced in detail. The different families of the user specific circuits, in particular FPGA and PLD are discussed.
The tutorial will engross some lecture content, especially analog and digital filters and also FPGA.

Content
Concepts for the implementation of integrated "System-on-Chip" solutions with highly integrated circuits on the sensor level, the analog and digital signal processing and the actuator will be discussed. In particular, concepts for the automotive sector are discussed.

Literature
Online material is available on: www.ims.kit.edu

Remarks
Current information can be found on the IMS (www.ims.kit.edu) webpage.

Course: Introduction to Neutron Cross Section Theory and Nuclear Data Generation [2190490]

Coordinators: R. Dagan
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral exam, 30 min.

Conditions
none

Recommendations
none

Learning Outcomes
The students:

- Understand the special importance of cross sections in various domains of natural science (Reactor physics, Material research, Solar radiation etc.)
- Are familiar with the theoretical methods and experimental effort to generate cross sections data.

Content
Cross section characterization
Summary of basic cross section theory
Resonance cross section
Doppler broadening
Scattering kernels
Basic of slowing down theory
Unit cell based XS data generation
Cross sections Data libraries
Data Measurements

Literature
Handbook of Nuclear Reactors Calculations Vol. I Y. Ronen, CRC Press 1986
D. Emendorfer. K.H. Höcker Theory of nuclear reactions, Parts I, II BI- Hochschultaschenbücher 1969 (in German)
P. Tippler, R. Llewellyn Modern Physics 2008

Course: Introduction to Production Operations Management [3118031]

Coordinators: K. Furmans, F. Schultmann, B. Deml, S. Peters
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Summer term	en

Learning Control / Examinations
The assessment is carried out as a written exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are able to describe the connections between production science work scheduling and –design, material flow and basics of economics.
- are able to differentiate between production systems and rate their characteristics.
- are capable of designing workplaces according to the requirements.
- can create material flow systems depending on the production system to ensure supply.
- are able to evaluate systems financially by having the economical knowledge.

Content
The lecture is given in cooperation by the Institute for Conveying Technologies and Logistics (IFL), the Institute of Human and Industrial Engineering (IFAB), the Institute of Production Science (wbk) and the Institute for Industrial Production (IIP). Basic knowledge about the planning and operation of a production business is provided. Subject areas are production science (production techniques, manufacturing and assembly systems), work scheduling, work control, work design, material flow as well as basics of economics (accounting, reinvestment analyses, legal forms).

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: IT-Fundamentals of Logistics [2118183]

Coordinators: F. Thomas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see “Studienplan Maschinenbau”, latest version)

examination aids: none

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe and classify automation technology for material flow and the information technology necessary,
- identify, analyze and design the business processes in internal logistics,
- identify risks of failure and counteract and
- transfer the knowledge to practical implementations.

Content
This lecture, with exercises, treats automation technology in material flow as well as the information technology that has a direct relationship with it. In the first few chapters and exercises, an overview is given of the motors and conveying technology elements used in materials handling, and the sensors required for the purpose are explained. The target control types as well as the topic of coding techniques and RFID (GS1, barcodes, scanner, etc.) are treated in detail. Material flow controls are defined based on these chapters. Among other things, the functions of a stored-memory controller are explained in this section. Hierarchically classified control structures and
their integration in network structures are considered in detail. The principles of communications systems (bus systems etc.) are supplemented with information on the use of the Internet as well as data warehousing strategies. An overview of modern logistics systems, especially in stores administration, illustrates new problem solution strategies in the area of information technology for logistics systems. After an analysis of the causes for system failures, measures are worked
out for reducing the risks of failure. Furthermore, the objectives, task areas as well as various scheduling strategies in the area of transport management and control are presented. Worthwhile information on Europe-wide logistics concepts round off this practice-oriented lecture series. The presentation of the lectures will be multimedia-based. Exercises repeat and extend the knowledge principles imparted in the lectures and illustrate the
subject with practical examples.
Focuses:

- System architecture for logistics solutions / Modularization of conveyors
- Material Flow Control System (MFCS) / Transport Handling
- Coding technique, GS 1 / RFID
- Data communication between controllers, computers and networks
- Business processes for internal logistics – software follows function
- Adaptive IT - Future-oriented software architecture
- System stability and data backup –Software-Engineering

- XTS – The Extensible Transport System

Literature
Detailed script can be downloaded online (www.tup.com), updated and enhanced annually.
CD-ROM with chapters and exercises at the end of the semester available from the lecturer, also updated and enhanced annually.

Course: IT-Security Management for Networked Systems [24149]

Coordinators: H. Hartenstein
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
5	2/1	Winter term	de

Learning Control / Examinations

Conditions
Dependencies according to the module description.

Learning Outcomes

Content
The course of this module teaches how to manage modern highly distributed IT systems and services. As a foundation, key concepts and models commonly used in the areas of IT Security Management, Network Management, Identity Management, and IT Service Management are introduced and discussed.
Based on these concepts, selected technical architectures, protocols, and tools found within the mentioned areas of interest are evaluated. Among others, IT security workflows are illustrated by means of the “BSI Grundschutz”. It is explained how highly distributed computer networks can be monitored and controlled, and the management of public IP networks is evaluated. The course also focuses on Identity and Access Management as well as Firewalls, Intrusion Detection, and Prevention. Furthermore, concrete examples taken from the daily operation of the Steinbuch Centre for Computing (SCC), for instance in the context of the glass fiber backbone KITnet, are discussed to underline presented conclusions. By presenting current research activities in the areas of Peer-to-Peer networks (e.g. BitTorrent) and social networks (e.g. Facebook) management approaches are put into a global context

Media
Slides

Literature
Jochen Dinger, Hannes Hartenstein, Netzwerk- und IT-Sicherheitsmanagement : Eine Einführung, Universitätsverlag Karlsruhe, 2008, ISBN: 978-3866442092
Claudia Eckert, IT-Sicherheit. Konzepte - Verfahren - Protokolle, 8. Auflage, Oldenbourg Wissenschaftsverlag, 2013, ISBN: 978-3486721386
Andrew S. Tanenbaum, Computernetzwerke, 5. Auflage, Pearson Studium, 2012, ISBN: 978-3868941371
Messaoud Benantar, Access Control Systems: Security, Identity Management and Trust Models, Springer, 2006, ISBN: 978-0387004457

Course: Introduction to Ceramics [2125757]

Coordinators: M. Hoffmann
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (30 min) taking place at a specific date.
The re-examination is offered at a specific date.

Conditions
none

Recommendations
Fundamentals in natural science are recommended for students in mechanical and industrial engineering. The lecture requires the basics of the material science courses in mechanical or industrial engineering for bachelor students.

Learning Outcomes
The students know the most relevant crystal structures and defects of non metallic inorganic materials, are able to read binary and ternary phase diagrams and are familar with powdertechnological shaping techniques, sintering and grain growth. They know the basics of the linear elastic fracture mechanics, are familar with Weibull statistics, K-concept, subcritical crack growth, creep and the opportunities for microstructural reinforcement of ceramics. The students are able to explain the correlation among chemical bonding, crystal and defect structures and the electrical properties of ceramics.

Content
After a short introduction to interatomic bonding, fundamental concepts of crystallography, the stereographic projection and the most important symmetry elements will be given. Different types of crystal structures are explained and the relevance of imperfections are analysed with respect to the mechanical and electrical properties of ceramics. Then, the impact of surfaces, interfaces and grain boundaries for the preparation, microstructural evolution and the resulting properties is discussed. Finally, an introduction is given to ternary phase diagrams.
The second part of the course covers structure, preparation and application aspects of nonmetallic inorganic glasses, followed by an introduction to the properties and processing methods of fine-grained technical powders. The most relevant shaping methods, such as pressing, slip casting, injection moulding and extrusion are introduced. Subsequently, the basics of science of sintering and the mechanisms for normal and abnormal grain growth are discussed. Mechanical properties of ceramics are analysed using basic principles of linear elastic fracture mechanics, Weibull statistics, concepts for subcritical crack growth and creep models to explain the behaviour at elevated temperatures. Furthermore it is demonstrated that mechanical properties can be siginificantly enhanced by various types of microstructural toughening mechanisms. The electronic and ionic conductivity of ceramic materials are explained based on defect-chemical considerations and band structure models. Finally, the characteristics of a dielectric, pyroelectric, and piezoelectric behaviour is discussed.

Media
Slides for the lecture:
available under http://ilias.studium.kit.edu

Literature

- H. Salmang, H. Scholze, "Keramik", Springer
- Kingery, Bowen, Uhlmann, "Introduction To Ceramics", Wiley
- Y.-M. Chiang, D. Birnie III and W.D. Kingery, "Physical Ceramics", Wiley
- S.J.L. Kang, "Sintering, Densification, Grain Growth & Microstructure", Elsevier

Course: Cognitive Modeling [24612]

Coordinators: T. Schultz, F. Putze
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
Knowledge in the area of cognitive systems or biosignal processing is helpful.

Learning Outcomes
Students have a general overview of the methods for modeling human cognition and affect in the context of human-machine interaction. They are capable of modeling human behavior in a given application, e.g. to simulate realistic virtual environments or to enable natural interaction between user and machine.

Content
The lecture centers on the modeling of human cognition and affect in the context of human-machine interaction. It deals with models which can be used by computer systems to describe, explain and predict human behavior. Important topics of the lecture are: human behavior models, human learning (similarities and differences to machine learning), knowledge representation, models of affect and cognitive architectures. The relevance of cognitive modeling for future computer systems is pointed out and examples of open research questions in the area of human-machine interaction are given.

Media
Slides.

Literature
Elective literature:
Will be announced in the lecture.

Course: Cognitive Systems [24572]

Coordinators: R. Dillmann, A. Waibel
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Summer term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Basic knowledge in informatics is helpful.

Learning Outcomes

- The relevant elements of technical cognitive systems can be named and their tasks can be described.
- The problems in the relevant areas can be recognized and processed.
- Further approaches and methods can be exploited autonomously and applied successfully.
- Variations of the problems can be solved successfully.
- The educational objectives shall be achieved by visiting the complementary tutorials.

The students know the basic concepts and methods of image representation and processing, e.g. homogenous point operations, histogram analysis and image filters. They are able to explain and assess methods for segmenting image data based on threshold, colour, edges and point features. They understand the properties of stereo camera systems, e.g. epipolar geometry and triangulation for 3D reconstruction. They are proficient in propositional logic and predicate logic. They know planning languages and different algorithms for path planning as well as models for representation of objects and numerical representations of robots.
The students will be able to handle the fundamental steps of signal processing and can list their advantages and disadvantages. Given a certain problem, they will be able to select the appropriate signal processing steps. The students will be able to work with the taxonomie of classification systems and are able to classify methods in terms of the taxonomie. Students shall be able to give examples for every class in the taxonomie. Students shall be able to build simple naïve Bayes classifiers and to analyse them with respect to error probability.
Students shall be able to name the fundamental terms of machine learning, as well as to be familiar with the basic methods of machine learning. Students shall be familiar with the principles of a multi layer perceptron and to be able to handle the basics of back-propagation training. Further, they shall be able to name and describe further types of neural networks. The students will be able to describe the basic design of a statistical speech recognition system for large vocabulary speech recognition. They shall be able design simple models for automatic speech recognition and to estimate their parameters. They shall further be able to conduct a simple pre-processing for speech recognition. They also shall be able to work with the fundamental error measures of speech recognition and to calculate them.

Content
Cognitive systems act on the basis of perception and knowledge. After reception of stimuli through receptors, the signals are processed, and based on a knowledge base actions are triggered. In the lecture, the involved modules of a cognitive system are presented. To these belong in addition to acquisition and processing of environmental information (e.g. images, speech), the representation of knowledge as well as the assignment of features with the aid of classifiers. Further core themes of the lecture will be learning and planning methods, and their implementation. The presented methods and approaches will be deepened in the tutorials by means of exercises.

Media
Slides, lecture notes (available for download)

Literature
„Artificial Intelligence – A Modern Approach“, Russel, S.; Norvig, P.; Prentice Hall. ISBN 3895761656.

Elective literature:
„Computer Vision – Das Praxisbuch“, Azad, P.; Gockel, T.; Dillmann, R.; Elektor-Verlag. ISBN 0131038052.
“Discrete-Time Signal Processing”, Oppenheim, Alan V.; Schafer, Roland W.; Buck, John R.; Pearson US Imports & PHIPEs. ISBN 0130834432.
“Signale und Systeme”, Kiencke, Uwe; Jäkel, Holger; Oldenbourg, ISBN 3486578111.

Course: Design with Plastics [2174571]

Coordinators: M. Liedel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral duration: 20 - 30 min. aids: none

Conditions
none, recomm. 'Polymer Engineering I'

Learning Outcomes
Students will be able to
• distinguish polymer compounds from other construction materials regarding chemical differences, thermal behaviour and solid conditions.
• discuss main plastics processes regarding advantages and disadvantages of materials selection and part geometry design and to make appropiate selections.
• analyze complex application requirements concerning material impacts on strength and to use the classic dimensioning method specific to the application to evalute the lifetime part strength limit.
• evaluate part tolerances and geometry by appropiate methods considering molding shrinkage, production tolerances, post shrinkage, heat expansion, swelling, elastic and creep deformation.
• design plastic specific joining geometries like snap fits, screw bosses, weld seams and film hinges.
• detect classic molding failures and understand potential causes as well as to reduce the probability of molding failures by defining an optimized design.
• understand benefits and limits of selected simulation tools in the plastic technology discipline (strength, deformation, filling, warpage).
• assess polymer classes and plastic part designs with respect to suitable recycling concepts and ecological consequences.

Content
Structure and properties of plastics materials,
Processing of plastics,
Behavior of plastics under environmental impacts,
Classic strength dimensioning,
Geometric dimensioning,
Plastic appropriate design,
Failure examples,
Joining of plastic parts,
Supporting simulation tools,
Structural foams,
Plastics Technology trends.

Literature
Scriptum will be handed out during the lecture.
Recommended literature are provided in the lecture.

Course: Lightweight Engineering Design [2146190]

Coordinators: A. Albers, N. Burkardt
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH], Entwicklung und Konstruktion (MACH) (p. 26)[BSc-MIT - B-PM3]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The type of examination (written or oral) will be announced at the beginning of the lecture.
written examination: 60 min duration
oral examination: 20 min duration
Auxiliary means: none.

Conditions
none

Learning Outcomes
The students are able to ...

- evaluate the potential of central lightweight strategies and their application in design processes.
- apply different stiffing methods qualitatively and to evaluate their effectiveness.
- evaluate the potential of computer-aided engineering as well as the related limits and influences on manufacturing.
- reflect the basics of lightweight construction from a system view in the context of the product engineering process.

Content
General aspects of leightweight design, lightweight strategies, construction methods, design principles, lightweight construction, stiffening techniques, lightweight materials, virtual product engineering, bionics, joining techniques, validation, recycling
Additionally, guest speakers from industry will present lightweight design from an practical point of view.

Media
Beamer

Literature
Klein, B.: Leichtbau-Konstruktion. Vieweg & Sohn Verlag, 2007
Wiedemann, J.: Leichtbau: Elemente und Konstruktion, Springer Verlag, 2006
Harzheim, L.: Strukturoptimierung. Grundlagen und Anwendungen. Verlag Harri Deutsch, 2008

Remarks
Lecture slides are available via eLearning-Platform ILIAS.

Course: Kooperation in interdisziplinären Teams [2145166]

Coordinators: S. Matthiesen, S. Hohmann
Part of the modules: Key Competences (p. 47)[BSc-MIT - B-SQ]

ECTS Credits	Hours per week	Term	Instruction language
2		Winter term	

Learning Control / Examinations
Written examination
No auxiliary material
Joint examination for lecture and project.

Conditions
Participation on the course mechatronic systems and products requires participation on the courses workshop mechatronic systems and products and cooperation in interdisciplinary teams at the same time.

Recommendations
None
Knowledge in CAD is advantageous but not necessary.

Learning Outcomes
The lecture provides the theoretic basics, which will be applied and enhanced in development project during the semester. The project will take part in small groups, where the students have to organize and distribute the tasks on their own. The educational objectives are as follows:
The students

- are able to describe the difficulties of interdisciplinary projects.
- are able to coordinate processes, structures, responsibilities and interfaces within a project.
- know different solutions for mechanic/electric problems.
- know the elements of the treated product development processes, are able to describe different views onto them and execute them.
- know the model based systems engineering approaches and the basics of modelling with SysML.
- know the basic principles of virtual design and are able to apply the methods of virtual system design.
- are able to identify the differences between virtuality and reality.
- are able to recognize the advantages of early validation.
- are able to work in teams.

Content

- Introduction
- Product development processes
- MBSE and SysML
- Mechatronic selection of solutions
- Methods of early validation
- Architectural design
- Virtual functional design
- Validation and verification
- Reflection and presentation of the team results

Literature

Alt, Oliver (2012): Modell-basierte Systementwicklung mit SysML. In der Praxis. In: Modellbasierte Systementwicklung mit SysML.
Janschek, Klaus (2010): Systementwurf mechatronischer Systeme. Methoden - Modelle - Konzepte. Berlin, Heidelberg: Springer.
Weilkiens, Tim (2008): Systems engineering mit SysML/UML. Modellierung, Analyse, Design. 2., aktualisierte u. erw. Aufl. Heidelberg: Dpunkt-Verl.

Remarks

All lecture notes and excercises are provided via the elearning platform ILIAS.

Course: Cooling of thermally high loaded gas turbine components [2170463]

Coordinators: H. Bauer, A. Schulz
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral
Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
None.

Learning Outcomes
The students are able to:

- name and differentiate beween different cooling methods and analyse them
- judge on the advantages and disadvantages of cooling methods and discuss approaches for the improvement of complex cooling methods
- to outline the basics of forces convectice heat transfer and film cooling
- design colled gas turbine components in a simplified manner
- comment on the experimental and numerical methods for the characterisation of heat transfer

Content
Hot gas temperatures of modern gas turbine engines exceed the maximum tolerable material temperatures by several hundreds of K. To ensure reliability of lifetime, complex cooling technology must be applied. Various cooling methods will be introduced in this lesson. Specific pros and cons will be identified and new concepts for further improvement of cooling will be discussed. Furthermore, the fundamentals of forced convection heat transfer and film cooling wil be imparted and a simplified design process of a cooled gas turbine components will be demonstrated. Finally, experimental and numerical methods for the characterization of heat transfer will be presented.

Course: Curves and surfaces for Geometric Design [24626]

Coordinators: H. Prautzsch
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
9	4/2	Winter / Summer Term	

Learning Control / Examinations

Conditions
None.

Learning Outcomes
Basic knowledge about smooth freeform curves and surfaces, and about their representations in CAD systems and in computer graphics. In particular knowledge of control points and the geometric properties of Bézier and B-spline representations.

Content
Bézier and B-spline-Techniken, polarforms, algorithms of de Casteljau, de Boor and Boehm, Oslo-Algorithm, Stärk's C{̂}k construction, subdivision, change of representations, algorithms to generate and intersect curves and surfaces, interpolation with splines, tensorproduct- and triangular patches, convex surfaces, Powell-Sabin, Clough-Tocher and Piper's elements, construction of smooth freeform surfaces, vertex enclosure problem, boxsplines.

Course: Warehousing and distribution systems [2118097]

Coordinators: M. Schwab, J. Weiblen
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version 29.06.2011)

Conditions
none

Recommendations
logistics lecture

Learning Outcomes
Students are able to:

- Describe the areas of typical warehouse and distribution systems with the respective processes and can illustrate it with sketches,
- Use and choose strategies of warehouse and distribution systems according to requirements,
- Classify typical systsems using criteria discussed in the lecture, and
- Reson about the choice of appropriate technical solutions.

Content

- Introduction
- Yard management
- Receiving
- Storage and picking
- Workshop on cycle times
- Consoldiation and packing
- Shipping
- Added Value
- Overhead
- Case Study: DCRM
- Planning of warehouses
- Case study: Planning of warehouses
- Distribution networks
- Lean Warehousing

Media
presentations, black board

Literature
ARNOLD, Dieter, FURMANS, Kai (2005)
Materialfluss in Logistiksystemen, 5. Auflage, Berlin: Springer-Verlag

ARNOLD, Dieter (Hrsg.) et al. (2008)
Handbuch Logistik, 3. Auflage, Berlin: Springer-Verlag
BARTHOLDI III, John J., HACKMAN, Steven T. (2008)
Warehouse Science
GUDEHUS, Timm (2005)
Logistik, 3. Auflage, Berlin: Springer-Verlag
FRAZELLE, Edward (2002)
World-class warehousing and material handling, McGraw-Hill
MARTIN, Heinrich (1999)
Praxiswissen Materialflußplanung: Transport, Hanshaben, Lagern, Kommissionieren, Braunschweig, Wiesbaden: Vieweg
WISSER, Jens (2009)
Der Prozess Lagern und Kommissionieren im Rahmen des Distribution Center Reference Model (DCRM); Karlsruhe : Universitätsverlag
A comprehensive overview of scientific papers can be found at:
ROODBERGEN, Kees Jan (2007)
Warehouse Literature

Remarks
none

Course: Laser Physics [23840]

Coordinators: M. Eichhorn
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	

Learning Control / Examinations
The assessment will consist of a oral exam (30 min) (following §4 (2), 2 of the examination regulation).

Conditions
None.

Learning Outcomes

- Knows the fundamental relations and background of lasers
- Has the necessary knowledge for understanding and dimensioning of Lasers, laser media, optical resonators and pump strategies
- Understands the pulse fabrication with lasers and their fundamentals
- has the necessary knowledge of several lasers; Gas-, solid state, fibers- and disc- lasers in the visible and middle infrared range

Content
1 Quantum-mechanical fundamentals of lasers
1.1 Einstein relations and Planck's law
1.2 Transition probabilities and matrix elements
1.3 Mode structure of space and the origin of spontaneous emission
1.4 Cross sections and broadening of spectral lines
2 The laser principle
2.1 Population inversion and feedback
2.2 Spectroscopic laser rate equations
2.3 Potential model of the laser
3 Optical Resonators
3.1 Linear resonators and stability criterion
3.2 Mode structure and intensity distribution
3.3 Line width of the laser emission
4 Generation of short and ultra-short pulses
4.1 Basics of Q-switching
4.2 Basics of mode locking and ultra-short pulses
5 Laser examples and their applications
5.1 Gas lasers: The Helium-Neon-Laser
5.2 Solid-state lasers
5.2.1 The Nd3+-Laser
5.2.2 The Tm3+-Laser
5.2.3 The Ti3+:Al2O3 Laser
5.3 Special realisations of lasers
5.3.1 Thermal lensing and thermal stress
5.3.2 The fiber laser
5.3.3 The thin-disc laser

Media
Script & tutorial of lecturer

Literature

- A. E. Siegman, *Lasers*, (University Science Books).

- B. E. A. Saleh, M. C. Teich, *Fundamentals of Photonics* (Wiley-Interscience).
- F. K. Kneubühl, M. W. Sigrist, *Laser* (Teubner).

Remarks
The course comprises of the interleaved lecture blocks, exercises, and tutorials. Current information can be found on the IPQ (http://www.ipq.kit.edu/) webpage.

Course: Laser in automotive engineering [2182642]

Coordinators: J. Schneider
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination (30 min)

no tools or reference materials

Conditions
Basic knowledge of physics, chemistry and material science is assumed.
It is not possible, to combine this lecture with the lecture *Physical basics of laser technology* [2181612].

Recommendations
None.

Learning Outcomes
The student

- can explain the principles of light generation, the conditions for light amplification as well as the basic structure and function of Nd:YAG-, CO_2- and high power diode-laser sources.
- can describe the most important methods of laser-based processing in automotive engineering and illustrate the influence of laser, material and process parameters
- can analyse manufacturing problems and is able to choose a suitable laser source and process parameters.
- can explain the requirements for safe handling of laser radiation and for the design of safe laser systems.

Content
Based on a short description of the physical basics of laser technology the lecture reviews the most important high power lasers and their various applications in automotive engineering. Furthermore the application of laser light in metrology and safety aspects will be addressed.

- physical basics of laser technology
- laser beam sources (Nd:YAG-, CO_2-, high power diode-laser)
- beam properties, guiding and shaping
- basics of materials processing with lasers
- laser applications in automotive engineering
- economical aspects
- savety aspects

Media
lecture notes via ILIAS

Literature
W. M. Steen: Laser Material Processing, 2010, Springer
W. T. Silfvast: Laser Fundamentals, 2008, Cambridge University Press

Remarks
It is allowed to select only one of the lectures “Laser in automotive engineering” (2182642) or “Physical basics of laser technology” (2181612) during the Bachelor and Master studies.

Course: Leadership and Product Development [2145184]

Coordinators: A. Ploch
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	

Learning Control / Examinations
oral exam

Conditions
none

Learning Outcomes
The students are able to name, explain und discuss the main elements of leadership theories, methods and management development basics as well as the bordering topics of change management, intercultural competences, team work and corporate governance.

Content
Leadership theories
Management tools
Communication as management tool
Change management
Management development and MD-Programs
Assessment center and management audits
Team work, team development und team roles
Intercultural competences
Leadership and ethics, Corporate Governance
Executive Coaching
Lectures of industrial experts

Course: Power Electronics for Regenerative Energy Sources [23347]

Coordinators: B. Burger
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Oral Exam

Conditions
Module Power Electronics

Learning Outcomes
The goal is to get a survey of the different possibilities of generating energy from regenerative sources. The students should attain special knowledge about photovltaics and power electronics for solar cells.
At first, a survey about regenerative energy generation is given in the lecture. After that, a special view is given on photovoltaic installations and solar cells.

Content
The different possibilities of generating energy from regenerative sources are presented in this lecture. These are
- wind energy
- water power
- solar heating
- geothermal energy
- photovoltaics

The integration of these energy sources in existing power supply systems is explained in this lecture. Further themes are the isolated networks and energy storage systems.
A focus of the lecture is on photovoltaics, the following themes are explained in detail.
- PV-DC-systems
- battery charge controllers
- MPP trackers
- PV - grid interconnections
- inverter circuits
- control of direct power / inductive power
- characteristics of solar cells
- system efficiencies

Literature
Papers about the topics are distributed in the lesson.

Remarks
Current information can be found on the ETI (www.eti.kit.edu) webpage.

Course: Light Engineering [23739 + 23741]

Coordinators: C. Neumann
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes

Content

Course: Light and Display Engineering [23747]

Coordinators: R. Kling
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	en

Learning Control / Examinations
Oral exam 20min

Conditions
none

Recommendations
Comprehensive Overview lecture o fascinating Lighting and Display Technologies.

Learning Outcomes
Attending students get the basic knowledge of Light and Display Engineering and applications fields from Human Sensing to Light Sources, from Displays to Optics Design and Luminaires and Light Planning.
They can transfer this successfully to other parts of their study.

Content
Overview of lecture:
1. Motivation: Light & Display Engineering
2. Light, the Eye and the Visual System
3. Light in non - visual Processes
4. Fundamentals in Light Engineering
5. Color and Brightness
6. Light Sources and drivers
7.Optics Design
8. Displays
9. Luminaires
10 Light Planning Tools

Literature
lecture notes

R.H. Simons Lighting engineering
J.Chen: Handbook of visual Display Technology

Remarks
You will find the latest information online on https://studium.kit.edu/

Course: Linear Electronic Networks [23256]

Coordinators: O. Dössel
Part of the modules: Electronics Basics I (p. 15)[BSc-MIT - B3]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
Written exam (see actual document “Studienplan” and notice of the examination office ETIT).
Grades result from the written examination and the project.

Conditions
None.

Learning Outcomes
This course provides fundamental knowledge of linear electronic circuits. Methods to analyse complex DC and AC circuits are taught.

Content

- Methods to analyse complex linear electric circuits
- Definitions U, I, R, L, C, independent sources, dependent sources
- Kirchhoff’s laws, node-voltage method, mesh-current method
- Thevenin and Norton equivalents, Delta to Wye transformation, maximum power
- operational amplifier, inverting amplifier, summing amplifier, emitter follower, noninverting amplifier, difference amplifier
- sinusoidal currents, differential equations for L- and C-circuits, complex numbers,
- complex RLC-circuits, impedance, complex power, maximum power transfer
- bridge circuits, Wheatsone, Maxwell-Wien, Wien bridge
- series and parallel resonance
- two-port circuits, Z, Y, A-matrix, impedance transformation, phasor-diagrams, Bode
- diagrams, high pass, low pass, band pass
- operational amplifier and RLC-circuits
- transformer, mutual inductance, transformer equations, equivalent circuits
- three-phase-circuits, power calculations in balanced circuits

Remarks
The course comprises of the interleaved lecture blocks, exercises, and tutorials. Current information can be found on the ITIV (http://www.ibt.kit.edu/) webpage and within the eStudium-teachingplatform (www.estudium.org).

Course: Logistics and Supply Chain Management [2581996]

Coordinators: M. Wiens
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3,5	2/0	Summer term	en

Learning Control / Examinations
The assessment consists of an oral (30 minutes) or a written (60 minutes) exam (following §4(2), 1 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Recommendations
None.

Learning Outcomes

- The students know the central tasks and challenges of modern logistics management.
- The students apply key concepts in the area of logistics.
- The students apply methods of risk evaluation and risk management in supply chains.
- The students know key incentive-schemes and planning-tools relevant to supply chain management.
- The students apply exemplary methods to solve practical problems.

Content

- Introduction: Basic Terms and Concepts
- Logistics Systems and Supply Chain Management
- Supply Chain Risk Management
- Extensions and Applications

Media
Medie will be provided on learning platform.

Literature
will be announced in the course

Course: Logistics - organisation, design and control of logistic systems [2118078]

Coordinators: K. Furmans
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)

examination aids: none

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe logistical tasks,
- Design logistical systems suitable to the respective task,
- Dimension stocastical stock models,
- Determine essential influencing parameters on the bullwhip effect and
- Use optimizing solution methods.

Content
multistage logistic process chains
transport chain in logistic networks
distribution processes
distribution centers
logistics of production systems
dependencies between production and road traffic
information flow
cooperative strategies (like kanban, just-in-time, supply chain management)

Media
presentations, black board

Literature
None.

Remarks
none

Course: Automotive Logistics [2118085]

Coordinators: K. Furmans
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see “Studienplan Maschinenbau”, version of 29.06.2011)

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe essential logistic questions, in a complex production network. As an example the automobile industry is used.
- Choose and apply solution possibilities for logistic problems in this area.

Content

- Logistic questions within the automobile industry
- basic model of automobile production and distribution
- relation with the suppliers
- Disposition and physical execution
- Vehicle production in the interaction of shell, paint shop and assembly
- Sequence planning
- Assembly supply
- vehicle distribution and linkage with selling processes
- Physical execution, planning and control

Media
presentations, black board

Literature
None.

Remarks
none

Course: Airport logistics [2117056]

Coordinators: A. Richter
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)

Conditions
none

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe material handling and informations technology activities on airports,
- Evaluate processes and systems on airports as the law stands, and
- Choose appropriate processes and material handling systems for airports.

Content
Introduction
airport installations
luggage transport
passenger transport
security on the airport
legal bases of the air traffic
freight on the airport

Media
presentations

Literature
None.

Remarks
Limited number of participants: allocation of places in sequence of application (first come first served)
Application via "ILIAS" mandatory
personal presence during lectures mandatory

Course: Low Power Design [24672]

Coordinators: J. Henkel
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
Module “Entwurf und Architekturen für Eingebettete Systeme”
Basic knowledge of the module “Optimierung und Synthese Eingebetteter Systeme” is helpful but not mandatory.
The lecture is suited for both computer science and electrical engineering students.

Learning Outcomes
Students learn to consider energy-saving measures at all levels of the design of embedded systems while at the same time maintaining the computing power. Upon completion of the course the student is able to identify and rectify problematic energy consumption in embedded systems.

Content
This course provides an overview of design methods, synthesis methods, estimation techniques, software techniques, operating system strategies, etc. with the aim to minimize power consumption of embedded systems while maintaining the required performance at the same time. Both research-related as well as established (i.e. implemented in current products) techniques at different abstraction levels (from the circuit to the system) are covered in the lecture.

Media
Slides

Course: Machine Vision [2137308]

Coordinators: C. Stiller, M. Lauer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

no reference materials

Conditions
Basic studies and preliminary examination; fundamentals in measurement, system and control theory, e.g. from the lecture "Measurement and Control Systems"

Learning Outcomes
Machine vision (or computer vision) describes the computer supported solution of visual tasks similar to a human. The technical domain machine vision incorporates numerous research areas like optics, digital image processing, 3D measurement technology and pattern recognition. One main focus is image understanding having the goal to gather the meaning of an image and draw conclusions from this semantic meaning. The subjects in the course machine vision are similar to the standard image processing procedure. The students shall acquire an overview on major Machine Vision methods and gather practical experience from computer exercises and experiments.

Content
1. Illumination
2. Image acquisition
3. Image preprocessing
4. Feature extraction
5. Stereo Vision
6. Robust parameter estimation
7. Classification and interpretation

Literature
Main results are summarized in pdf-file. Further recommendations will be presented in the lecture.

Course: Magnetohydrodynamics [2153429]

Coordinators: L. Bühler
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral,
Duration: 30 minutes
No auxiliary means

Conditions
none

Learning Outcomes
The students can describe the fundamentals of magnetohydrodynamics. They are qualified to explain the interrelations of electro and fluid dynamics so as to analyze magnetohydrodynamic flows in engineering applications or for phenomena in geo and astrophysics.

Content

- Introduction
- Basics of electro and fluid dynamics
- Exact solutions, Hartmann flow, pump, generator, channel flows
- Inductionless approximation
- Developing flows, change of cross-section, variable magnetic fields
- Alfven waves
- Stability, transition to turbulence
- Liquid dynamos

Literature
U. Müller, L. Bühler,2001,Magnetofluiddynamics in Channels and Containers, ISBN 3-540-41253-0, Springer
R. Moreau, 1990, Magnetohydrodynamics, Kluwer Academic Publisher
P. A. Davidson, 2001, An Introduction to Magnetohydrodynamics, Cambridge University Press
J. A. Shercliff, 1965, A Textbook of Magnetohydrodynamics, Pergamon Press

Course: Management of Business Networks [2590452]

Coordinators: C. Weinhardt
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	en

Learning Control / Examinations
The assessment consists of a written exam (60 min) (according to §4(2), 1 of the examination regulation) and by submitting written essays as part of the exercise (according to §4(2), 3 of the examination regulation). 65% of the final grade is based on the written exam and 35% is based on assignments from the exercises. Successful completion of the exercises is a prerequisite for admission to the written exam. The points obtained in the exercises only apply to the first and second exam of the semester in which they were obtained.

Conditions
None.

Learning Outcomes
The student

- indentifes the coordination problems in a business network,
- explains the theorie of strategic and operative management,
- analyses case studies in logistics considering the organization theory and network analysis,
- argues and constructs new solutions for the case studies by means of electronic tools.

Content
The significant and lasting impact of web-based business-to-business (B2B) networks has just recently become apparent. The exploratory phase during the first Internet hype bred a variety of approaches which were often bold in business nature, yet simple and unfounded in system architecture. Only very few survived and proved sustainable. Nowadays web-based B2B networks are increasingly reappearing and even promoted by major traditional companies and governments. However, this new wave of networks is more mature and more powerful in functionality than their predecessors. As such they provide not only auction systems but also facilities for electronic negotiation. This implies a shift from price-focused to relationship-oriented trading. But what motivates this shift? Why do firms enter business networks? How can these networks be best supported by IT? The course intends to resolve these questions. Firstly, an introduction in organization theory will be given. Secondly, the problems of networks will be addressed. Thirdly, an analysis of how IT can alleviate those problems will be undertaken.

Media

- PowerPoint
- E-learning platform ILIAS
- Recorded lecture available on the internet, if circumstances allow

Literature

- Milgrom, P., Roberts, J., Economics, Organisation and Management. Prentice-Hall, 1992.
- Shy, O., The Economics of Network Industries. Cambridge, Cambridge University Press, 2001.
- Bichler, M. The Future of e-Markets - Multi-Dimensional Market Mechanisms. Cambridge, Cambridge University Press, 2001.

Course: Leadership and Conflict Management (in German) [2110017]

Coordinators: H. Hatzl
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Elective Subject: oral exam (approx. 30 min)
Optional Subject: oral exam (approx. 30 min)
Optional Subject Economics/Law: oral exam (approx. 30 min)

Conditions

- Compact course
- Limited number of participants; seats are assigned according the date of registration
- Registration via ILIAS is required
- Compulsory attendance during the whole lecture

Recommendations

- Knowledge of Work Science and Economics is helpful

Learning Outcomes

- Knowledge of techniques for management and leadership
- Preparation for management and leadership tasks in the job

Content

1. Introduction to the course
2. Goal definition and goal achievement
3. Management techniques within planning
4. Communication and information
5. Decision-making
6. Leadership and co-operation
7. Self management
8. Conflict management
9. Case studies

Literature
Handout and literature are available on ILIAS for download.

Course: Machinery and Processes [2185000]

Coordinators: H. Kubach, M. Gabi, H. Bauer, U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Winter / Summer Term	

Learning Control / Examinations
successful lab course and written exam (2 h)
Taking part at the exam is possible only when lab course has been successfully completed

Conditions
Successful lab course is a precondition to take part at the exam.

Learning Outcomes
The students can name and describe basic energy conversion processes and energy converting machines. They can explain the application of these energy conversion processes in various machines. They can analyze and evaluate the processes and machines in terms of functionality and efficiency and they are able to solve basic technical problems in terms of operating the machines.

Content
basics of thermodynamics
thermal fluid machines

- steam turbunes
- gas turbines
- combined-cycle plants
- turbines and compressors
- aircraft engines

hydraulic fluid machines

- oerating performance
- characterization
- control
- cavitation
- wind turbines, propellers

internal combustion engines

- characteristic parameters
- engine parts
- kinematics
- engine processes
- emissions

Media
slides to download
Documentation of the labcourse

Remarks
Lab course and lecture take place in summer and winter semester.
In the SS the lecture is held in English. The lab course is always bilingual.

Course: Machine Dynamics [2161224]

Coordinators: C. Proppe
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	en

Learning Control / Examinations
Written examination (compulsory subject), auxiliary means: own manuscripts
Oral examination (optional subject) , no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to apply engineering-oriented calculation methods in order to model and to understand dynamic effects in rotating machinery. This includes the investigation of runup, stationary operation of rigid rotors including balancing, transient and stationary behavior of flexible rotors, critical speeds, dynamics of slider-crank mechanisms, torsional oscillations.

Content
1. Introduction
2. Machine as mechatronic system
3. Rigid rotors: equations of motion, transient and stationary motion, balancing
4. Flexible rotors: Laval rotor (equations of motion, transient and stationary behavior, critical speed, secondary effects), refined models)
5. Slider-crank mechanisms: kinematics, equations of motion, mass and power balancing

Literature
Biezeno, Grammel: Technische Dynamik, 2. Edition, 1953

Holzweißig, Dresig: Lehrbuch der Maschinendynamik, 1979

Dresig, Vulfson: Dynamik der Mechanismen, 1989

Course: Machine Dynamics II [2162220]

Coordinators: C. Proppe
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
oral exam, no auxiliary means allowed

Conditions
none

Recommendations
Machine Dynamics

Learning Outcomes
Students are able to develop and analyze detailed models in machine dynamics that encompass continuum models, fluid structure interaction, and stability analyses.

Content
- hydrodynamic bearings
- rotating shafts in hydrodynamic bearings
- belt drives
- virbation of turbine blades

Literature
R. Gasch, R. Nordmann, H. Pfützner: Rotordynamik, Springer, 2006

Course: Mechanical Design I (CIW/VT/MIT/IP-M) [2145179]

Coordinators: S. Matthiesen
Part of the modules: Mechanical Design (p. 18)[BSc-MIT - B6]

ECTS Credits	Hours per week	Term	Instruction language
3	3	Winter term	de

Learning Control / Examinations
Concomitant to the lecture a workshop with 3 workshop sessions take place over the semester. During the workshop the students were divided into groups and their mechanical design knowledge will be tested during a colloquium at the beginning of every single workshop session. The attendance is mandatory and will be controlled. The pass of the colloquia and the process of the workshop task are required for the successful participation.
Furthermore an online test is carried out.
Further information's will be announced at Ilias and at the beginning of the lecture mechanical design I.

Conditions
none

Learning Outcomes
The students are able to ...

- describe complex systems using the system technique.
- identify and formulate functional connections of a technical system.
- use the contact and channel approach (C&C²-A).
- chose a spring and to calculate it.
- identify different bearings and bearing arrangements and to select a suitable one for the particular situation.
- dimension bearing arrangements for different load cases.
- use the basic rules and pincipales of visualization and to create a technical drawing.
- describe the functional connections of a technical system using the C&C²-A approach and sytem theorie.

Furthermore the students can describe as a team technical solutions with a gear and draw chosen components in different technical expositions.

Content
Introduction in product engineering
Tools of visualization (technical drawing)
Product manufacturing as problem solving
Product manufacturing of technical systems:

- system theory
- element model C&C²-A

Basics of chosen design- and machining elements

- springs
- bearings
- sealings

Concommitant to the lectures tutorials take place with the following contents:
Gear workshop
Tutorial "tools of visualization (technical drawing)"
Tutorial "technical systems product development, sytem theory, element model C&C²-A"
Tutorial "springs"

Tutorial “bearing and bearing arrangements”

Media
Beamer
Visualizer
Mechanical components

Literature
Lecture notes:
The lecture notes can be downloaded via the eLearning platform Ilias.
Literature:
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X
or per full text access provided by university library
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8

Remarks
Lecture notes:
The Productdevelopment knowledge base PKB will be provided in digital form for registered students. All lecture notes and additional slides will be provided in Ilias.

Course: Mechanical Design II (CIW/VT/MIT/IP-M) [2146195]

Coordinators: S. Matthiesen
Part of the modules: Mechanical Design (p. 18)[BSc-MIT - B6]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Summer term	de

Learning Control / Examinations
Concomitant to the lecture a workshop with 3 workshop sessions take place over the semester. During the workshop the students were divided into groups and their knowledge will be tested during a colloquium at the beginning of every single workshop session. The attendance is mandatory and will be controlled. The pass of the colloquia and the process of the workshop task are required for the successful participation.
Further information's will be announced at Ilias and at the beginning of the lecture mechanical design II.

Conditions
Successful participation in mechanical design I.

Learning Outcomes
The students are able to ...

- name and describe the function principals of different sealing's as well as evaluate and use special sealing's under consideration of particular boundary condition and choosing criteria's.
- understand the different types of dimensioning and relevant load parameters. They have knowledge about strength hypothesizes, are able to use and perform the strength calculations independently.
- use the basic rules of designing on concrete problems. They understand the different designing stages and are able to name and take into account the requirements of designing.
- describe manufacturing processes and their caracteristics, as well as deriving and using the resulting boundary conditions of designing.
- understand the different effects of component connections and their dimensioning. They are able to choose and calculate a suitable connection and to illustrate their advantages and disadvantages.
- list and describe different bolt connection applications.
- describe their construction and to describe their function by using the spring model.
- reproduce, use and discuss the bolt connection formulas
- understand the dimensioning of a bolt connection and to analyze load states and their impacts by using the tension chart.
- dimension a bearing arrangement and to choose, evaluate and dimension suitable bearings
- dimension chosen component connections mathematically (form closure, frictional closure) and to use DIN 7190 für calculation of a frictional connection.

The students are able to develop technical solutions in a team, to implement their ideas in technical solutions and to illustrate their own working- and decision process by using protocols and diagrams.

Content
Sealings
Design
Dimensioning
Component connections
Bolt connection
Tutorials take place in concomitant to the lectures.

Media
Beamer

Visualizer
Mechanical components

Literature
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X,
also available as electronic paper at the KIT catalogue.
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8)

Remarks
Lecture notes:
The Productdevelopment knowledge base PKB will be provided in digital form for registered students. All lecture notes and additional slides will be provided in Ilias.

Course: Mechanical Design III [2145151]

Coordinators: A. Albers, N. Burkardt
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH], Entwicklung und Konstruktion (MACH) (p. 26)[BSc-MIT - B-PM3]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Winter term	de

Learning Control / Examinations
Concomitant to the lecture a workshops with 3 workshop sessions take place over the semester. During the workshop the students were divided into groups and their mechanical design knowledge will be tested during a colloquium at the beginning of every single workshop session. The attendance is mandatory and will be controlled. The pass of the colloquia and the process of the workshop task are required for the successful participation.
Further information's will be announced at Ilias and at the beginning of the lecture mechanical design III.

Conditions
Successful participation in mechanical design I and II.

Learning Outcomes
The students are able to ...

- identify different component connections and their application and to use them for particular problems.
- chose and dimension bolt connections for different boundary conditions.
- list different types of gears and their advantages and disadvantages.
- develop technical solutions in a team, evaluate the principal feasibility, implement their ideas in technical solutions and illustrate, plan and evaluate their own working- and decision process by using protocols and diagrams.

Content
component connection
bolt connection
gears

Media
Beamer
Visualizer
Mechanical components

Literature
Lecture notes:
The lecture notes can be downloaded via the eLearning platform Ilias.
Literature:
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X
or per full text access provided by university library
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8
CAD:
3D-Konstruktion mit Pro/Engineer - Wildfire, Paul Wyndorps, Europa Lehrmittel, ISBN: 978-3-8085-8948-9
Pro/Engineer Tipps und Techniken, Wolfgang Berg, Hanser Verlag, ISBN: 3-446-22711-3(für Fortgeschrittene)

Remarks
Lecture notes:
The Productdevelopment knowledge base PKB will be provided in digital form for registered students. All lecture notes and additional slides will be provided in Ilias.

Course: Mechanical Design IV [2146177]

Coordinators: A. Albers, N. Burkardt
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH], Entwicklung und Konstruktion (MACH) (p. 26)[BSc-MIT - B-PM3]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
Concomitant to the lecture a workshops with 3 workshop sessions take place over the semester. During the workshop the students were divided into groups and their mechanical design knowledge will be tested during a colloquium at the beginning of every single workshop session. The attendance is mandatory and will be controlled. The pass of the colloquia and the process of the workshop task are required for the successful participation.
Further information's will be announced at Ilias and at the beginning of the lecture mechanical design IV.

Conditions
Successful participation in mechanical design I, mechanical design II and mechanical design III.

Learning Outcomes
The students are able to ...

- differentiate different clutch systems, name their functions, explain system specific phenomena's und use the dimensioning basics for clutches.
- use different clutch systems depending on the particular application.
- name different types of dimensioning and relevant influencing parameters of load.
- name and use independently strength hypothesizes.
- perfom and use independently strength calculations.
- name the fundamental characteristics of hydraulic systems, fundamental symbols of fluid technic and to interpret function diagrams.
- design and dimension simple hydraulic facilities by using circuit diagrams.
- develop unconventional technical solutions in team work, evaluate their principal feasibility, implement their ideas in technical solutions and illustrate, plan and evaluate their own working- and decision process by using protocols and diagrams.
- create technical drawings according common standardization regulations.
- create a CAD model of technical systems by using the top down method.

Content
Basic connections - part 2
Coupling fundamentals
Function and working principles
Significant characteristics and classification
Non-shiftable shaft couplings
Shiftable shaft couplings
Elastic couplings
Gear transmission fundamentals
Function and working principles
Fundamentals of gear transmissions
Significant characteristics and classification
Selection criteria
Fundamentals of further gear drives
Fundamentals of lubrication and lubricants

Tooth system fundamentals
Function and working principles
Tooth pitch characters
Cycloid as slope curve
Evolvent as slope curve
Manufacturing technologies
Transverse contact ratio
Profile offset
Application limits and technical defects
Dimensioning
Root bearing
Flank bearing
Hydraulic fundamentals
Basic functions and working principles
Significant characteristics and classification
Model types and characteristics
Selection criteria
Application
Dimensioning

Media
Beamer
Visualizer
Mechanical components

Literature
Lecture notes:
The lecture notes can be downloaded via the eLearning platform Ilias.
Literature:
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X
or per full text access provided by university library
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8
CAD:
3D-Konstruktion mit Pro/Engineer - Wildfire, Paul Wyndorps, Europa Lehrmittel, ISBN: 978-3-8085-8948-9
Pro/Engineer Tipps und Techniken, Wolfgang Berg, Hanser Verlag, ISBN: 3-446-22711-3(für Fortgeschrittene)

Remarks
Lecture notes:
The product development knowledge base PKB will be provided in digital form for registered students. All lecture notes and additional slides will be provided in Ilias.

Course: Material flow in logistic systems [2117051]

Coordinators: K. Furmans
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
Inverted Classroom: preparation of lectures and giving them (50%)
solving case studies and defence of the solution (25%)
final - soving a case alone 25&
oral / written (if necessary) => (see "Studienplan Maschinenbau", current version)

Conditions
At most threee weekly tasks not successfully completed

Recommendations
Recommended compulsory optional subject:
Stochastics in mechanical engineering

Learning Outcomes
after successful completion of the course, you are able (alone and in a team) to:

- accurately describe a material handlingy system in a conversation with an expert
- Model and parameterize the system load and the typical design elements of a material hanfling system
- design a material handling system for a task
- Assess the performance of a material hanfling system in terms of the requirements
- Change the main lever for influencing the performance
- Expand the boundaries of today's methods and system components conceptually if necessary

Content

- elements of material flow systems (conveyor elements, fork, join elements)
- models of material flow networks using graph theory and matrices
- queueing theory, calculation of waiting time, utilization
- warehouseing and order-picking
- shuttle systems
- sorting systems
- simulation
- calculation of availability and reliability
- value stream analysis

Media
presentations, black board, book

Literature
Arnold, Dieter; Furmans, Kai : Materialfluss in Logistiksystemen; Springer-Verlag Berlin Heidelberg, 2009

Remarks
Students work in teams of 5 people
The lectures will be prepared on the basis of material provided by the students

The teams report, who has prepared what part, but everyone can present all parts
Randomly selected people hold a lecture part - about 20 minutes and allowed to another Teammember take.
Every two weeks will be processed in the team a case study and presented at an information market and defends
To conclude in a written examination, a case study is solved alone

Course: Materials and Processes for Body Lightweight Construction in the Automotive Industry [2149669]

Coordinators: D. Steegmüller, S. Kienzle
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are able to name the various lightweight approaches and identify possible areas of application.
- are able to identify the different production processes for manufacturing lightweight structures and explain their functions.
- are able to perform a process selection based on the methods and their characteristics.
- are able to evaluate the different methods against lightweight applications on the basis of technical and economic aspects.

Content
The objective of the lecture is to build up an overview of the relevant materials and processes for the production of a lightweight body. This includes both the actual production and the joining for the body. The lecture covers the different lightweight approaches and possible fields of application in the automotive industry. The methods are discussed with practical examples from the automotive industry.
The following topics will be covered:

- lightweight designs
- aluminum and steel for lightweight construction
- fibre-reinforced plastics by the RTM and SMC process
- joining of steel and aluminum (clinching, riveting, welding)
- bonding
- coating
- finishing
- quality assurance
- virtual factory

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Materials and Devices in Electrical Engineering [23211]

Coordinators: A. Weber
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	en

Learning Control / Examinations
Written Exam

Conditions
None.

Learning Outcomes
The lecture provides fundamental knowledge about Materials and Devices applied in Electrical Engineering.
The lecture of "Materials and Devices in Electrical Engineering" concerns the fundamental ideas of the electrical materials. It contains the minimum subject matter which can be recommended to the studying of "Electrical Engineering".

Content
Materials play a central role for the progress of technology and economy. Their applications determine the innovation degree of modern technologies like the information-, energy-, traffic-, manufacturing-, environmental and medical technology. Many innovations in electrical engineering could only be realized on the basis of new material and production engineering. Therefore the development of materials and their applications in systems become one of the key fields of the industrial technology in the 21st century with outstandingly high strategic meaning.
The lecture of "Materials and Devices in Electrical Engineering" concerns the fundamental ideas of the electrical materials.
Topics covered: Structure of Atoms and Solids, Electrical Conductors, Dielectric Materials, Magnetic Materials

Literature
William D. Callister, Materials Science and Engineering, John Wiley & Sons, Inc.,ISBN No. 0-471-32013-7

Remarks
Copies of the slides are available at http://www.iwe.kit.edu/.

Course: Mathematical methods of vibration theory [2162241]

Coordinators: W. Seemann
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
written or oral exam
Announcement 6 weeks prior to examination date.

Conditions
Technische Mechanik III, IV / Engineering Mechanics III, IV

Learning Outcomes
The students know to solve single differential equations with constant coefficients by various methods. For inhomogenious differential equations the inhomogenity may be arbitrary. They realize the relations between the different methods. For matrix-differential equations the students may derive the eigenvalue problem for free vibration and may obtain solutions for eigenvalues and eigenvectors. They know the modal transformation which is helpful to solve forced vibration. They may decide about stability of time-independent steady state solutions of nonlinear systems. They can derive boundary value problems by variational methods and know in principle how to solve them. For simple one-dimensional continua they may get analytical solutions. They can apply perturbation methods to derive analytical solutions for problems with small parameters.

Content
Linear, time-invariant, ordinary single differential equations: homogeneous solution; harmonic, periodic and non-periodic excitations; Duhamel's integral; Fourier and Laplace transform; introduction into the theory of distributions; Systems of ordinary differential equations: matrix notation, eigenvalue theory, fundamental matrix, forced vibrations via modal expansion and transition matrix; Introduction into the dynamic stability theory; Partial differential equations: solution in product form, eigenvalue theory, modal expansion using Ritz series; Variational methods, Hamilton's principle, boundary value problems representing vibrating continua; Perturbation methods

Literature
Riemer, Wedig, Wauer: Mathematische Methoden der Technischen Mechanik

Course: Mathematical Methods in Fluid Mechanics [2154432]

Coordinators: B. Frohnapfel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Summer term	de

Learning Control / Examinations
written

duration: 3 hours

Aux. means: formula sheet, pocket calculator

Conditions
None.

Recommendations
Basic Knowledge about Fluid Mechanics

Learning Outcomes
The students can to simplify the Navier-Stokes equations for specific flow problems. They are able to employ mathematical method in fluid mechanics effectively in order to solve the resulting conservation equations analytically, if possible, or to enable simpler numerical access to the problem. They can describe the limits of applicability of the assumptions made to model the flow behavior.

Content
The lecture will cover a selection of the following topics:

- Potential flow theory
- Creeping flows
- Lubrication theory
- Boundary-layer theory
- Laminar-turbulent transition (linear stability theory)
- Turbulent flows
- Numerical solution of the governing equation (finite difference methods)

Media
chalk board, Power Point

Literature
Kundu, P.K., Cohen, K.M.: Fluid Mechanics, Elsevier, 4th Edition, 2008
Batchelor, G.K.: An Introduction to Fluid Dynamics, Cambridge Mathematical Library, 2000
Pope, S. B.: Turbulent Flows, Cambridge University Press, 2000
Ferziger, H., Peric, M.: Computational Methods for Fluid Dynamics, Springer, 2008

Course: Mathematical models and methods in combustion theory [2165525]

Coordinators: V. Bykov, U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
The attendance of this course enables students to:

- study, understand and apply the fundamental concepts of combustion modelling,
- develop ideal models for the description of auto-ignition, explosions, flame quenching and detonations,
- understand the basic mathematical (asymptotic) methods applied in the analysis of these models,
- perform a mathematical analysis of the models,
- determine the mathematical properties of the solutions obtained from the models.

Content
The lecture shall introduce the basics of the mathematical modeling and the analysis of reacting flow systems. The fundamental models of combustion processes are outlined together with asymptotical methods, which deliver reasonable approximate solutions for numerous combustion processes. Many examples of simplified models for the description of auto-ignition, explosions, flame quenching and detonations will be presented and discussed. The main analytical methods will be illustrated using these simple examples.

Literature
Combustion Theory, F A Williams, (2nd Edition), 1985, Benjamin Cummins.
Combustion - Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, J. Warnatz, U. Mass and R. W. Dibble, (3nd Edition), Springer-Verlag, Heidelberg, 2003.
The Mathematical Theory of Combustion and Explosions, Ya.B. Zeldovich, G.I. Barenblatt, V.B. Librovich, G.M. Makhviladze, Springer, New York and London, 1985.

Course: Mathematical models and methods for Production Systems [2117059]

Coordinators: K. Furmans, J. Stoll
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	en

Learning Control / Examinations
oral

examination aids: none

Conditions
none

Recommendations
Basic knowledge of statistic
recommended compusory optional subject:

- Stochastics in Mecanical Engineering

recommended lecture:

- Material flow in logistic systems (also parallel)

Learning Outcomes
Students are able to:

- Describe material flow systems with analytical solvable stochastic models,
- Derive Approches for control systems (KANBAN) based on easy models of queueing theory,
- Execute practical exercised on workstations and
- Use simulation and exakt methods.

Content

- single server systems: M/M/1, M/G/1: priority rules, model of failures
- networks: open and closed approximations, exact solutions and approximations
- application to flexible manufacturing systems, AGV (automated guided vehicles) - systems
- modeling of control approaches like constant work in process (ConWIP) or kanban
- discrete-time modeling of queuing systems

Media
black board, lecture notes, presentations

Literature
Wolff: Stochastic Modeling and the Theory of Queues, Prentice Hall, 1989

Shanthikumar, Buzacott: Stochastic Models of Manufacturing Systems

Remarks
none

Course: Mechanics and Strengths of Polymers [2173580]

Coordinators: B. Graf von Bernstorff
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination

Duration: 20 - 30 minutes

no notes

Conditions
basic knowledge in materials science (e.g. lecture materials science I and II)

Learning Outcomes
The students are prepared to

- repeat the calculus on strength and design of engineering parts exposed to complex loadings,
- estimate the influence of time and temperature on the strength of polymeric materials,
- relate the strength of materials to their molecular structure, morphology and processing parameters and
- derive failure mechanisms for homogenuous polymers and composite materials therefrom.

Content
Molecular structure and morphology of polymers, temperature- and time dependency of mechanical behavior, viscoelasticity, time/temperature- superposition principle, yielding, crazing and fracture of polymers, failure criterions, impact and dynamic loading, corresponding principle, tough/brittle-transition, introduction to the principles of fiber reinforcement and multiple cracking in composites

Literature
A literature list, specific documents and partial lecture notes shall be handed out during the lecture.

Course: Mechanics in Microtechnology [2181710]

Coordinators: P. Gruber, C. Greiner
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
compulsory preconditions: none

Learning Outcomes
The students know and understand size and scaling effects in micro- and nanosystems. They understand the impact of mechanical phenomena in small dimensions. Based on this they can judge how they determine material processing as well as working principles and design of microsensors and microactuators.

Content
1. Introduction: Application and Processing of Microsystems
2. Scaling Effects
3. Fundamentals: Stress and Strain, (anisotropic) Hooke's Law
4. Fundamentals: Mechanics of Beams and Membranes
5. Thin Film Mechanics: Origin and Role of Mechanical Stresses
6. Characterization of Mechanical Properties of Thin Films and Small Structures: Measurement of Stresses and Mechnical Parameters such as Young'sModulus and YieldDtrength; Thin Film Adhesion and Stiction
7. Transduction: Piezo-resistivity, Piezo-electric Effect, Elektrostatics,...
8. Aktuation: Inverse Piezo-electric Effect, Shape Memory, Elektromagnetic Actuation,. . .

Literature
Folien,
1. M. Ohring: „The Materials Science of Thin Films", Academic Press, 1992
2. L.B. Freund and S. Suresh: „Thin Film Materials"
3. M. Madou: Fundamentals of Microfabrication", CRC Press 1997
4. M. Elwenspoek and R. Wiegerink: „Mechanical Microsensors" Springer Verlag 2000
5. Chang Liu: Foundations of MEMS, Illinois ECE Series, 2006

Course: Mechano-Informatics and Robotics [2400077]

Coordinators: T. Asfour
Part of the modules: Informatik (Robotik) (p. 29)[BSc-MIT - B-PI3], Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Mechatronical Systems and Products [2145161]

Coordinators: S. Matthiesen, S. Hohmann
Part of the modules: Mechatronics and Products (p. 20)[BSc-MIT - B8]

ECTS Credits	Hours per week	Term	Instruction language
3.5	3	Winter term	

Learning Control / Examinations
Written examination
No auxiliary material
Joint examination for lecture and project.

Conditions
Participation on the course mechatronic systems and products requires participation on the courses workshop mechatronic systems and products and cooperation in interdisciplinary teams at the same time.

Recommendations
None
Knowledge in CAD is advantageous but not necessary.

Learning Outcomes
The lecture provides the theoretic basics, which will be applied and enhanced in development project during the semester. The project will take part in small groups, where the students have to organize and distribute the tasks on their own. The educational objectives are as follows:
The students

- are able to describe the difficulties of interdisciplinary projects.
- are able to coordinate processes, structures, responsibilities and interfaces within a project.
- know different solutions for mechanic/electric problems.
- know the elements of the treated product development processes, are able to describe different views onto them and execute them.
- know the model based systems engineering approaches and the basics of modelling with SysML.
- know the basic principles of virtual design and are able to apply the methods of virtual system design.
- are able to identify the differences between virtuality and reality.
- are able to recognize the advantages of early validation.
- are able to work in teams.
- Students are able to understand and apply model description with Bond graphs and generalized system elements
- Students are able to synthesize and analyze multi-domain models
- Students are able to apply parameter identification methods

Content

- Introduction
- Product development processes
- MBSE and SysML
- Mechatronic selection of solutions
- Methods of early validation

- Architectural design
- Virtual functional design with mutli domain models
- identification
- Validation and verification
- Reflection and presentation of the team results

Literature

Alt, Oliver (2012): Modell-basierte Systementwicklung mit SysML. In der Praxis. In: Modellbasierte Systementwicklung mit SysML.
Janschek, Klaus (2010): Systementwurf mechatronischer Systeme. Methoden - Modelle - Konzepte. Berlin, Heidelberg: Springer.
Weilkiens, Tim (2008): Systems engineering mit SysML/UML. Modellierung, Analyse, Design. 2., aktualisierte u. erw. Aufl. Heidelberg: Dpunkt-Verl.

Remarks

All lecture notes and excercises are provided via the elearning platform ILIAS.

Course: Measurement II [2138326]

Coordinators: C. Stiller
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination

Duration: 30 minutes

no reference material

Conditions
None.

Recommendations
Fundamentals in measurement, system and control theory, e.g. from the lecture "Measurement and Control Systems"

Learning Outcomes
The capabilities of modern sensor technology pave the way for novel applications in engineering. Especially digital measurement techniques may be used even in very complex environments and thus have strong impact on technological progress. Stochastic models of measurement processes form the basis for meaningful information processing and provide a valuable tool for engineering. This interdisciplinary lecture addresses students in mechanical engineering and related subjects. The lecture gives an overview of digital technology and stochastics. These areas form the basics of estimation methods that can be embedded elegantly in the theory of state observers. Applications in signal processing for modern environmental perception (video, Lidar, Radar) illustrate the discussed subjects.

Content
1. Amplifiers
2. Digital technology
3. Stochastic modeling for measurement applications
4. Estimation
5. Kalman Filter
6. Environmental perception

Literature
Various Scripts

Course: Metals [2174598]

Coordinators: M. Heilmaier, K. von Klinski-Wetzel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Summer term	de

Learning Control / Examinations
Oral exam (appr. 30 min.) combined with “materials physics”.

Conditions
Materials physics

Learning Outcomes
The students are familiar with the thermodynamic foundations of phase transformations, the kinetics of phase transformations in the solid state, the mechanisms of microstructure formation and microstructure-property relationships and can apply them to metallic materials. They can assess the effects of heat treatments and of alloying on the microstructure and the mechanicla and physical properties of metallic materials. This competence is in particular deepened for iron- and aluminum-based alloys.

Content
Properties of pure elements; thermodynamic foundations of single-component and of binary systems, as well as multiphase systems; nucleation and growth; diffusion processes in crystalline materials; phase diagrams; effects of alloying; nonequilibrium microstructures; heat treatment technology

Literature
D.A. Porter, K. Easterling, Phase Transformation in Metals and Alloys, 2nd edition, Chapman & Hall, London 1997, J. Freudenberger: http://www.ifw-dresden.de/institutes/imw/lectures/lectures/pwe

Course: Methoden der Automatisierungstechnik [23184]

Coordinators: S. Hohmann
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	de

Learning Control / Examinations
Written Exam

Conditions
None.

Learning Outcomes
The goal of the lecture has still to be defined.
The lecture has still to be defined in more detail.
Supporting the lecture, assignments to the curriculum are distributed. Their solution is presented and discussed during lecture hall exercises.

Content

Literature
Supplements for the lecture are available on the IRS webpage (http://www.irs.kit.edu/).

Course: Methods of Signal Processing [23113]

Coordinators: Puente León
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Winter term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Knowledge of the fundamentals in signal processing and measurement engineering.

Learning Outcomes
After completing the course, students are able to:

- understand the basics of signal processing theory and describe the properties and the representation of signals.
- understand the fundamentals of time frequency analysis.
- understand the theroetical background of estimation theory and apply as well as evaluate various estimation techniques.
- apply the theoretical knowledge to practical problems.

Content
This lecture is offered to master students in electrical engineering and information technology who focus deeper in the field of signal processing and estimation theory.
During the last years, time frequency analysis became an important part of signal processing theory. By means of time frequency analysis, signals with variable frequency content can be analyzed. Thus, time frequency analysis and synthesis are discussed in detail. The lecture also gives an extensive overview about parameter estimation and state estimation theory.
The lecture starts with fundamentals on signal processing. The main signal properties are discussed. Signal representation in the Hilbert space is explained and different possibilities for signal representation in basis and frame are presented.
Time frequency analysis is introduced by the short time Fourier transform (STFT). The wavelet transform, its application and realization as well as another time frequency distribution – the Wigner-Ville distribution – are discussed.
The second part of the lecture is concerned with estimation theory. After fundamental considerations on signal modeling, parameter estimation techniques are introduced. Different estimators, like least squares, Gauß-Markov and so on are derived and compared. Subsequently, model based estimation and Bayes estimation is presented. The Kalman filter is discussed for state estimation.
The lecture "Methods of Signal Processing" moderates advanced knowledge in signal processing and estimation theory. The theoretical considerations are exemplified by numerous examples of real applications.

Literature
Uwe Kiencke, Michael Schwarz, Thomas Weickert: Signalverarbeitung - Zeit-Frequenz-Analyse und Schätzverfahren, Oldenbourg, 2008.

Course: Analysis tools for combustion diagnostics [2134134]

Coordinators: U. Wagner
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination, Duration: 25 min., no auxiliary means

Conditions
none

Recommendations
Fundamentals of Combustion Engines helpful

Learning Outcomes
The students can name and explain state-of-the-art methods to analyse the process in combustion as well as special measuring techniques such as optical and laser analysis. They are able to thermodynamically model, analyse and evaluate the engine process.

Content
energy balance at the engine
energy conversion in the combustion chamber
thermodynamics of the combustion process

flow velocities

flame propagation

special measurement techniques

Literature
Lecture notes available in the lectures

Course: Microoptics and Lithography [2142884]

Coordinators: T. Mappes
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral, duration 20 minutes, aids: none

Conditions
Basics in optics

Learning Outcomes

Content

Course: Microactuators [2142881]

Coordinators: M. Kohl
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
(1) as core subject in the major "Micoactuators and Microsensors" combined with the core subject "New Actuators and Sensors", oral, 60 minutes
or
(2) as optional subject, oral, 30 minutes

Conditions
None.

Recommendations
The lecture addresses students in the fields of mechanical engineering, mechatronics and information technology, materials science and engineering, electrical engineering and economic sciences. A comprehensive introduction is given in the basics and current developments on the microscopic length scale.
The lecture is core subject of the major course "Microactuators and Microsensors" of the specialization "Mechatronics and Microsystems Technology" in Mechanical Engineering.
Mechanical Engineering: Specialization M&M / Major 54

Learning Outcomes
- Knowledge of the actuation principles including pros and cons
- Knowledge of important fabrication technologies
- Explanation of layout and function of the microactuators
- Calculation of important properties (time constants, forces, displacements, etc.)
- Development of a layout based on specifications

Content
- Basic knowledge in the material science of the actuation principles
- Layout and design optimization
- Fabrication technologies
- Selected developments
- Applications

The lecture includes amongst others the following topics:

- Microelectromechnical systems: linear actuators, microrelais, micromotors
- Medical technology and life sciences: Microvalves, micropumps, microfluidic systems
- Microrobotics: Microgrippers, polymer actuators (smart muscle)
- Information technology: Optical switches, mirror systems, read/write heads

Literature
- Lecture notes
- D. Jendritza, Technischer Einsatz Neuer Aktoren: Grundlagen, Werkstoffe, Designregeln und Anwendungsbeispiele, Expert-Verlag, 3. Auflage, 2008
- M. Kohl, Shape Memory Microactuators, M. Kohl, Springer-Verlag Berlin, 2004
- N.TR. Nguyen, S.T. Wereley, Fundamentals and applications of Microfluidics, Artech House, Inc. 2002
- H. Zappe, Fundamentals of Micro-Optics, Cambride University Press 2010

Course: Microprocessors I [24688]

Coordinators: W. Karl
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes

Content

Media
Slides

Course: Modelling of Microstructures [2183702]

Coordinators: A. August, B. Nestler, D. Weygand
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Winter term	de

Learning Control / Examinations
We regularly hand out exercise sheets. The individual solutions will be corrected.
Exam: oral 30 minutes or written.

Conditions
None.

Recommendations
materials science
fundamental mathematics

Learning Outcomes
The student can

- explain the thermodynamic and statistical foundations for liquid-solid and solid-solid phase transition processes and apply them to construct phase diagrams.
- describe the specific characteristics of dendritic, eutectic and peritectic microstructures.
- explain the mechanisms of grain and phase boundary motion induced by external fields
- use the phase-field method for simulation of microstructure formation processes using modeling approaches and challenges of current research
- has experiences in computing and conduction simulations of microstructure formation from an integrated computer lab.

Content

- Brief Introduction in thermodynamics
- Statistical interpretation of entropy
- Gibbs free energy and phase diagrams
- Free energy functional
- Phasefield equation
- Gibbs-Thomson-equation
- Driving forces
- Grand chemical potential functional and the evolution equations
- For compare: Free energy functional with driving forces

Media
Black board and slides.

Literature

1. Gottstein, G. (2007) Physikalische Grundlagen der Materialkunde. Springer Verlag Berlin Heidelberg
2. Kurz, W. and Fischer, D. (1998) Fundamentals of Solidification. Trans Tech Publications ltd, Switzerland Germany UK USA

3. Porter, D.A. Eastering, K.E. and Sherif, M.Y. (2009) Phase transformation in metals and alloys (third edition). CRC Press, Taylor & Francis Group, Boca Raton, London, New York
4. Gaskell, D.R., Introduction to the thermodynamics of materials
5. Problem sheets

Course: Microsystems Technology [23625]

Coordinators: S. Hey
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
The goal of the lecture is to impart a basic knowledge on concepts and procedures out of the wide area of microtechnology and system engineering. In particular the ability to discuss technical subjects with experts of the different technical disciplines shall be acquainted.
Procedures and methodologies out of the area of micro structure technology as microlithography, edging technologies and ultra precise cutting machines are presented and the application of these technologies in the area of micromechanics and microoptics are discussed.

Content
In the begnning history and concept of microsystems technology will be discussed in the context of applications in automotive, production and medical engineering. Then the major technologies in micro structuring, as lithography, thin film techniques, edging procedures and ultra precise cutting methods are presented. Applications of these technologies especially in the fabrication of micro machining and micro optic components are described. For understanding different classes of microoptic elements an introduction in optics, diffraction and fiber optics technologies will be given. Various classes of microoptical components will be explained. In addition, both the concepts of refractive & diffractive optical components and active & passive waveguides belong to integrated optical systems and fibers. Micromechanical manufacturing processes with silicon and plastic using the LIGA procedure will be demonstrated by means of examples from automotive and medical applications.

Literature
Online material is available on: ILIAS

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- Menz, W. und Mohr, J.: Mikrosystemtechnik für Ingenieure. Wiley-VCH, Weinheim, 1997
- Mescheder, U.: Mikrosystemtechnik. B.G. Teubner, Stuttgart, 2000
- Gerlach, G. und Dötzel, W.: Grundlagen der Mikrosystemtechnik. Hanser, München, 1997
- Hecht, E.: Optics. Addison-Wesley, San Francisco, 2002
- Sinzinger, S. und Jahns, J.: Microoptics. Wiley-VCH, Weinheim, 1999
- Büttgenbach, S.: Mikromechanik. Teubner, Stuttgart, 1994
- Fatikow, S. und Rembold, U.: Microsystem Technology and Microrobotics. Springer, Berlin, 1997
- Gardner, J.W. und Varadan, V.K. and Osama O,A.: Microsensors, MEMS, and Smart Devices. Wiley-VCH, Weinheim, 2001

Remarks
Current information can be found on the ITIV (www.itiv.kit.edu) webpage and within ILIAS.

Course: Microwave Measurement Techniques [23420 + 23422]

Coordinators: M. Pauli
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	de

Learning Control / Examinations
Oral Exam

Conditions
Fundamentals on High Frequency Techniques

Learning Outcomes
The goal is to relay theoretical fundamentals and an understanding of basic measurement setups.
This course contains all the essential components of today's high frequency measurement techniques. Particular attention is given to the description of measurement systems and methodologies used in modern applications. A one-day excursion to companies that produce high-frequency measurement equipment and components is offered.

Content
Lecture
The lecture deals with the fundamental principles and gauges from today's high-frequency measurement systems. The course requires a basic understanding of RF technology and is conceived for 8th semester students.
The introduction of the lecture sets the necessary basics and provides the measurable parameters such as frequency and power up front. Additionally features specific to the measurement in the microwave frequency region are pointed out.
The first components are the measurement generators. First up follows a classification of generators, which are then discussed in detail. These generators include signal-, sweepgenerators and synthesizers. Assemblies, circuits, and typical block diagram of the oscillators used as the heart of measurement generators are presented. The conclusion of this part is the investigation of the output spectra of these generators.
In the following power and frequency measurements are discussed. For power measurements principal sources of error as well as the actual detectors are presented. As an example, the calorimeters, bolometers or Schottky diode are mentioned. Power measurements of pulsed and modulated signals conclude the power measurement topic. Concerning frequency measurements mechanical and electronic measurement gauges are explained. Block diagrams and procedures, both for the direct measurement as well as the heterodyne measurement principle are discussed.
Now to measure an entire spectrum and not just a single frequency the spectrum analyzer is introduced. After the fundamentals of spectral analysis follows the block diagram with the components of an analyzer. This part concludes with the physical limitations of such analyzers and application such as the measurement of spectra of modulated signals.
As a gauge of the modulation range, the frequency-time analyzer is discussed. Topics here are the zero dead time counters as the heart of the analyzer as well as measurements of frequency and phase dynamic, jitter and specific pulse compression modulations for Radar signals.
In the penultimate part of the lecture the measurement of phase noise is presented. After the an introduction the causes of phase noise and the definition of the various observables are discussed. Subsequently the different methods of measurement such as the direct measurement method, the phase discriminator method, the frequency discriminator method and Allan variance measurements in time domain are explained. At the end of this section, a comparison of the different presented methods is displayed.
The conclusion of the lecture is the linear network analysis. This begins with the presentation of the structure of a network analyzer. In addition, the difference between scalar and vector network analysis is shown. Besides the calibration of such network analyzers and the introduction of error models necessary to describe the calibration, Frequency Domain Reflectometry (FDR) is presented.
Exercises
Accompanying the lecture exercises as well as the lecture topics are deepened in a lecture hall exercise. In addition, an experimental half-day lecture in the laboratory is offered, which shows the measuring instruments in practice. Some standard measurements are presented. A one day excursion to a high-frequency technology company gives students an insight into the work of a radio frequency engineer.

Media
Lecture, exercises, experimental lecture and excursion

Literature
Thumm, M., Wiesbeck, W., Kern, S., Hochfrequenzmesstechnik-Verfahren und Messsysteme, BG. Teubner Verlag, Stuttgart, 2nd edition, 1998

Remarks
The course comprises of the interleaved lecture blocks and exercises. Additionally students get practical experience through the experimental lecture and the visit to a high-frequency technology company. Current information can be found on the IHE (www.ihe.kit.edu) webpage.

Course: MD - Team Orientated Mechanical Design (3 + 4) [2145154]

Coordinators: A. Albers, N. Burkardt
Part of the modules: Entwicklung und Konstruktion (MACH) (p. 26)[BSc-MIT - B-PM3], Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
2	2	Winter / Summer Term	

Learning Control / Examinations
Concomitant to the lecture mechanical design III and IV a workshop with 3 workshop sessions take place over each semester. During the workshop the students were divided into groups and their mechanical design knowledge will be tested during a colloquium at the beginning of every single workshop session. The attendance is mandatory and will be controlled. The pass of the colloquia and the process of the workshop task are required for the successful participation.
Further information's will be announced at Ilias and at the beginning of the lecture mechanical design III and IV.

Conditions
Workshop MD III:
Successful attendance on mechanical design I and II.
Workshop MD IV:
Successful attendance on mechanical design I, II and III.
A successful participation at the workshops in mechanical design III and IV is compulsory to attend the exam.

Learning Outcomes
The students are able to develop technical solutions in a team, to implement their ideas in technical solutions and to illustrate their own working- and decision process by using protocols and diagrams.

Content
Interrogation of the purchased knowledge in mechanical design by means of the workshop task.

Literature
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8
CAD:
3D-Konstruktion mit Pro/Engineer - Wildfire, Paul Wyndorps, Europa Lehrmittel, ISBN: 978-3-8085-8948-9
Pro/Engineer Tipps und Techniken, Wolfgang Berg, Hanser Verlag, ISBN: 3-446-22711-3 (für Fortgeschrittene)

Remarks
Bonus
The student can achieve an extra bonus for the mechanical design exam.
The bonus amounts to 0,3 exam points and it can only be achieved in case of passed MD-exam (lowest passing grade 4,0).
More details will be announced in mechanical design III and IV.

Course: Mobile Machines [2114073]

Coordinators: M. Geimer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Summer term	de

Learning Control / Examinations
oral examination.

Conditions
Knowledge in Fluid Power is required.

Recommendations
It is recommended to attend the course *Fluid Power Systems* [2114093] beforehand.

Learning Outcomes
After completion of the course the students have knowledge of:

- a wide range of mobile machines
- operation modes and working cycles of important mobile machines
- selected subsystems and components

Content

- Introduction of the required components and machines
- Basics of the structure of the whole system
- Practical insight in the development techniques

Media
Lecture notes.

Course: Mobile Communication [24643]

Coordinators: O. Waldhorst, M. Zitterbart
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	2/0	Winter term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Knowledge of the lectures *Introduction in Computer Networks* [24519] (or similar lectures) and *Telematics* [24128].

Learning Outcomes
The students are introduced to the fundamental terms used in mobile communications. They are equipped with a portfolio of basic methods for implementing mobile communication systems. Furthermore, they learn how prominent mobile communication systems with practical relevance are structured and operated. In this context, the students will develop an understanding of typical problems in mobile communication systems and learn how to chose and apply methods from the portfolio to solve them.

Content
The course starts with a discussion of typical problems related to wireless transmissions, e.g., signal propagation and fading, reflections and interference. Subsequently, it develops a portfolio of methods for modulation of digital data, multiplexing, coordination of concurrent medium access, and mobility management. To illustrate where and how these methods are applied in practice, typical mobile communication systems are introduced. These include wireless local area networks using IEEE 802.11, wireless personal area networks using Bluetooth, as well as wireless telecommunication systems using GSM, UTMS with HSPA and LTE. Discussions of network-layer mechanisms (e.g., mobile ad-hoc networks and MobileIP) and transport layer protocols close the course.

Media
Slides.

Literature
J. Schiller; Mobilkommunikation; Addison-Wesley, 2003.
Elective literature:
C. Eklund, R. Marks, K. Stanwood, S. Wang; IEEE Stadard 802.16: A Technical Overview of the WirelessMANTM Air Interface for the Broadband Wireless Access; IEEE Communications Magazine, June 2002.
H. Kaaranen, A. Ahtiainen, et. al., UMTS Networks – Architecture, Mobility and Services, Wiley Verlag, 2001.
B. O'Hara, A. Petrick, The IEEE 802.11 Handbook – A Designers Companion IEEE, 1999.
B. A. Miller, C. Bisdikian, Bluetooth Revealed, Prentice Hall, 2002
J. Rech, Wireless LAN – 802.11-WLAN-Technologien und praktische Umsetzung im Detail, Verlag Heinz Heise, 2004.
B. Walke, Mobilfunknetze und ihre Protokolle, 3. Auflage, Teubner Verlag, 2001.
R. Read, Nachrichten- und Informationstechnik; Pearson Studium 2004.
What You Should Know About the ZigBee Alliance http://www.zigbee.org.
C. Perkins, Ad-hoc Networking, Addison Wesley, 2000.
H. Holma, WCDMA For UMTS, HSPA Evolution and LTE, 2007

Course: Model based Application Methods [2134139]

Coordinators: F. Kirschbaum
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	

Learning Control / Examinations
take-home exam, short presentation with oral examination

Conditions
none

Recommendations
knowledge in Basics of combustion engines, vehicular systems, control theorie and statistics.

Learning Outcomes
The student can name the most important methods for model-based calibration of powertrain ECUs. Particulary he can choose and apply the correct approach for empirical modeling for a given powertrain calibration task (fuel consumption, emissions, air path, driveability, etc.) and type of plant (linear-nonlinear, static-dynamic, etc.). He is capable to solve typical Problems of a calibration engineer of automotive OEMs or suppliers.

Content
The efforts for the calibration of automotive powertrain ECUs are increasing due to new engine or powertrain technologies and tightening emission laws. From a present view only model based calibration methods are capable to handle this situation. The lecture presents a selection of practice-proofed model-based calibration methods.

Media
Lecture notes, blackboard, presentations and life demonstrations via projector

Course: Model Predictive Control [23188]

Coordinators: B. Pfeiffer
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
The goal is to relay theoretical and practical fundamentals on the field of control methods in distributed control systems and Model Predictive Control.
Students attending this lecture will obtain the theoretical background to apply Model Predictive Control and asses its advantages as well as its limitations. Three lectures will give the opportunity to hands on training and familiarize students with standard industry software.

Content
Introduction: Requirements of modern Automation Systems, Standards of Local PID-Control, Advanced control methods;
Architecture of modern process control systems, Advanced PID-Structures;
Tutorial Part I: PCS 7;
Principles of Model-based Predictive Control (MPC): Basic definitions (Modelling, Prediction, Optimization, Moving Horizon), Internal Model Control (IMC), General Structure of MPC;
Mathematical modelling and Identification of processes: Linear models, Nonlinear models, Suitability for MPC;
Tutorial Part II: MPC Engineering and Process identification;
MPC Approaches and Methods: Glossary, MPC for linear processes, MPC for nonlinear processes;
Online-Optimization for MPC: Linear Programming, Quadratic Programming;
Realization and Implementation of MPC: Commercial Software tools, Integration in process control systems;
MPC: Application and settlement of project: Conception , Installation and Test, Modelling, Controller design, Acceptability test, Maintenance;
Application examples: Distillation Column, Glass melting Process, Polymerization reactor;
Tutorial Part III: Predictive Control of distillation column

Literature
a) Dittmar, R., Pfeiffer, B.-M.: Modellbasierte prädiktive Regelung. Oldenbourg Verlag 2004.
b) Camacho, E. F., Bordons, C.: Model predictive control. Springer 1999.
c) Garcia, C. E., Prett, M., Morari, M.: Model predictive control: theory and practice – a survey. Automatica 25 No. 3, pp. 335-348, 1989.
d) Bergold, S.: Methoden zur Regelung von Mehrgrößenprozessen in der Verfahrenstechnik, Dissertation of the Universität Kaiserslautern, D386, 1999.

Remarks
The course comprises of the interleaved lecture blocks and tutorial parts. Current information can be found on the IRS webpage (http://www.irs.kit.edu/).

Course: Modelling and Identification [23166 + 23168]

Coordinators: S. Hohmann
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
The goal of the lecture is to impart knowledge about the theoretical and experimental modelling of dynamic systems. Lecture that deals with the fundamental engineering duty of modelling technical processes. This comprises as well the theoretical modeling based on the physical analysis leading to the equations of the process as the identification as the experimental determination of its parameters.
Supporting the lecture, assignments to the curriculum are distributed. Their solution is presented and discussed during lecture hall exercises.

Content
Lecture
Introduction: System design (System design based on requirements, heuristic system design, Model based system design), Modelling process (Top-Down approach, Validation and verification, Classes of models, Bottom-up approach);
Structuring: Overview, Structuring with Matlab/Simulink, Structured analysis);
Generalized equivalent circuit diagrams: Generalized Variables, Basic system elements (electrical and magnetic systems, mechanical systems, fluid systems. multi-port systems), interconnection rules;
Theoretical Modelling: Generalized network method, Variational method, Building of State space equations;
Identification with non-parametric models: Frequency response analysis, correlation analysis;
Identification with parametric models: Overview, Parameter identification, model adjustment methods, Least-squares method for static processes, Least-squares method for dynamic processes, Instrumental variables method, Maximum Likelihood method.
Exercises
To accompany the lecture material, assignments will be given out and discussed during lecture hall exercises.

Literature
Wellstead, P.E.: Physical System Modelling. Academic Press 1979.

Remarks
Supplementals for the lecture are available on the IRS webpage (http://www.irs.kit.edu/).
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the IRS webpage (http://www.irs.kit.edu/).

Course: Modeling of Thermodynamical Processes [2167523]

Coordinators: R. Schießl, U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter / Summer Term	de

Learning Control / Examinations
Exam prerequisite
Oral exam
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
After completing the course the students are able to:

- formulate thermodynamical basics in a mathematical scheme
- abstract and model complex thermodynamic processes.
- determine and implement adequate numerical schemes for the solution of the resulting systems of equations.

Content
Thermodynamic basics
Numerical solver strategies for algebraic equations
Optimization issues
Ordinary and partial differential equations
Application to various problems in thermodynamics (engine processes, determination of equilibrium states, unsteady processes in inhomogeneous systems)

Literature
Lecture notes
Numerical Recipes {C, FORTRAN}; Cambridge University Press
R.W. Hamming; Numerical Methods for scientists and engineers; Dover Books On Engineering; 2nd edition; 1973
J. Kopitz, W. Polifke; Wärmeübertragung; Pearson Studium; 1. Auflage

Course: Modelling and Simulation [2183703]

Coordinators: B. Nestler, P. Gumbsch
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Winter / Summer Term	de

Learning Control / Examinations
We regularly hand out exercise sheets. In addition, the course will be accompanied by practical exercises at the computer.
written examination: 90 minutes

Conditions
None.

Recommendations
preliminary knowlegde in mathematics, physics and materials science

Learning Outcomes
The student can

- explain the basic algorithms and numerical methods which are beside other applications relevant for materials simulations.
- describe and apply numerical solution methods for partial differential equations and dynamical systems
- apply numerical methods to solve heat and mass diffusion problems which can also be used to model microstructure formation processes
- has experiences in how to implement and program the introduced numerical methods from an integrated computer lab.

Content
The course gives an introduction to modelling and simulation techniques.
The following topics are included:
- splines, interpolation methods, Taylor series
- finite difference method
- dynamical systems
- numerics of partial differential equations
- mass and heat diffusion
- microstructure simulation
- parallel and adaptive algorithms
- high performance computing
- practical exercises

Media
Slides and black board. The slides will be provided as a manuscript for the course.

Literature

1. Scientific Computing, G. Golub and J.M. Ortega (B.G.Teubner Stuttgart 1996)

Course: Modeling and simulation of energy systems for buildings [2158206]

Coordinators: F. Schmidt
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations

Conditions
Can not be combined with the lecture Building Simulation [2157109]

Learning Outcomes

Content

Course: Modern Radio Systems Engineering [23430]

Coordinators: T. Zwick
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	en

Learning Control / Examinations
Oral Exam

Conditions
Basic knowledge of microwave and communications engineering

Learning Outcomes
At the end of this lecture the students will understand how to design an analogue frontend for a radio system on a block diagram level. Especially the non-idealities of typical radio frequency (RF) building blocks and their effects on the overall system performance will be part of the acquired knowledge.
The course gives a general overview of radio systems with their components. Thereby the focus is on the analogue parts of the system with their non-idealities. Based on the physical functionality of the various building blocks parameters are derived, which allow the consideration of their influence on the overall radio system performance.

Content
1. Introduction to radio systems
- Overview over wireless communication systems
- Modulation and detection
- Typical system performance parameters
- System components
2. Radio channel fundamentals and antennas
- Wireless radio channel
- Antenna parameters
3. Noise
- Noise sources
- Noise temperature, noise figure, signal-to-noise ratio
- Noise figure of cascaded stages
- Mixer noise calculation
- Noise calculation in base band
4. Non-linearity and time variance
- Effects of non-linearity: gain compression, inter-modulation
- Cascaded nonlinear stages
5. Sensitivity and dynamic range
6. Transceiver Architectures
- Transmitter architectures: heterodyne/homodyne
- Receiver architectures: heterodyne/homodyne, image-reject, digital-IF, sub-sampling
- Oscillators: phase noise, oscillator pulling and pushing
7. Case studies
- Generic PSK system
- UMTS receiver
- FMCW Radar

Literature
Material to the lecture can be found online at www.ihe.kit.edu.

Remarks
Current information can be found at the webpage of the IHE (www.ihe.kit.edu).

Course: Modern Control Concepts I [2105024]

Coordinators: L. Gröll
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam (after lecture period)

Conditions
none

Recommendations
Measurement and control systems

Learning Outcomes
After completion this lecture, the students are able

- to analyse linear systems with respect to different properties,
- to design linear feedback systems with feedforward add-on in time and frequency domain under consideration of input saturation, time delay, unmeasurable states and couplings between system parts,
- to use Matlab for simulation, analysis and synthesis in numerical and computeralgebraic way,
- to realise controllers per software in practice

Content

1. Introduction (classification, overviews, model simplification)
2. Simulation and analysis of dynamical systems with Matlab
3. Linearisation (equilibrium manifold, low-delta-method, Hartman-Grobman-theorem, design methodology for linear setpoint controller)
4. Two-degree-of-freedom control (structure, reference signal design)
5. PID-Controller (practical realisation, design hints, anti-windup-methods, Smith-predictor, switching technics, complex example)
6. Multi variable control and advanced control structures
7. State space (geometric view, role of zeros)
8. Tracking control with state feedback and supplemental integrator
9. Observer (LQG-design, disturbance observer, reduced observer)
10. Limits of control (existence subject, limits in time and frequency domain)

Literature

- Aström, K.-J., Murray, R.M.: Feedback Systems, 2012
- Rugh, W.: Linear System Theory. Prentice Hall, 1996

Course: Engine measurement techniques [2134137]

Coordinators: S. Bernhardt
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination, Duration: 0,5 hours, no auxiliary means

Conditions
None.

Recommendations
Combustion Engines A or Fundamentals of Combustion Engines I helpful

Learning Outcomes
The students are able to explain the principles of modern measuring devices and are able to determin the right device for a certain measuring problem. The are able to analyse and evaluate the results.

Content
Students get to know state-of-the-art measurement techniques for combustion engines. In particular basic techniques for measuring engine operating parameters such as torque, speed, power and temperature.

Possible measurement errors and abberations are discussed.

Furthermore techniques for measuring exhaust emissions, air/fuel ratio, fuel consumption as well as pressure indication for thermodynamic analysis are covered.

Literature
Lecture notes available in the lectures or in the 'Studentenhaus'

1. Grohe, H.:Messen an Verbrennungsmotoren
2. Bosch: Handbuch Kraftfahrzeugtechnik
3. Veröffentlichungen von Firmen aus der Meßtechnik
4. Hoffmann, Handbuch der Meßtechnik
5. Klingenberg, Automobil-Meßtechnik, Band C

Course: Multilingual Human-Machine Communication [24600]

Coordinators: T. Schultz, F. Putze
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes
The students will be introduced to the foundations of automatic speech recognition and processing. The lecture begins with the theoretical background on signal processing and models of speech production and perception. The focus here is on statistical methods. The current state of the art is presented using many real-world applications. After attending the lecture, students should be able to assess the potential as well as the challenges and limitations of modern speech technology and applications.

Content
The lecture offers an introduction to the foundations of automatic speech recognition and processing. The lecture begins with the theoretical background on signal processing and models of speech production and perception. The focus here is on statistical methods. Then, the central approaches and methods for a successful transition from theory to practice are presented. The current requirements for speech recognition and processing regarding globalization and multilingualism are illustrated using several examples of state of the art systems.
For further information, see http://csl.anthropomatik.kit.edu.

Media
slides (online at http://csl.anthropomatik.kit.edu)

Literature
Elective literature:
Xuedong Huang, Alex Acero und Hsiao-wuen Hon, Spoken Language Processing, Prentice Hall PTR, NJ, 2001
Tanja Schultz und Katrin Kirchhoff (Hrsg.), Multilingual Speech Processing, Elsevier, Academic Press, 2006

Remarks
Language of the lecture: German (English by request)

Course: Multimedia Communications [24132]

Coordinators: R. Bless, M. Zitterbart
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	2/0	Winter term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Knowledge of the lectures *Introduction in Computer Networks* [24519] (or similar lectures) and *Telematics* [24128].

Learning Outcomes
Objective of the lecture is to present techniques, procotols, and latest developments in Internet-based multimedia communications. Especially in the context of increasing amount of voice communications over the Internet (Voice over IP), key technologies and protocols such as RTP and SIP are intensively discussed so that their function and principles are understood in detail.

Content
This lecture describes techniques and protocols to transmit audio and video data over the Internet. Topics are audio/video conferences, audio/video transport protocols, Voice over IP SIP for signaling, establishment and control of multimedia sessions, RTP for transport of multimedia data over the Internet, RTSP for control of A/V streams, ENUM, A/V Streaming, Middleboxes and Caches, DVB, Advanced TVand Video on Demand.

Media
Slides. Protocol traces.

Literature
James F. Kurose, Keith W. Ross: Computer Networking, 6th Edition,
Pearson, 2013, ISBN-10: 0-273-76896-4, ISBN-13 978-0-273-76896-8,
Chapter Multimedia Networking
Weiterführend:
Stephen Weinstein: The Multimedia Internet, Springer, 2005, ISBN 0-387-23681-3
Alan B. Johnston: SIP – understanding the Session Initiation Protocol, 2nd ed., Artech House, 2004
R. Steinmetz, K. Nahrstedt: Multimedia Systems, Springer 2004, ISBN 3-540-40867-3
Ulrick Trick, Frank Weber: SIP, TPC/IP und Telekommunkationsnetze, Oldenbourg, 4. Auflage, 2009

Course: Multirate Systems [23548 + 23549]

Coordinators: H. Göckler
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
Basics of Digital Signal Processing

Learning Outcomes
The goal is to relay theoretical and practical fundamentals
Presentation of fundamental methods to represent, analyse, simulate, and synthesise digital multirate systems in conjunction with associated filter banks as well as signal flow graphs of the underlying algorithms.
Supporting the lecture, assignments to the curriculum are distributed. Their solution is presented and discussed during lecture hall exercises.

Content
Tasks and goals of sample rate conversion. Fundamentals of sample rate conversion: Discrete sampling, polyphase and aliasing component representations.
Sample rate reduction and increase, synchronous decimation and interpolation by an integer (L,M) and a rational (L/M) conversion factor, asynchronous, time-varying sample rate conversion.
Transposition of multirate systems: Complementary and inverse system, transposition invariant properties.
Basics on filter design for multirate systems: appropriate specification, survey of design approaches and their suitability.
Efficient filter structures for sample rate conversion: FIR filters, polyphase and Farrow structures.
Efficient algorithms for sample conversion.
M-channel filter banks: Analysis and synthesis bank (matrix representation), frequency (de)multiplexer, subband coder and transmultiplexer filter bank.
Aliasing-free and perfectly reconstructing filter banks, paraunitarity, spectral factorisation.
Efficient filter bank implementations: Uniform complex-modulated filter bank, DFT-polyphase filter bank, tree-structured filter banks.
Applications (CATV system, satellite communications); Challenging exercises with detailed standard solutions supplemented with share-ware MATLAB routines in Internet

Literature
Textbook „Multiratensysteme“ is provided (15 copies) by the university library. It represents the basis of lecture and exercises.

Course: Nachrichtentechnik I [23506]

Coordinators: F. Jondral
Part of the modules: Kommunikationstechnik (ETIT) (p. 23)[BSc-MIT - B-PE3], Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Summer term	de

Learning Control / Examinations

Conditions
Mathematics I – III, Probability Theory, Signals and Systems

Learning Outcomes

Content
This lecture provides an introduction to communications based on mathematics and systems theory.
The first chapter covers signals and systems in the complex baseband. It is shown that essential portions of signal processing may be performed at the equivalent lowpass representation (which is in most cases efficient in terms of computing effort). The second chapter introduces basic notations of Shannon's information theory. Here, specific attention is given to the definitions of *information* and *channel capacity*. The third chapter is on transmission channels in mobile communication.
The fourth chapter introduces to the problem of source coding and demonstrates facsimile transmission as a practical application. Chapters five and six are on channel (forward error correction) coding. After general comments on channel coding, the first part of this presentation deals with block codes whereas in the second part convolutional coding is discussed together with the Viterbi-algorithm as the fundamental decoding method.
The most popular modulations modes are treated in chapter seven. The introduction of phase shift keying (PSK) as well as of minimum shift keying are on focus here. A section on multicarrier transmission is integrated in order to underline the increasing acceptation of this technology in broadcast, wireless local area networks and mobile communications. Chapter eight considers the foundations of decision theory like it is applied signal detection in Radar or for demodulation in communications. Demodulators are on focus too in the ninth chapter. Here, special attention is given to PSK and MSK again.
Chapter ten points out the compromises a system's developer has to respond to when working on practical problems. Shannon's limit, that gives the maximum symbol rate up to which in principle a transmission is possible with arbitrary low error rate, as well as bandwidth efficiency, an effective quality criterion for transmission with respect to licensing costs are discussed. Chapter eleven is on multiple input multiple output (MIMO). MIMO methods provide a means for increasing the capacity in mobile networks. They play a prominent role in communications research over the last couple of years. Now, they are about to be introduced into practical applications. Chapter twelve covers the basic schemes of frequency division multiple access (FDMA), time division multiple access (TDMA) and code division multiple access (CDMA).
Chapters 13 and 14 pick up the areas of synchronization and channel equalization that are essential for almost every receiver. Chapter 15 provides a short overview over networking with special emphasis on the open systems interconnection (OSI) layered model for communications. The last three chapters successively introduced the global system for mobile communications (GSM), the universal mobile communications system (UMTS) and, representing broadcast systems based on OFDM digital audio broadcast (DAB).

Literature
Will be announced in the lecture.
Elective literature:
Will be announced in the lecture.

Remarks
The lecturer reserves the right to alter the contents of the course without prior notification.

Course: Nachrichtentechnik II [23511]

Coordinators: H. Jäkel, F. Jondral
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3/1	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content
The lecture Nachrichtentechnik II broadens and complements knowledge acquired in the lecture Nachrichtentechnik I. The lecture covers the following topics:
Communication basics and Transmission characteristics: This section discusses the vector representation of signals with orthogonal base functions and the transition from the base band to the band pass region. The representation is used to introduce transmission characteristics like spectrum or error probability for linear modulation techniques. Furthermore, the first and the second Nyquist criterion are discussed.
The mobile channel: Modeling of the mobile channel as well as its description within the coherence context are topics of this section. The tapped-delay-line model is introduced and common fading models like Rayleigh, Rice or Nakagami are discussed.
Equalization: This section is motivated by the signal distortion caused by the mobile channel. The functionality of the zero-forcing equalizer, the MMSE and FIR-based equalizers are analyzed.
Synchronization: A coherent transmission of data requires synchronization in the receiver. Several methods for time, frequency and phase synchronization are derived and founded on estimation theory.
Data link Control: This chapter focuses on the data link layer in the ISO/OSI model. The data flow control as well as multiplexing and access methods are discussed. Queuing theory is introduced for analysis. All methods are motivated by examples of protocols and MAC specifications.

Literature
Will be announced in the lecture.

Course: Nanoelectronics [23668]

Coordinators: M. Siegel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
To understand the reasons behind Moore's Law and CMOS scaling. To understand the electrical properties of silicon devices as they are scaled below 100nm. To understand principles of nano-devices (SET, Coulomb blockade, nano flash) To understand resonant tunneling devices. To understand superconducting nano sensors and devices (SPD, Nano-JJ). To understand the various methods to fabricate and measure nanoscale features. To understand nano devices for quantum computing.

Content

-
- Moore's Law Microelectronic
- Roadmap Characteristics of Electrons
- Limits of Silicon Technology
- New ultimate MOSFET's (Nanotubes, organic FET)
- Nanoelectronic Devices
- Single-electron Transistor (Coulomb blockade, Nano-Flash)
- Nanoscaling Memory Devices
- Resonant Tunnelling Devices
- Superconducting Nanostructures (Nano-JJ, SPD)
- Molecular electronics
- Characteristics of Nanostructures
- Devices and Circuits for Quantum computers

Literature
Online material is available on: www.ims.kit.edu

Course: Nanoplasmonics [23743]

Coordinators: H. Eisler
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	en

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
The lecture series deals with the fundamentals of light-matter interaction, especially with nanoscale metal systems for the next generation of information technology. The synergy of utilizing light as the carrier of information beyond the diffraction limit opens the horizon for high packing density of plasmonic transmission lines with high speed information bandwidth capabilities.

Content
Basics, Fundamentals, Volume: 3D-case
• General introduction and motivation
• Short history of nanoplasmonics
• Mawell's Equations
• Optical properties of simple metals
Nanoscale Surface: 2D-Case
• Surface Plasmons and Surface Plasmon Polariton (SPP)
• SPPs at one and two interfaces (IMI introduction)
• SPP excitation with light and SPP sensors
• Imaging SPP propagation
Nanoscale Single Entities: 0D-Case
• Localized Surface Plasmon (LSP)
• Mie scattering and beyond
Nanoscale Single Entities: 1D-Case
• Resonant Optical Antenna
• Optical Antennas as pointed structures
• Plasmon particle coupling

Remarks
You will find the newest Information online on https://studium.kit.edu/

Course: Nanoscale Systems for Optoelectronics [23716]

Coordinators: H. Eisler
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	en

Learning Control / Examinations
Oral exam

Conditions
Optics, Solid State Physics

Learning Outcomes
Bridging the EE Education towards quantum confined materials systems, fundamentals and applications as prototype and serial devices, such as quantum dot Smart TV screens, quantum dot PV, quantum dot single photon sources

Content
Interaction of Light with Nanoscale Systems
- general introdcution and motivation
- artificial quantum structures (semiconductor quantum dots, quantum wires...)
- quantum dot lasers, quantum dot-LED, quantum materials solar cells, single photon sources
Optical Interactions between Nanoscale Systems
- Förster energy transfer (dipole-dipole interaction)
- super-emitter concept
- SERS (surface enhanced Raman spectroscopy: bio-sensors)

Literature

- Principles of Nano-Optics, L. Novotny and B. Hecht, Cambridge University Press, 2006
- Absorption and Scattering of Light by Small Particles, C. F. Bohren and D. R. Huffman, John Wiley& Sons, INC. 1998
- Principles of Optics, Born and Wolf, Cambridge Univ

Remarks
You will find the newest Information online on https://studium.kit.edu/

Course: Nanotechnology with Clusterbeams [2143876]

Coordinators: J. Gspann
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
written examination
presence in more that 70% of the lectures
Duration: 1 h

aids: none

Conditions
None.

Learning Outcomes
Nanotechnology is presented on the basis of a technology for nano- and microstructuring by accelerated nanoparticles (clusters), mainly in view of nanomechanics.

Content
Nanotechnology in biology
Nanosystemstechnology
Cluster beam generation, ionisation and acceleration; cluster properties
Structure generation using accelerated metal clusters
Structuring via gas cluster impact; reactive accelerated cluster erosion (RACE)
Atomic force microscopy of impact structures; nanotribology
Comparison with femtosecond laser machining (Winter term only)
Simulations; Fullerene synthesis, impact structures, visionary nanomachinery

Literature
Foil copies with short commentaries are distributed during the lectures.

Course: Nanotribology and -Mechanics [2181712]

Coordinators: M. Dienwiebel, H. Hölscher
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2		

Learning Control / Examinations
presentation (40%) and oral examination (30 min, 60%)

no tools or reference materials

Conditions
preliminary knowlegde in mathematics and physics

Learning Outcomes
The student can

- explain the physical foundations and common models used in the field of nanotribology and nanomechanics
- describe the most important experimental methods in nanotribology
- critically evauate scientific papers on nanotribological issues with respect to their substantial quality

Content
Part 1: Basics:

- Nanotechnology
- Forces at nanometer scale
- contact mechanics models (Hertz, JKR, DMT)
- Experimental methods (SFA, QCM, FFM)
- Prandtl-Tomlinson model
- Superlubricity
- Atomic-Scale Wear

Part 2: Topical papers

Literature
Lecture notes, slides and copies of articles

Course: Meshes and point clouds [24122]

Coordinators: H. Prautzsch
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes
Students are introduced into an active research area and will be acquainted with the important common techniques.

Content
Data structures for point clouds and triangular meshes, triangulation algorithms, marching cubes, fairing and mesh smoothing, parametrization, hierarchical representations, segmentation, deformation transfer, animation.

Media
Blackboard and slides

Literature
Elective literature:
See http://i33www.ira.uka.de/pages/Lehre/Vorlesungen/NetzeUndPunktwolken.html

Course: Network Security: Architectures and Protocols [24601]

Coordinators: M. Zitterbart
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4	2/0	Summer term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Knowledge of the lectures *Introduction in Computer Networks* [24519] (or similar lectures) and *Telematics* [24128].

Learning Outcomes
The course aims at teaching fundamental concepts of the design of secure communication protocols. More advanced topics include existing security protocols of the internet and local networks.

Content
The lecture Network Security: Architectures and Protocols considers challenges and technologies in the design of secure communication protocols, as well as topics of data security and privacy. Complex systems like Kerberos will be discussed explicitly and their design decision considering security aspects will be outlined. A special focus is set on PKI-basics, infrastructures, as well as on specific PKI-formats. Furthermore, an emphasis is set on the commonly used security protocols IPSec, TLS/SSL, and protocols of infrastructure security.

Media
Slides.

Literature
Roland Bless et al. Sichere Netzwerkkommunikation. Springer-Verlag, Heidelberg, Juni 2005.
Elective literature:

- Charlie Kaufman, Radia Perlman, and Mike Speciner. Network Security: Private Communication in a Public World. 2nd Edition. Prentice Hall, New Jersey, 2002.
- Carlisle Adams and Steve Lloyd. Understanding PKI. Addison Wesley, 2003
- Rolf Oppliger. Secure Messaging with PGP and S/MIME. Artech House, Norwood, 2001.
- Sheila Frankel. Demystifiying the IPsec Puzzle. Artech House, Norwood, 2001.
- Thomas Hardjono and Lakshminath R. Dondeti. Security in Wireless LANs and MANs. Artech House, Norwood, 2005.
- Eric Rescorla. SSL and TLS: Designing and Building Secure Systems. Addison Wesley, Indianapolis, 2000.

Course: Novel actuators and sensors [2141865]

Coordinators: M. Kohl, M. Sommer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
(1) as core subject in the major "Microactuators and Microsensors" combined with the core subject "Micro Actuators", oral, 60 minutes
or
(2) as optional subject, oral, 30 minutes
Tutorial „not graded":
- 1 assignment about 5 pages and 1 presentation, 15 minutes in the tutorial, 2 ECTS
Successful attendance is required for the oral exam

Conditions
None.

Learning Outcomes
- Knowledge of the principles of actuation and sensing including pros and cons
- Explanation of layout and function of important actuators and sensors
- Calculation of important properties (time constants, forces, displacements, sensitivity, etc.)
- Development of a layout based on specifications

Content
Contents: - Basic knowledge in the material science of actuator and sensor principles
- Layout and design optimization
- Fabrication technologies
- Selected developments
- Applications
Index: The lecture includes amongst others the following topics:

- Piezo actuators
- Magnetostrictive actuators
- Shape memory actuators
- Electro-/magnetorheological actuators
- Sensors: Concepts, materials, fabrication
- Micromechanical sensors: Pressure, force, inertia sensors
- Temperature sensors
- Micro sensors for bio analytics
- Mechano-magnetic sensors

The lecture addresses students in the fields of mechanical engineering, mechatronics and information technology, materials science and engineering, electrical engineering and economic sciences. A comprehensive introduction is given in the basics and current developments on the macroscopic length scale.
The lecture is core subject of the major course "Actuators and Sensors" of the specialization "Mechatronics and Microsystems Technology" in Mechanical Engineering.

Literature
- Lecture notes
- Donald J. Leo, Engineering Analysis of Smart Material Systems, John Wiley & Sons, Inc., 2007
- „Sensors Update", Edited by H.Baltes, W. Göpel, J. Hesse, VCH, 1996, ISBN: 3-527-29432-5
- "Multivariate Datenanalyse – Methodik und Anwendungen in der Chemie", R. Henrion, G. Henrion, Springer 1994, ISBN 3-540-58188-X

Course: Neutron physics of fusion reactors [2189473]

Coordinators: U. Fischer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
None.

Learning Outcomes
The aim of this lecture is to provide the neutron physics principles required for analysis of nuclear fission and fusion reactors. First of all, the basic nuclear interaction processes are presented which are important for the physical behaviour of the reactors. Next the neutron transport phenomenon in matter is described by means of the Boltzmann transport equation. Suitable mathematical solution methods are presented such as the diffusion approximation for nuclear fission reactors and the Monte Carlo method for fusion reactors. The knowledge acquired will eventually be used to solve neutron physics problems related to the design and optimization of the reactors.

Content
Nuclear interaction processes and energy release

Chain reaction and criticality

Neutron transport, Boltzmann equation

Diffusion approximation, Monte Carlo method

Neutronic reactor design

Literature
K. H. Beckurts, K. Wirtz, Neutron Physics, Springer Verlag, Berlin, Germany (1964)

W. M. Stacey, Nuclear Reactor Physics, John Wiley & Sons, Wiley-VCH, Berlin(2007)

J. Raeder (Ed.), Kontrollierte Kernfusion. Grundlagen ihrer Nutzung zur Energieversorgung, Teubner, Stuttgart (1981)

Course: Nonlinear Control Systems [23173]

Coordinators: M. Kluwe
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations
Written Exam

Conditions
Knowledge of the basics of system dynamics and Control Engineering is assumed. Therefore it is recommended to attend for example the course 23155 Systemdynamik und Regelungstechnik (contained in the Bachelor-module Systemtheory) beforehand.

Learning Outcomes
The goal is to relay theoretical and practical fundamentals on the field of nonlinear control.
Advanced lecture in the field of nonlinear System Dynamics and Control that teaches students to carry out description, analysis and synthesis of nonlinear control systems.

Content
Nonlinear systems (definition, description and typical structures), stability of nonlinear systems;
Analysis and synthesis of nonlinear systems in the phaseplane:
Principles, trajectories of the nonlinear control-loop and stability of equilibrium points;
Lyapunov-stability of nonlinear systems:
principle of Lyapunov's stability theorem, stability criterias, additional criterias for stability and instability, stability analysis, Lyapunov's stability theorem for linear and linearized systems;
Synthesis of nonlinear systems in state space:
Exact feedback linearization of nonlinear SISO- and MIMO-systems;
Harmonic Balance:
Describing Function and the harmonic balance equation, Describing Function and the nonlinear polar plot, detection of oscillations with the harmonic Balance, stability of oscillations and equilibrium points;
Popov criterion:
Absolute stability and prerequisites of the Popov criterion, Definition and application of the Popov criterion, extensions and boundaries of the Popov criterion.

Literature

- Föllinger, Otto: Nichtlineare Regelungen (Band I und II). 8. Auflage, Oldenbourg Verlag 1998

Elective literature:

- Khalil, H.K.: Nonlinear Systems. Prentice-Hall 1996
- Isidori, A.: Nonlinear Control Systems, An Introduction. 3. Auflage, Springer Verlag 1995

Remarks
Supplemental sheets for the lecture are available on the IRS webpage.
Furthermore, the demonstrations in Matlab/Simulink used in the lecture for visualization of the presented topics can be downloaded from the IRS webpage (http://www.irs.kit.edu/) for own experiments.

Course: Nuclear Medicine and Measuring Techniques I [23289]

Coordinators: F. Maul, H. Doerfel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Winter term	de

Learning Control / Examinations
oral exam

Conditions
None.

Learning Outcomes
The course presents the connection between clinical problems and their metrological solution on the basis of nuclear medical examples from function diagnosis and therapy.
The basic concept of the course is the presentation of metrological procedures illustrated by nuclear medical examples by both lecturers. Basic metrological and nuclear medical concepts are communicated. The course includes an excursion to the Research Centre Karlsruhe with a visit of the whole body counter in order to measure the natural radioactivity in the body of the students.

Content
- Virtual tour through a nuclear medical establishment and introduction into basic concepts of nuclear physics
- Physical and biological interactions of ionizing radiation
- Design of nuclear medical detector systems using the example of Iodine metabolism
- Biokinetics of radioactive materials for internal dosimetry and determination of kidney clearance
- Impact of statistical uncertainties and biological fluctuations on the analytical results
- Quality control: metrological and medical standardization of analytical methods
- Epidemiological data and models for cost-benefit assessment.

Remarks
Current information can be found on the IBT (http://www.ibt.kit.edu/) webpage and within the eStudium-teachingplatform (www.estudium.org).

Course: Nuclear Medicine and Measuring Techniques II [23290]

Coordinators: H. Doerfel, F. Maul
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
1,5	1	Summer term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Learning Outcomes
The course deals with the measuring techniques of scintigraphy, SPECT and PET using appropriate medical examples. Nuclear medical concepts are communicated as well as basic clinical terms. In this context important diseases are addressed such as coronary heart and cancer diseases.
The winter term course „Nuclear Medicine and Measuring Techniques I" is not required for this course. On the other hand there is only small overlapping of both courses. The summer term course mainly addresses the qualitative and quantitative nuclear medical imaging procedures. Other imaging procedures of nuclear medicine are also considered. The lectures are presented by both lecturers together in order to emphasise the various links in between nuclear medicine and measuring techniques. The course includes an excursion to the Nuclear Medical Clinic of the Karlsruhe Municipal Clinical Centre.

Content
- Overview of scintigraghic methods for medical examination and introduction into medical imaging
- Planar and whole body scintigraphy using the example of visualisation of bone remodelling (skeletal szintigraphy)
- Tomography (SPECT) for visualisation of myocardial blood flow
- Metrological conditions for quantification of myocardial scintigraphy for prognostic assessment
- PET and PET/CT for diagnostics of cancer dimension
- Quantitative assessment of diagnostic radiopharmaceuticals *in vivo* for evaluation of malign disease biology
- Quantitative intercomparisons of regional metabolism of healthy and diseased subjects by means of FDG brain PET

Remarks
Current information can be found on the IBT (http://www.ibt.kit.edu/) webpage and within the eStudium-teachingplatform (www.estudium.org).

Course: Numerical field calculation in Computer Aided Design environments [23386]

Coordinators: B. Schaub
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Learning Outcomes
Practical application of field simulation in state-of-the-art computer aided design environments
Computer aided simulation based design is nowadays common practice in engineering departments of the electrical power industry as well as in all other branches of industry. In order to reduce development cost and time and to avoid design errors already in early phases of the development process, future products are optimized using simulation models (so-called virtual prototypes) long before a physical prototype has to be build and tested. High performance hardware, together with efficient mathematical methods for modeling, simulation and visualization allow for a realistic representation of geometric and visual appearance of the future product as well as its physical properties and functionalities.
The lecture aims to convey a basic understanding of the computer-aided product development process (commonly known as Computer Aided Engineering, CAE), and of the underlying methods and tools, whereas the main focus is on methods for numerical field calculation. The prospective engineer shall be enabled to work in a state-of-the-art environment for product development in an effective and efficient way.

Content
The lecture starts with an introduction to the process of computer aided product design. Methods, tools and data models which are available to the engineer in a state-of-the-art environment for simulation based product design are presented. Particular topics are goals and approach of simulation based design, product data management (PDM), product lifecycle management (PLM), product models as well as tools and methods for modelling, simulation, calculation and visualization.
The second part of the lecture is dedicated to the topic of simulation, which is the most important component of simulation based design. After an introduction of the different types and application areas of simulation, an emphasis is put on numerical field calculation, a type of simulation widely used in product development. The whole process of numerical field calculation, starting from modelling to solving and results visualization is explained.
After a review of some basics of field theory and discrete mathematics, an overview of field calculation methods is presented. Numerical, analytical and experimental methods are compared. The following part of the lecture is focused on numerical methods only, since these methods are of high significance for simulation based product design.
The following methods for numerical field calculation are discussed in detail:

-
- Finite difference method (FDM)
- Finite element method (FEM)
- Integral Methods

Mesh-free methods, e.g. Monte Carlo method
After a detailed discussion of these methods with emphasis on the Finite Element Method, some supporting methods the process of numerical field calculation are introduced. These are particularly methods for modelling and meshing (i.e. creation of a simulation model), as well as methods or the presentation of results and the calculation of secondary results. Since every numerical field calculation requires the solution of a large, linear or nonlinear system of equations, underlying mathematical methods are reviewed and compared with respect to their practical applicability.

The last part of the lecture deals with the hardware and software environment, which is needed for an efficient application of simulation based design in the context of product development. The main focus here is the deployment of parallel computing environments and the therefore required parallelization of the most critical algorithms.

Literature
A script and all presentations used during the lecture are available as PDF files on CD. Further literature is mentioned at the end of each chapter in the script.

Course: Numerical Mathematics [0187400]

Coordinators: C. Wieners, D. Weiß, Neuß, Rieder
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature
Elective literature:
- lecture notes (N. Neuß)
- W. Dahmen/A. Reusken: Numerik für Ingenieure und Naturwissenschaftler

Course: Numerical Modeling of Multiphase Flows [2130934]

Coordinators: M. Wörner
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination (in German or English language)
Duration: 30 minutes
Auxiliary means: none

Conditions
Bachelor

Learning Outcomes
The students can describe the physical fundamentals of multiphase flows (with focus on gas-liquid flows). The students are qualified to select for multiphase flow applications in energy and process engineering appropriate numerical methods and physical models, and to thoroughly evaluate the simulation results, so as to anaylze the specific advantages, disadvantages and restrictions of each method.

Content

1. Introduction in the subject of multi-phase flows (terms and definitions, examples)
2. Physical fundamentals (dimensionless numbers, phenomenology of single bubbles, conditions at fluid interfaces, forces on a suspended particle)
3. Mathematical fundamentals (governing equations, averaging, closure problem)
4. Numerical fundamentals (discretization in space and time, truncation error and numerical diffusion)
5. Models for interpenetrating continua (homogeneous model, algebraic slip model, standard two-fluid model and its extensions)
6. Euler-Lagrange model (particle equation of motion, particle response time, one-/two-/four-way coupling)
7. Interface resolving methods (volume-of-fluid, level-set and front-capturing method)

Literature
A brief script can be downloaded from http://bibliothek.fzk.de/zb/berichte/FZKA6932.pdf.
Powerpoint presentations can be downloaded after each lecture from the ILIAS system.
A list of recommended books is provided in the first lecture.

Remarks
For some topics of the lecture exercises are provided (working on them is optional).

Course: Numerical simulation of reacting two phase flows [2169458]

Coordinators: R. Koch
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral exam
Duration: approximately 30 minutes

no tools or reference materials are allowed

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have the ability to:

- describe and apply the governing equations of fluid mechanics
- select and judge appropriate methods for predicting turbulent flows
- explain the procedures of numerical solver algorithms
- judge the numerical methods, on which comon CFD software is based
- judge and apply different approaches to characterize sprays
- apply methods for predicting the break up of liquids
- analyse and evaluate methods and models for the calculation of mulitphase flows
- describe reactive flows and the corresponding models

Content
The course is devoted to diploma/master students and doctoral candidates of mechanical and chemical engineering. It gives an overview of the numerical methods used for CFD of single and two phase flows. The course introduces methods for reacting single and two phase flows, as they are typically found in gas turbines and piston engines operated by liquid fuel.
1. Single phase flow: Basic equations of fluid dynamics, Turbulence: DNS, LES, RANS; Finite volume methods, Numerical solvers.

2. Two phase flows: Basics of atomisation, Characterisation of sprays, Numerical prediction of droplet movement, Numerical methods for predicitng of liquid disintegration (VoF, SPH), Numerical methods for secondary atomisation; Droplet evaporation

3. Reacting flows: Combustion models; Single droplet combustion, Spray combustion.

Literature
Lecture notes

Course: Numerical Simulation of Turbulent Flows [2153449]

Coordinators: G. Grötzbach
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
oral;

Duration: 30 minutes

no auxiliary means

Conditions
None.

Recommendations
basics in fluid mechanics

Learning Outcomes
The students are qualified to describe the fundamentals of direct numerical simulation (DNS) and large eddy simulation (LES) of turbulent flows and contrast the respective properties to those of conventional turbulence modelling approaches. They can describe subgrid scale models, peculiarities of wall modelling, suitable numerical solution schemes and evaluation methods. They have obtained the knowledge required to identify the best modelling approach (among the available methods) for the problem at hand, thus being able to solve given thermal and fluid dynamical problems appropriately.

Content
The lecture series will introduce in following subjects of the turbulence simulation method:

- Appearance of turbulence and deduction of requirements and limits of the simulation method.
- Conservation equations for flows with heat transfer, filtering them in time or space.
- Some subgrid scale models for small scale turbulence and their physical justification.
- Peculiarities in applying boundary and initial conditions.
- Suitable numerical schemes for integration in space and time.
- Statistical and graphical methods to analyse the simulation results.
- Application examples for turbulence simulations in research and engineering

Media
black board, plus pictures, movies, and script in English (distributed chapter by chapter)

Literature
J. Piquet, *Turbulent Flows – Models and Physics*
Springer, Berlin (2001)
G. Grötzbach, *Revisiting the Resolution Requirements for Turbulence Simulations in Nuclear Heat Transfer.*
Nuclear Engineering & Design Vol. 241 (2011) pp. 4379-4390
P. Sagaut, C. Meneveau, *Large-eddy simulation for incompressible flows: An introduction.*
Springer Verlag (2010)
G. Grötzbach,Script in English

Course: Public Law I - Basic Principles [24016]

Coordinators: G. Sydow
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Winter term	de

Learning Control / Examinations
The assessment consists of a written exam concerning the courses *Public Law I* [24016] and *Public Law II* [24520] (according to Section 4(2), 1 of the examination regulation).

Conditions
None.

Recommendations
Parallel to the lectures tutoria are offered in which legal thinking and argumentation is practised. Their attendance is strongly recommended.
During the semester, test exams to each lecture are offered with extensive coaching. During the lecture-free time, a Q-and-A-lecture is offered.Details on the homepage of the ZAR (www.kit.edu/zar).

Learning Outcomes
The lecture covers the core principles of public law. Students shall become acquainted with the basics of constitutional law, the fundamental rights which route governmental actions and the entire legal system, as well as possibilities of actions and instruments (especially law, administrative act, public-private contract) of the public authority. Furthermore the distinction between public and private law will be clarified. Moreover, possibilities of legal protection regarding administrative behavior will be addressed. Students shall learn to classify problems in public law and to solve (simple) administrative and constitutional cases.

Content
The course covers core material of constitutional and administrative law. It begins with the differentiation between public and private law. In the constitutional law part, the course will concentrate on the rule of law and individual rights, especially those protecting communication and entrepreneurship. The administrative law part will explain the different legal instruments of the administration how to act (rule, order, contract, etc.) and their propositions. Also, court proceedings to sue the administrative will be discussed. Students will learn the technique how to solve (simple) administrative and constitutional cases

Media
extensive script with cases; content structure, further information in the lectures

Literature
tba in srciptum
Elective literature:
tba in scriptum

Course: Public Law II - Public Economic Law [24520]

Coordinators: G. Sydow
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam (60min) according to Section 4(2), 1 of the examination regulation.

Conditions
None.

Recommendations
Parallel to the lectures tutoria are offered in which legal thinking and argumentation is practised. Their attendance is strongly recommended.
During the semester, test exams to each lecture are offered with extensive coaching. During the lecture-free time, a Q-and-A-lecture is offered.Details on the homepage of the ZAR (www.kit.edu/zar)

Learning Outcomes
Public economic law is of significant importance to supervise the German economy. In order to understand the functionality of mandatory interventions into market mechanisms in a thoroughly normed legal system, appropriate legal knowledge is required. This knowledge is to be provided in the lecture. In doing so, substantive law ought to be dealt with in a deepened way, while responsible authorities and institutions as well as possibilities of legal protection in the area of public commercial law will be taught at a glance. The lecture's primary aim is to exercise handling the corresponding legal norms. It proceeds the lecture *public law I*.

Content
In a first step legal basics of the economic system (such as financial system and freedom of property and profession) will be presented. In this context, interaction between the Basic Constitutional Law and presettings of European Community law will be elaborated on as well. Thereafter, regulatory instruments of the administrative law will be analysed extensively. As particular matters, we will deal with industrial code, further trade law (handicrafts code; law of gastronomy), basic principles of telecommunication law, state aid law and public procurement law. A last part is devoted to the institutional design of the economy's regulation.

Media
extensive script with cases; content structure, further information in the lectures

Literature
Will be announced in the lecture.
Elective literature:
tba in lecture slides

Course: OFDM Based Transmission Techniques [23545]

Coordinators: M. Schnell
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
The goal is to relay the theoretical fundamentals of multi-carrier communications.
The main focus of this lecture is on the theory of multi-carrier communications. The multiplexing technique OFDM (Orthogonal Frequency-Division Multiplexing) is described in detail which is the common basis for multi-carrier systems. In addition, multiple-access techniques which are based on OFDM are presented and discussed.

Content
This lecture comprises a theoretical treatment of the most important multi-carrier communications techniques. In addition, existing and planned multi-carrier systems and standards are presented and discussed. Requirement for participation in this lecture is basic knowledge in digital communications. The lecture starts with a short revision course on the theoretical basics in digital communications and continues with the treatment of OFDM. The theory behind OFDM is described in great detail and the resulting characteristics are explained and discussed. Besides the basic OFDM principle and the role of the guard interval methods for synchronization, channel estimation, and equalization are considered in detail. Basic concepts for the OFDM system design complete the first part of the lecture.
The second part of the lecture is devoted to multi-carrier based multiple-access systems. It is explained, how the standard multiple-access systems TDMA, FDMA, and CDMA can be combined appropriately with OFDM. Especially, the theory of the following multi-carrier multiple-access systems is described in detail: Multi-Carrier Code-Division Multiple-Access (MC-CDMA), Multi-Carrier Direct-Sequence Code-Division Multiple-Access (MC-DS-CDMA), Spread-Spectrum Multi-Carrier Multiple-Access (SS-MC-MA) and Orthogonal Frequency-Division Multiple-Access (OFDMA). In addition, Interleaved Frequency-Division Multiple-Access (IFDMA) is explained and discussed which constitutes a special case of multi-carrier technique, since in contrast to the above mentioned techniques IFDMA allows for a pure time-domain realization. In addition, the relation between IFDMA and OFDM is presented. Multi-carrier multiple-access techniques are currently under discussion for the next generation mobile radio system ("4G").
The third and last part of this lecture deals with standardized wireless OFDM systems. Both broadcast and point-to-point communications standards are considered: DAB (Digital Audio Broadcasting) and DVB-T (Digital Video Broadcasting – Terrestrial) as examples for broadcast standards, and HIPERLAN/2 (HIgh PERformance Local Area Network), the European variant of the IEEE 802.11a standard, as example for a wireless local network standard. In addition, the basic concepts of WiMAX and LTE (Long-Term Evolution of 3G mobile radio) are explained.

Literature
The material for the lecture is available via e-mail request addressed to the lecturer. (E-mail: Michael.Schnell@DLR.de)

Course: Operative CRM [2540520]

Coordinators: A. Geyer-Schulz
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Winter term	de

Learning Control / Examinations
Assessment consists of a written exam of 1 hour length following §4 (2), 1 of the examination regulation and by submitting written papers as part of the exercise following §4 (2), 3 of the examination regulation.
The course is considered successfully taken, if at least 50 out of 100 points are acquired in the written exam. In this case, all additional points (up to 10) from excersise work will be added. The grades of this lecture are assigned following the table below:

Grade	Minimum points
1.0	95
1.3	90
1.7	85
2.0	80
2.3	75
2.7	70
3.0	65
3.3	60
3.7	55
4.0	50
5.0	0

Conditions
None.

Recommendations
The attendance of courses *Customer Relationship Management* [2540508] and *Analyitical CRM* [2540522] is advised.

Learning Outcomes
The Student

- understands the theory of methods for process and data analyses and applies them for the design and implementation of operative CRM-processes in the complex context of companies,
- takes privacy problems into account,
- evaluates existing operative CRM-processes in companies and gives recommendation for their improvement. This requires the knowledge of example processes and the ability to transform them according to the given setting.
- uses literature for the solution of case studies, communicates with professionals and summarizes his recommendations and drafts in precise and coherent texts.

Content
The Student should be able to understand and implement methods and applications within the operative CRM. This includes, but is not limited to the analysis of business processes, as a basis for improvements in CRM, and applications like call centers.

Literature
Jill Dyché. The CRM Handbook: A Business Guide to Customer Relationship Management. Addison-Wesley, Boston, 2 edition, 2002.
Ronald S. Swift. Accelerating Customer Relationships: Using CRM and RelationshipTechnologies. Prentice Hall, Upper Saddle River, 2001.

Elective literature:

Alex Berson, Kurt Thearling, and Stephen J. Smith. Building Data Mining Applications for CRM. Mc Graw-Hill, New York, 2000.
Stanley A. Brown. Customer Relationship Management: A Strategic Imperative in theWorld of E-Business. John Wiley, Toronto, 2000.
Dimitris N. Chorafas. Integrating ERP, CRM, Supply Chain Management, and SmartMaterials. Auerbach Publications, Boca Raton, Florida, 2001.
Keith Dawson. Call Center Handbook: The Complete Guide to Starting, Running, and Improving Your Call Center. CMP Books, Gilroy, CA, 4 edition, 2001.
Andreas Eggert and Georg Fassot. eCRM – Electronic Customer Relationship Management: Anbieter von CRM-Software im Vergleich. Schäffer-Poeschel, Stuttgart, 2001.
Seth Godin. Permission Marketing. Kunden wollen wählen können. FinanzBuch Verlag, München, 1999.
Paul Greenberg. CRM at the Speed of Light: Capturing and Keeping Customers in Internet Real Time. Osborne/McGraw-Hill, 3rd ed. edition, Aug 2004.
Philip Kotler. Marketing Management: Millennium Edition. Prentice Hall, Upper Saddle River, 10 edition, 2000.
Don Peppers and Martha Rogers. The One To One Future. Currency Doubleday, New York, 1997.
Duane E. Sharp. Customer Relationship Management Systems Handbook. Auerbach, 2002.
Len Silverston. The Data Model Resource Book: A Library of Universal Data Models for All Entreprises, volume 1. John Wiley & Sons, 2001.
Toby J. Teorey. Database Modeling and Design. Morgan Kaufmann, San Francisco, 3 edition, 1999.
Chris Todman. Designing a Data Warehouse : Supporting Customer Relationship Management.

Remarks

As of winter term 2014/15 this lecture is hold in alternation with “2540522 - Analytical CRM”. The current schedule can be seen on the chair’s website (http://www.em.uni-karlsruhe.de/studies/).

Course: Optical Waveguides and Fibers [23464 + 23465]

Coordinators: C. Koos
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Learning Outcomes
Understanding the physics of basic components for optical communication
Two basic components of optical communication systems are treated, waveguides and senders. Beginning with fundamentals of wave propagation, the physics of waveguides and their applications are explained. The course then turns to light sources and describes the structure of LED and laser diodes as well as their spectral and dynamical properties.

Content
Lecture
The course concentrates ¾ after a brief introduction to optical communication systems ¾ on the two basic components, namely optical waveguide and transmitters (senders). The lecture addresses students of Electrical Engineering and Physics. While formulae and their derivation are definitely needed for explaining the function of devices, the emphasis is on a physical understanding.
The topics covered are:
Introduction (The nature of light. Communication with light)
Light Waveguides
Fundamentals of wave propagation (Medium properties. Kramers-Kronig relation. Wave equation and solution in homogeneous medium. Monochromatic waves. Phase and group velocity. Properties of silica glass. Attenuation. Scattering. Absorption. Dispersion) ¾ Plane boundary ¾ Principles of waveguiding ¾ Slab waveguides (Eigenvalues in pictures. Eigenvalue equation. Vector and scalar solution. Modal cutoff. Group delay dispersion. Transmission speed. Bends. Directional coupler. Y-branch) ¾ Strip waveguides ¾ Fibre waveguides (Modal fields. Weakly guiding fibre. Step-index fibre. Conventional, dispersion shifted, dispersion-compensating and dispersion flattened fibre. Parabolic-index fibre. Mode orthogonality. Coupling efficiency) ¾ Intensity modulation (Gaussian impulse. Light source. Impulse response. Transfer function. Noise-free light source. Gaussian beam. Noisy light source. Chirp-free input impulse. Sinusoidal modulation. Multimode waveguides. Mode coupling) ¾ Singlemode fibre data
Light sources
Counting of modes ¾ Luminescence and laser radiation (Lifetime. Linewidth. Laser action. Laser active materials. Two, three-level and four-level systems.Semiconductors. Compound semiconductors) ¾ Semiconductor physics (Energy bands. Density of states. Filling of electronic states. Impurities. Doping. Heterojunctions. Band diagram for heterostructures. Emission and absorption of light. Induced and spontaneous transitions. Optical amplification. Radiative and nonradiative transitions) ¾ Light-emitting diode (Output power. Modulation properties. Devices. Surface emitter. Edge emitter. Superluminescent diode. LED spectrum) ¾ Laser diode (Basic relations. Rate equations. Threshold current. Normalized rate equations. Characteristic curves. Powers and Efficiencies. Small-signal and large-signal intensity modulation. Amplitude-phase coupling. LD spectrum. Devices. Gain-guided lasers. Index-guided laser. DFB-Laser. VCSEL)
Optical amplifiers
Semiconductor amplifier (Fabry-Perot amplifier. Travelling-wave amplifier) ¾ Doped fibre amplifier ¾ Optical amplifier noise (Noise figure)
Supplementary material
Summaries, problems and quizzes ¾ Solutions to problems and quizzes
Exercises
The exercises apply the lecture's material to practical problems for providing a deeper understanding. The exercises may be electronically downloaded prior to the exercise.

Literature
Online material (a complete English compuscript, supplemented with summaries, problems, quizzes and solutions, as well as the English PowerPoint pages presented during the lecture) can be downloaded from http://www.ipq.kit.edu <Lectures>. Further material for the interested ones (in German): Grau, G.; Freude, W.: Optische Nachrichtentechnik (Optical communications), 3. Ed. Berlin: Springer Verlag 1991. Since 1997 out of print. Corrected reprint from University Karlsruhe 2005, available via W. F. (W.Freude@ipq.uni-karlsruhe.de).

Remarks
Current information are available on the IPQ webpage (www.ipq.kit.edu).

Course: Optimization and synthesis of embedded systems (ES1) [24143]

Coordinators: J. Henkel
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
Requirements, if present, are explained in the module description.

Learning Outcomes

Content
Cost-efficient and error-free development of embedded systems is a not to be underestimated challenge which has an increasing influence on the complete system's value. Especially in Europe, the design of embedded systems plays an important economical role in many industries, such as the automotive sector. A large number of well-known companies already deal with the development of embedded systems. This course deals comprehensively with all aspects of the development of hardware, software and the system level of embedded systems. This includes diverse areas such as modeling, optimization and synthesis of digital embedded systems.

Media
Slides

Course: Optical Technology in cars [23740]

Coordinators: C. Neumann
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
Light Engineering

Learning Outcomes

Content

Course: Optoelectronic Components [23486]

Coordinators: W. Freude
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2 / 1	Summer term	en

Learning Control / Examinations
The assessment will consist of a oral exam (20 min) according to §4 (2), 1 of the examination regulation.

Conditions
Fundamentals of wave propagation, pn-junction physics

Recommendations
Recommendations for lectures (but this is not mandatory for this course): "Electrodynamics and field calculations" or similar course on electrodynamics, "Semiconductor Devices" or similar course, "High-frequency Technology". Minimal background required: Calculus, differential equations, Fourier transforms and p-n junction physics.

Learning Outcomes
Understanding the physics of most important components for optical communication
Fundamentals and applications of integrated optical waveguides and optical fibres, of light sources like lasers and LED, of pin-photodetectors and of optical receivers are explained.
The exercises apply the lecture's material to practical problems for providing a deeper understanding. The exercises may be electronically downloaded prior to the exercise.

Content
Lecture
The course concentrates ¾ after a brief introduction to optical communication systems ¾ on basic opto-electronic communication components, namely on optical waveguides, semiconductor light sources, optical amplifiers, pin photodiodes, noise in optical receivers, receiver limits and detection errors. The lecture addresses students of Electrical Engineering and Physics. While formulae and their derivation are definitely needed for explaining the function of devices, the emphasis is on a physical understanding.
The topics covered are:
Introduction (The nature of light. Communication with light)
Light Waveguides
Fundamentals of wave propagation (Medium properties. Kramers-Kronig relation. Wave equation in a homogeneous medium. Phase and group velocity. Properties of silica glass) ¾ Plane boundary ¾ Principles of waveguiding ¾ Slab waveguides (Eigenvalues in pictures. Eigenvalue equation. Vector and scalar solution. Modal cutoff. Group delay dispersion. Transmission speed. Bends. Directional coupler. Y-branch) ¾ Strip waveguides ¾ Fibre waveguides (Modal fields. Weakly guiding fibre. Step-index fibre. Conventional, dispersion shifted, dispersion-compensating and dispersion flattened fibre. Parabolic-index fibre. Mode orthogonality. Coupling efficiency) ¾ Singlemode fibre data
Light sources
Counting of modes ¾ Luminescence and laser radiation (Lifetime. Linewidth. Laser action. Laser active materials. Semiconductors. Compound semiconductors) ¾ Semiconductor physics (Energy bands. Density of states. Filling of electronic states. Impurities. Doping. Heterojunctions. Band diagram. Emission and absorption of light. Induced and spontaneous transitions. Optical amplification. Radiative and nonradiative transitions) ¾ Light-emitting diode (Output power. Modulation properties. Devices. Surface emitter. Edge emitter. Superluminescent diode. LED spectrum) ¾ Laser diode (Basic relations. Rate equations. Threshold current. Normalized rate equations. Characteristic curves. Powers and Efficiencies. Small-signal and large-signal intensity modulation. Amplitude-phase coupling. LD spectrum. Devices. Gain-guided lasers. Index-guided laser. DFB-Laser. VCSEL)
Optical amplifiers
Semiconductor amplifier (Fabry-Perot amplifier. Travelling-wave amplifier) ¾ Doped fibre amplifier
pin photodiode
Basic equations (Short-circuit photocurrent. Equivalent electrical circuit) ¾ Materials ¾ Time and frequency response ¾ Cutoff frequency, quantum efficiency and responsivity ¾ Device structures
Noise
Noise mechanisms ¾ Photocurrent noise ¾ Thermal noise ¾ Electronic amplifier noise ¾ Optical amplifier noise

Receivers and detection errors
Pin photodiode receiver limits ¾ Detection errors
Supplementary material
Summaries, problems and quizzes ¾ Solutions to problems and quizzes
Exercises
The exercises apply the lecture's material to practical problems for providing a deeper understanding. The exercises may be electronically downloaded prior to the exercise.

Media
Detailed textbook-style lecture notes, and lecture slides

Literature
Online material (a complete English compuscript, supplemented with summaries, problems, quizzes and solutions, as well as the English PowerPoint pages presented during the lecture) can be downloaded from http://www.ipq.kit.edu <Lectures>. Further material for the interested ones (in German): Grau, G.; Freude, W.: Optische Nachrichtentechnik (Optical communications), 3. Ed. Berlin: Springer Verlag 1991. Since 1997 out of print. Corrected reprint from University Karlsruhe 2005, available via W. F. (W.Freude@ipq.uni-karlsruhe.de)

Remarks
Current information is available on the IPQ webpage (www.ipq.kit.edu).

Course: Optoelectronics [23726 + 23728]

Coordinators: U. Lemmer
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes

Content

Literature
The corresponding documents are avalible under https://studium.kit.edu/

Remarks
You will find the newest Information online on https://studium.kit.edu/

Course: Optoelctronic measurement technology [23736]

Coordinators: K. Trampert
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes

Content

Course: Managing Organizations [2577902]

Coordinators: H. Lindstädt
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3.5	2/0	Winter term	de

Learning Control / Examinations
The assessment will consist of a written exam (60 min) taking place at the beginning of the recess period (according to Section 4 (2), 2 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
After passing this course students are able to

- evaluate strengths and weaknesses of existing organisational structures and rules.
- compare alternatives of organisational structure in practice and assess and interpret them regarding their effectiveness and efficiency.
- assess the management of organisational changes.

Content
The course should enable the participants to assess the strengths and weaknesses of existing organisational structures and rules using systematic criteria. Here concepts and models for designing organisation structures, regulating organizational processes and managing organisational changes are presented and discussed using case studies. The course is structured to relate to actions and aims to give students a realistic view of the opportunities and limits of rational design approaches.

Media
Slides.

Literature

- Laux, H.; Liermann, F.: *Grundlagen der Organisation*, Springer. 6. Aufl. Berlin 2005.
- Lindstädt, H.: *Organisation*, in Scholz, C. (Hrsg.): Vahlens Großes Personallexikon, Verlag Franz Vahlen. 1. Aufl. München, 2009.
- Schreyögg, G.: *Organisation. Grundlagen moderner Organisationsgestaltung*, Gabler. 4. Aufl. Wiesbaden 2003.

The relevant excerpts and additional sources are made known during the course.

Remarks
The credits for the course “Managing Organizations” have been changed from 4 to 3,5 from summer term 2015 on.

Course: Passive Components [23206]

Coordinators: E. Ivers-Tiffée
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT], Bauelemente der Elektrotechnik (ETIT) (p. 22)[BSc-MIT - B-PE2]

ECTS Credits	Hours per week	Term	Instruction language
4.5	3	Winter term	de

Learning Control / Examinations
Written exam (see actual document "Studienplan" and notice of the examination office ETIT).
Grades result from the written examination.

Conditions
None.

Learning Outcomes
The objective of the lecture is to impart students the fundamental ideas of passive components.
The lecture concerns the fundamental ideas of the electrical properties of materials. It is designed to provide students with an understanding of the close interaction between the development of new materials and the emergence of new technologies and technical applications.

Content
Materials play a decisive role in technological progress, especially in key technologies such as electrical engineering and information technology or environmental engineering.
Based on a survey of the structure of atoms and solids and the fundamental electrical conduction mechanisms, this lecture provides an overview of the electrical properties of materials with regard to their applications in passive components.
The lecture focuses on metallic and non-metallic conductors and their components (e.g., non-linear resistors such as NTC, PTC, or varistors), the polarization mechanisms in dielectrics and their applications, e.g., capacitors, piezo-/ferroelectrics, as well as on magnetic materials and their applications (coils, storage media).
The imparted knowledge serves as a basis of decision for all engineers working in research and development in their respective area of responsibility. It is therefore of interest for all students regardless of their field of specialisation. In addition, the content of this lecture forms the foundation for all of the continuative courses of our field of specialisation.

Literature
Online material is available at http://www.iwe.kit.edu; Literature: Ivers-Tiffée, von Münch: Werkstoffe der Elektrotechnik. 10th edition, Teubner 2007.

Remarks
The course comprises lectures and exercises. Current information can be found on the IWE website (http://www.iwe.kit.edu).

Course: Intellectual Property Rights and Strategies in Industrial Companies [2147161]

Coordinators: F. Zacharias
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
oral exam

Conditions
none

Learning Outcomes
The students understand and are able to describe the basics of intellectual property, particularly with regard to the filing and obtaining of property rights. They can name the criteria of project-integrated intellectual property management and strategic patenting in innovative companies. Students are also able to describe the key regulations of the law regarding employee invention and to illustrate the challenges of intellectual properties with reference to examples.

Content
The lecture will describe the requirements to be fulfilled and how protection is obtained for patents, design rights and trademarks, with a particular focus on Germany, Europe and the EU. Active, project-integrated intellectual property management and the use of strategic patenting by technologically oriented companies will also be discussed. Furthermore, the significance of innovations and intellectual property for both business and industry will be demonstrated using practical examples, before going on to consider the international challenges posed by intellectual property and current trends in the sector.
Within the context of licensing and infringement, insight will be provided as to the relevance of communication, professional negotiations and dispute resolution procedures, such as mediation for example. The final item on the agenda will cover those aspects of corporate law that are relevant to intellectual property.
Lecture overview:

1. Introduction to intellectual property
2. The profession of the patent attorney
3. Filing and obtaining intellectual property rights
4. Patent literature as a source of knowledge and information
5. The law regarding employee inventions
6. Active, project-integrated intellectual property management
7. Strategic patenting
8. The significance of intellectual property
9. International challenges and trends
10. Professional negotiations and dispute resolution procedures
11. Aspects of corporate law

Course: Photovoltaics [23737]

Coordinators: M. Powalla
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Summer term	

Learning Control / Examinations
Turorials, written exams, alternatively oral exam.

Conditions
Basic knowledge of thermodynamics and solid state physics.

Recommendations
Complement to “Energy Systems” and “Fundamentals of Energy Technology”.

Learning Outcomes
After the course attendants can:

- understand energy conversion in semiconductors.
- discuss emerging technological and production relevant aspects.
- capture the interaction of photovoltaic energy sytems with different system components.
- quantify losses.

Content

- The significance of photovoltaics in national and global energy supply.
- Physical fundamentals of energy conversion.
- Photovoltaic cells (specific parameters, materials, loss assessment).
- Implementation concepts (Sillicon technology, thin layer cells, concentrator cells, dye cells and organic cells).
- Modular technique and production technology.
- Photovoltaic energy systems (Components, alternative current converter, solar tracking, system design).

Literature
P. Würfel, Physik der Solarzellen, 2. Auflage (Spektrum Akademischer Verlag, Heidelberg, 2000)
R. Sauer, Halbleiterphysik, (Oldenburg Wissenschaftsverlag, 2009)
H.J. Lewerenz, H. Jungblut, Photovoltaik (Springer, Berlin, 1995)
H.G. Wagemann, Photovototaik, (Vieweg, Wiebaden, 2010)
Tom Markvart, Luis Castaner, Photovoltaics Fundamentals and Applications, (Elsevier, Oxford, 2003)
Heinrich Häberlin, Photovoltaik, (AZ Verlag, Aarau, 2007)

Course: Photovoltaic Systems Technology [23380]

Coordinators: Schmidt
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at the beginning of the recess period (according to Section 4 (2), 2 of the examination regulation). The exam takes place in every summer semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
Students know the theoretical fundamentals of photovoltaic systems technology.

Content

- Introduction
- Ways of solar energy utilisation
- The terrestrial solar radiation
- Solar radiation measuring principles
- Fundamentals of solar cells
- Overview of typical cell technologies
- Efficiency values
- Equivalent circuit diagram of solar cells
- Properties of solar cells and solar modules
- Series and parallel connection of solar cells
- Matching of solar generators and loads
- MPP-Tracking
- Construction of PV-modules
- Partial shading, bypass-technologies
- Overview of different System configurations
- Batteries for PV applications
- Charge controllers
- Battery peripherals
- Inverters for stand-alone systems
- Inverters for grid connected systems
- European efficiency
- Safety and EMC aspects
- Annual yield of PV systems

- Economic evaluation of PV systems
- Examples of realised PV systems

Media
Copies of the main transparenvies will be distributed each lecture.

Literature
Elective literature:
„Regenerative Energiesysteme“, Volker Quaschning, ISBN: 978-3-446-40973-6
„Photovoltaik“, Heinrich Häberlin, ISBN:978-3-8007-3003-2

Course: Physics for Engineers [2142890]

Coordinators: P. Gumbsch, A. Nesterov-Müller, D. Weygand, T. Förtsch
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
written exam, 90 min

Conditions
None.

Learning Outcomes
The student

- has the basic understanding of the physical foundations to explain the relationship between the quantum mechanical principles and the optical as well as electrical properties of materials
- can describe the fundamental experiments, which allow the illustration of these principles

Content
1) Foundations of solid state physics

- Wave particle dualism
- Tunnelling
- Schrödinger equation
- H-atom

2) Electrical conductivity of solids

- solid state: periodic potentials
- Pauli Principle
- band structure
- metals, semiconductors and isolators
- p-n junction / diode

3) Optics

- quantum mechanical principles of the laser
- linear optics
- non-linear optics

Literature

- Tipler und Mosca: Physik für Wissenschaftler und Ingenieure, Elsevier, 2004
- Haken und Wolf: Atom- und Quantenphysik. Einführung in die experimentellen und theoretischen Grundlagen, 7. Aufl., Springer, 2000

Course: Physical basics of laser technology [2181612]

Coordinators: J. Schneider
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	

Learning Control / Examinations
oral examination (30 min)

no tools or reference materials

Conditions
Basic knowledge of physics, chemistry and material science is assumed.
It is not possible, to combine this lecture with the lecture *Laser Application in Automotive Engineering* [2182642]

Recommendations
None.

Learning Outcomes
The student

-
- can explain the principles of light generation, the conditions for light amplification as well as the basic structure and function of different laser sources.
- can describe the influence of laser, material and process parameters for the most important methods of laser-based materials processing and choose laser sources suitable for specific applications.
- can illustrate the possible applications of laser sources in measurement and medicine technology
- can explain the requirements for safe handling of laser radiation and for the design of safe laser systems.

Content
Based on the description of the physical basics about the formation and the properties of laser light the lecture goes through the different types of laser beam sources used in industry these days. The lecture focuses on the usage of lasers especially in materials engineering. Other areas like measurement technology or medical applications are also mentioned. An excursion to the laser laboratory of the Institute for Applied Materials (IAM) will be offered.

-
- physical basics of laser technology
- laser beam sources (solid state, diode, gas, liquid and other lasers)
- beam properties, guiding and shaping
- lasers in materials processing
- lasers in measurement technology
- lasers for medical applications
- savety aspects

The lecture is complemented by a tutorial.

Media
lecture notes via ILIAS

Literature
W. T. Silfvast: Laser Fundamentals, 2008, Cambridge University Press

W. M. Steen: Laser Material Processing, 2010, Springer

Remarks

It is allowed to select only one of the lectures “Laser in automotive engineering” (2182642) or “Physical basics of laser technology” (2181612) during the Bachelor and Master studies.

Course: Physical and chemical principles of nuclear energy in view of reactor accidents and back-end of nuclear fuel cycle [2189906]

Coordinators: R. Dagan, Dr. Volker Metz
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations
oral exam, 20 min.

Conditions
None

Recommendations
None

Learning Outcomes
The students

- understand the physical explanations of the known nuclear accidents
- can perform simplified calculations to demonstrate the accidents outcome.
- Define safety relevant properties of low/ intermediate / high level waste products
- Are able to evaluate principles and implications of reprocessing, storage and disposal options for nuclear waste.

Content

- Relevant physical terms of nuclear physics
- Decay heat removal- Borst-Wheeler equation
- The accidents in TMI- Three Mile Island, and Fukushima .
- Fission , chain reaction and reactor control systems
- Basics of nuclear cross sections
- Principles of reactor dynamics
- Reactor poisoning
- The Idaho and Chernobyl accidents
- Principles of the nuclear fuel cycle
- Reprocessing of irradiated fuel elements and vitrification of fission product solutions
- Interim storage of nuclear residues in surface facilities
- Multi barrier concepts for final disposal in deep geological formations
- The situation in the repositories Asse II, Konrad and Morsleben

Literature
AEA- Open documentation of the reactor accidents
K. Wirtz: Basics of Reactor technic Par I, II, Technic School Karlsruhe 1966 (in German)
D. Emendorfer. K.H. Höcker: Theory of nuclear reactions, Parts I, II BI- Hochschultaschenbücher 1969 (in German)
J. Duderstadt and L. Hamilton: Nuclear reactor Analysis, J. Wiley $ Sons , Inc. 1975.
R.C. Ewing: The nuclear fuel cycle: a role for mineralogy and geochemistry. Elements vol. 2, p.331-339, 2006
J. Bruno, R.C. Ewing: Spent nuclear fuel. Elements vol. 2, p.343-349, 2006

Course: Planning of Assembly Systems (in German) [2109034]

Coordinators: E. Haller
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Elective Subject: oral exam (approx. 30 min)
Optional Subject: oral exam (approx. 30 min)
The exam is offered in German only!

Conditions

- Compact course (one week full-time)
- Limited number of participants; seats are assigned according the date of registration
- Registration via ILIAS is required
- Compulsory attendance during the whole lecture

Recommendations

- Knowledge of Human Factors Engineering or Production Management/Industrial Engineering helpful

Learning Outcomes
The students

- know planning guidelines
- know vulnerability analysis
- are able to plan work systems (e.g. technical or organisational structuring principles, capacity planinng, proceedence diagram, payment system)
- are able to evaluate a planning solution
- are able to present results

Content

1. Planning guidelines
2. Vulnerability analysis
3. Planning of work systems (technical and organisational structuring principles, capacity planning, proceedence diagram, payment system)
4. Evaluation
5. Presentation

Literature
Handout and literature online ILIAS.

Course: Plasma Sources [23729]

Coordinators: R. Kling, W. Heering
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
Electronic processes and radiation mechanisms in solid state and plasma, Light sources : Halogen lamps, low pressure lamps, HID, LED, Laserdiods

Content

Literature

- H. Albrecht: Optische Strahlungsquellen,
- J.F. Waymouth: Electric Discharge Lamps,
- C. Meyer, H. Nienhuis: Discharge Lamps

Remarks
You will find the newest Information online on https://studium.kit.edu/

Course: PLM for Product Development in Mechatronics [2122376]

Coordinators: M. Eigner
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (30 min.).

Conditions
None.

Learning Outcomes
Students have a basic overview about product data management and product lifecycle management.
Students know components and core functions of PLM solutions
Students can describe trends in research and practice in the environment of PLM

Content
Product Data Management
Product Lifecycle Management

Course: PLM in the Manufacturing Industry [2121366]

Coordinators: G. Meier
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral group examination, Duration 1 hour, Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
Students know essential aspects of PLM Processes which are exemplarily introduced with examples form Heidelberger Druckmaschinen.
Students know objects of the PLM Process and know the interconnection between CAD and PLM.
Students understand the procedure of PLM-installation in an industrial enterprise and occurring challenges concerning strategy, vendor selection and psychology.
They are able to create installation concepts for PLM systems in the scope of team exercises and explain the approaches in presentations.

Content
A description of systematic requirement engineering is given, based on the introduction of PLM-Processes and (Multi-) Project management in the product development process. By the introduction of a PLM-Project, Objects of the PLM Process like material master, bill of material, documents and classifications are explained. Furthermore a 3D-Process chain is introduced to show the implementation of technical modifications. Finally, specific aspects of the mechatronic development are introduced.

Literature
Lecture slides

Course: Plastic Electronics [23709]

Coordinators: U. Lemmer
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	en

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes

Content
Outline of the course:
1. Introduction
2. Optoelectronic properties of organic semiconductors
3. Organic light emitting diodes (OLEDs
4. Applications in Lighting and Displays
5. Organic FETs
6. Organic photodetectors and solar cells
7. Lasers and integrated optics

Literature
The corresponding documents are avalible under https://studium.kit.edu/

Remarks
You will find the newest Information online on https://studium.kit.edu/

Course: Polymer Engineering I [2173590]

Coordinators: P. Elsner
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 20-30 Minutes

Conditions
None.

Learning Outcomes
The field of Polymer Engineering includes synthesis, material science, processing, construction, design, tool engineering, production technology, surface engineering and recycling. The aim is, to equip the students with knowledge and technical skills, and to use the material “polymer” meeting its requirements in an economical and ecological way.
The students

- are able to describe and classify polymers
  based on the fundamental synthesis processing techniques
- can find practical applications for state-of-the-art polymers and manufacturing technologies
- are able to apply the processing techniques, the application of polymers and polymer composites regarding to the basic principles of material science
- can describe the special mechanical, chemical and elctrical prooperties of polymers and correlate these properties to the chemical bindings.
- can define application areas and the limitation in the use of polymers

Content
1. Economical aspects of polymers
2. Introductiom of mechanical,
chemical end electrical properties
3. Processing of polymers
(introduction)
4. Material science of polymers
5. Synthesis

Literature
Recommended literature and selected official lecture notes are provided in the lecture

Course: Polymer Engineering II [2174596]

Coordinators: P. Elsner
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 20-30 Minutes

Conditions
Polymerengineering I

Learning Outcomes
The field of Polymer Engineering includes synthesis, material science, processing, construction, design, tool engineering, production technology, surface engineering and recycling. The aim is, that the students gather knowledge and technical skills to use the material “polymer” meeting its requirements in an economical and ecological way.
The students

- can describe and classify different processing techniques
  and can exemplify mould design principles based on technical parts.
- know about practical applications and processing of polymer parts
- are able to design polymer parts according to given restrictions
- can choose appropriate polymers based on the technical requirements
- can decide how to use polymers regarding the production, economical and ecological requirements

Content
1. Processing of polymers
2. Properties of polymer components
Based on practical examples and components
2.1 Selection of material
2.2 Component design
2.3 Tool engineering
2.4 Production technology
2.5 Surface engineering
2.6 Sustainability, recycling

Literature
Recommended literature and selected official lecture notes are provided in the lecture

Course: Power Management [2400036]

Coordinators: F. Bellosa
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes
The students describe the basic mechanisms and policies to manage the use of energy in computer systems. The student can assess the mechanisms offered by by the hardware to control the energy consumption concerning their usability in operating systems. The student can extract power states and energy characteristics and assign this information to processes and services.

Content
Students assess the effects of throttling mechanisms of the CPU concerning efficiency, effectiveness and integration in operating system structures. The model the energy consumption of computers and predict the heat production.
Students can describe the energy savings mechanism of memory and assess the impact of various memory allocation policies on the energy consumption.
Students can describe the properties of batteries and assess the impact of scheduling strategies on the effective capacity of batteries.
The students structure an instruction set agnostic interfaces to power management mechanisms (ACPI) and assess their impact on scalable system architectures.

Media
lecture slides in English

Course: Prädiktive Fahrerassistenzsysteme [23097]

Coordinators: P. Knoll
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature
Lecture Notes

Course: Information Technology Lab [23626]

Coordinators: K. Müller-Glaser
Part of the modules: Basics of Information Technology (p. 16)[BSc-MIT - B4]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Written - Delivery of the developed source code and the related documentation (see actual document "Studienplan" and notice of the examination office ETIT).

Conditions
None.

Learning Outcomes
At the end of the lab, the students should be able to decompose complex problems, presented in a natural language (specification), in simple and concise modules. They consequently can use appropriate algorithms and data structures in order to solve the problem. The implementation of a structured and executable source code should take into consideration predefined quality criteria (amongst others coding guidelines). Besides, the students should practice the writing of complex C++ source code and the use of an integrated development environment. This includes the verification of source code by means of test programs.

Content
The lab aims at applying the theoretical content taught in the lecture and exercise to a concrete problem. Therefore algorithms have to be implemented and tested in the programming language C++. These are embedded in a project based assignment dealing with the issue of time analysis of synchronous circuits. A program framework is provided.
The lab is conducted in small teams of four students. The team work is done under the supervision of tutors, who offer their support with respect to technical and project management related questions.
Basically the lab takes place in the second half of the semester and is divided into five phases, which last seven weeks. In the first week the students get a specification document, which they use to identify and understand the different tasks. In the next phase, the students should thoroughly plan their project and visualize the conceived modules by means of diagrams within one week. In the next step, which corresponds to the implementation phase, the students should realize their planning by implementing all the required modules and functions in C++ source code. To accomplish this part, they have three weeks time and they additionally need to take into consideration the rules of the given coding guidelines. In the sixth week, an overall test should be carried out in addition to the implemented module tests. In the last week, the documentation of the whole project has to be completed. Each group should provide a documentation of the project according to given guidelines (planning, software and testing).

Remarks
Current information can be found on the ITIV (www.itiv.kit.edu) webpage.

Course: Practical Aspects of Electrical Drives [23311]

Coordinators: M. Braun
Part of the modules: Energie- und Elektrische Antriebstechnik (ETIT) (p. 21)[BSc-MIT - B-PE1], Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4.5	3	Summer term	de

Learning Control / Examinations
Written exam (see actual document "Studienplan" and notice of the examination office ETIT).
Grades result from the written examination.

Conditions
None.

Recommendations
Participation of the lecture "Electrical Machines and Power Electronics"

Learning Outcomes
The goal is to relay practical aspects on the field of electrical drives.

Content
Lecture
electrical drives and inverters:
d. c. motor
induction motor
synchronous motor
linear motor
inverter topologies
co-operation of electrical drive and working unit:
characteristics of torque
coupling of motor and working unit
operating points
starting procedures and braking
torque of inertia
basic principles of electrical drives
rated values
operation mode
environmental conditions
heating
overload protection
noise emission
circle diagram of the induction motor
equivalent circuit of the induction motor
typical drive systems
dimensioning of electrical drives
speed control
inverter-fed drives
Exercises
motion and torque of inertia
modelling of temperature
circle diagram of the induction motor
project planing of drive systems

Literature
lecture notes available at the institute

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the ETI (www.eti.kit.edu) webpage.

Course: Principles of sensor fusion in integrated navigation systems [23069]

Coordinators: J. Wendel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Verbal exam

Conditions
None.

Learning Outcomes
The goal is to provide an insight into integrated navigation systems.
Focus of the lecture are the fundamentals of inertial navigation and satellite navigation systems like GPS and Galileo. Data fusion algorithms, which are used in integrated navigation systems, are addressed as well.

Content
This lecture provides an overview on the fundamentals of inertial navigation. Different types of accelerometers and gyroscopes are introduced, and the processing of their measurements by means of a strapdown algorithm is addressed. Then, the error characteristics of an inertial navigation system are analyzed.
Next, the satellite navigation systems Galileo and GPS are discussed. Main emphasis is on the signal structure and the measurement of the time-of-flight of the satellite signal using PRN codes. The architecture of a typical receiver, its code and carrier tracking loops are analyzed. Different strategies for acquisition and tracking are treated, too.
For the fusion of the information provided by the inertial sensors and the navigation reveiver, stochastic filters are used. Therefore, the Kalman filter equations are derived and discussed, followed by the design of a navigation filter. Different integration architectures like loosely, tightly, ultra-tightly and deeply coupled are addressed.
Finally, further navigation techniques, which can be used to aid an inertial navigation system, are introduced. Examples are terrain referenced navigation and image based navigation. Additionally, advanced data fusion algorithms like sigma point Kalman filter, particle filter and covariance intersection, are analyzed and compared. Adaptive filters and strategies to cope with time-correlated measurement and process noise are investigated as well.

Literature
The supporting material will be distributed at the beginning of each lecture. Literature: Jan Wendel; Integrierte Navigationssysteme; Oldenbourg Wissenschaftsverlag GmbH, 2007.

Course: Product Lifecycle Management [2121350]

Coordinators: J. Ovtcharova
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
written examination
Duration:
1,5 hours

Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can:

- clarify the management concept of PLM, its objectives and highlight the economic benefits of the PLM concept.
- illustrate the need for an integrated and cross-departmental business process - from planning, portfolio construction and return of customer information, from the use phase to maintenance and recycling of products.
- reason the processes and functions needed to support the entire product life cycle and discuss the main operating software systems (PDM, ERP, SCM, CRM) and their functions for supporting PLM.
- argue a method to successfully introduce the concept of Management PLM in companys.

Content
Product Lifecycle Management (PLM) is an approach to the holistic and cross-company management and control of all product-related processes and data throughout the life cycle along the extended supply chain - from design and production to sales, to the dismantling and recycling.
Product Lifecycle Management is a comprehensive approach for effective and efficient design of the product life cycle. Based on all product information, which comes up across the entire value chain and across multiple partners, processes, methods and tools are made available to provide the right information at the right time, quality and the right place.
The course covers:

- A consistent description of all business processes that occur during the product life cycle (development, production, sales, dismantling, ...)
- the presentation of methods for the performance of the PLM business processes,
- explaining the most important corporate information systems to support the life cycle (PDM, ERP, SCM, CRM systems) to sample the software manufacturer SAP

Literature
Lecture slides.

V. Arnold et al: Product Lifecycle Management beherrschen, Springer-Verlag, Heidelberg, 2005.

J. Stark: Product Lifecycle Management, 21st Century Paradigm for Product Realisation, Springer-Verlag, London, 2006.

A. W. Scheer et al: Prozessorientiertes Product Lifecycle Management, Springer-Verlag, Berlin, 2006.

J. Schöttner: Produktdatenmanagement in der Fertigungsindustrie, Hanser-Verlag, München, 1999.

M.Eigner, R. Stelzer: Produktdaten Management-Systeme, Springer-Verlag, Berlin, 2001.

G. Hartmann: Product Lifecycle Management with SAP, Galileo press, 2007.

K. Obermann: CAD/CAM/PLM-Handbuch, 2004.

Course: Product, Process and Resource Integration in the Automotive Industry [2123364]

Coordinators: S. Mbang
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
Oral examination, Durations: 20 min, Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
A considerable aspect of this lecture is to combine engineering knowledge with the practical, real industrial problems and applications.
Thus, the objectives of the lecture are:

- collaborative drafting of industrial and academic state of the art regarding the basics.
- specification of exigencies, requirements and concepts for an integrated CAx-process chain,
- introduction in the paradigms of the integrated process-oriented product development
- to convey practical industrial knowledge about the integrated product development in the automotive sector

Content
The lecture

- Overview of product development in the automotive sector (process- and work cycle, IT-Systems)
- Integrated product models in the automotive industry (product, process and resource)
- New CAx modeling methods (intelligent feature technology, templates & functional modeling)
- Automation and knowledge-based mechanism for product design and production planning
- Product development in accordance with defined process and requirement (3D-master principle, tolerance models)
- Concurrent Engineering, shared working
- Enhanced concepts: the digital and virtual factory (application of virtual technologies and methods in the product development)
- Systems: CAD/CAM modeling (CATIA V5), planning (CATIA/DELMIA), archiving – PDM (CATIA/SmarTeam).

Additionally, A practical industrial project study is offered, which is based on an integrated application scenario (from design of production resources, over testing and validation method planning to the manufacturing and implementation of the production resources).
Since the student will be divided in small teams, this study will also teach the students about team word and distributed development.

Literature
Lecture slides

Remarks
Max. 20 students, registration necessary (ILIAS)

Course: Production Economics and Sustainability [2581960]

Coordinators: M. Fröhling
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3,5	2/0	Winter term	de

Learning Control / Examinations
The assessment consists of an oral (30 minutes) or a written (60 minutes) exam (following §4(2), 1 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
Students shall be aware of issues concerning industrial production and sustainability and shall apply strategies to resolve these issues.

Content
The analysis and management of material flows on the company level and above will be the focus of this lecture. Herein, the discussion will be about cost-effective and environmentally acceptable steps to avoid, abate and recycle emissions and waste as well as ways of efficient resources handling. As methods material flow analysis (MFA), life cycle assessment (LCA) and OR methods, e.g. for decision support, are introduced.
Topics:
- regulations related to materials and substances
- raw materials, reserves and their availabilities/lifetimes
- material and substance flow analysis (MFA/SFA)
- material related ecoprofiles, e.g. Carbon Footprint
- LCA
- resource efficiency
- emission abatement
- waste management and closed-loop recycling
- raw material oriented production systems
- environmental management (EMAS, ISO 14001, Ecoprofit), eco-controlling

Media
Media will be provided on e-learning platform.

Literature
will be announced in the course

Course: Production Planning and Control [2110032]

Coordinators: A. Rinn
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Elective Subject: oral exam (approx.. 30 min)
Optional Subject: oral exam (approx. 30 min)
The exam is offered in German only!

Conditions

- Compact course
- Limited number of participants; seats are assigned according the date of registration
- Registration via ILIAS is required
- Compulsory attendance during the whole lecture

Recommendations

- Knowledge in Production Management/Industrial Engineering is required
- Knowledge of Work Science and Economics is helpful
- Knowledge of Informatics is not required, but helpful

Learning Outcomes

- Gain deeper insight within production management
- Increase knowledge of production planning and control
- Understand basic techniques for the modelling and the simulation of production systems

Content

1. Goals and recommanditions for production planning and control
2. Strategies for work control
3. Case study: Manufacturing of bicycles
4. FASI-Plus: Simulation of a bicycle factory for the production planning and control
5. Simulation of the order processing
6. Decision making about order control and procurement of purchased parts
7. Evaluation of the simulation protocols
8. Realisation of production planning and control

Literature
Handout and literature are available on ILIAS for download.

Course: Programming [24004]

Coordinators: R. Reussner, G. Snelting
Part of the modules: Informatik (Softwareentwicklung) (p. 28)[BSc-MIT - B-PI2], Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Previous knowledge in java programming is recommended but not mandatory.

Learning Outcomes
Students should learn

- basic structures of the programming language Java and how to apply them; in particular control and simple data structures, object orientation and implementation of basic algorithms
- basics of programming methodology and the ability to autonomously write executable small to medium sized Java programs

Content

- objects and classes
- types, values and variables
- methods
- control structures
- recursion
- references, lists
- inheritance
- input and output
- exceptions
- programming methodology
- implementation of basic algorithms in Java (such as sorting algorithms)

Media
beamer, slides, blackboard, practice sheets

Literature
P. Pepper, Programmieren Lernen, Springer, 3. Auflage 2007
Elective literature:
B. Eckels: Thinking in Java. Prentice Hall 2006
J. Bloch: Effective Java, Addison-Wesley 2008

Course: Programming Paradigms [24030]

Coordinators: G. Snelting, R. Reussner
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Winter term	de

Learning Control / Examinations

Conditions
The requirements are explained in the module description.

Learning Outcomes

Content

Media
Slides, secondary literature.

Literature
Will be announced in the lecture.

Course: Development of Oil-Hydraulic Powertrain Systems [2113072]

Coordinators: G. Geerling, I. Ays
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination

Conditions
knowledge in the fluidics

Learning Outcomes
The students are able to understand hydraulic systems und to develop them independently. They apply their competences in a simulation of a development project with real hydraulic components within a laboratory tutorial.

Content
The bloc course offered by the Chair of Mobile Machines (Mobima) conveys the basics of planning and development of mobile and industrial hydrostatic systems. The lecturer works for a market leading company producing fluid power drives and controls and gives a deep view into the process of planning and development using real life examples. The contents of the course are:

- marketing, project planning
- hydrostatic circuits
- heat balance, hydraulic accumulators
- filtration, noise lowering
- development exercises + laboratory tutorial

Course: Project Management in Rail Industry [2115995]

Coordinators: P. Gratzfeld
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
None

Recommendations
None

Learning Outcomes
The students learn the basic of project management.
They learn about the roles of project manager and project core team.
They understand the project phases and know about processes and tools.
They understand the governance process behind.

Content
Rail vehicles are capital-intensive goods which are manufactured in small series (like aircraft). The work to done at industry and customers is organized in “projects”. This is completely different to the way of working in large-scale production (like car industry). Everybody working in this type of business is part of a project and should be aware of the typical processes.
The lecturer provides a comprehensive overview about modern project management for small series of capital-intensive goods.
The content is not only valid for rail vehicles but also other areas.
The following topics will be discussed:
Introduction: definition of project and project management
Project management system: project phases, main processes and supporting processes, governance
Organization: organizational structure within a company, project organization, roles in a project organization
Main processes: project start, project plan, work brake down structure, detailed project schedule, risk and opportunity management, change management, project closure
Governance

Media
All slides are available for download (Ilias-platform).

Literature
A bibliography is available for download (Ilias-platform).

Remarks
None.

Course: Project management in Global Product Engineering Structures [2145182]

Coordinators: P. Gutzmer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
Auxilary means: none

Conditions
none

Learning Outcomes
Project management is essential for successful companies.
The students are able to describe, explain and compare characteristics and attributes of product development processes based on practical examples of industry.
They are able to specify processes of product development, their necessary organization structures and important attributes.
The participants learn to identify and evaluate aspects of product management within international operating companies.

Content
Product development process
Coordination of product development and handling of complexity
project management
matrix organization
planning / specification / target system
interaction of development and production

Literature
lecture notes

Course: Advanced powder metals [2126749]

Coordinators: R. Oberacker
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20-30 min) taking place at the agreed date. The re-examination is offered upon agreement.

Conditions
None.

Recommendations
Knowledge of basic material science is assumed.

Learning Outcomes
The students know the basics of powder metallurgy. They are able to assess the conditions for applying either powder metallurgy or competing production methods. They have knowledge on production, properties and application of the most important PM materials.

Content
The lecture gives an overview on production, properties and application of structural and functional powder metallurgy material. The following groups of materials are presented: PM High Speed Steels, Cemented Carbides, PM Metal Matrix Composites, PM Specialities, PM Soft Magnetic and Hard Magnetic Materials.

Media
Slides for the lecture:
available under http://ilias.studium.kit.edu

Literature

- W. Schatt ; K.-P. Wieters ; B. Kieback. „Pulvermetallurgie: Technologien und Werkstoffe“, Springer, 2007
- R.M. German. “Powder metallurgy and particulate materials processing. Metal Powder Industries Federation, 2005
- F. Thümmler, R. Oberacker. “Introduction to Powder Metallurgy”, Institute of Materials, 1993

Course: Quality Management [2149667]

Coordinators: G. Lanza
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as a written exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are capable to comment on the content covered by the lecture.
- are capable of substantially quality philosophies.
- are able to apply the QM tools and methods they have learned about in the lecture to new problems from the context of the lecture.
- are able to analyze and evaluate the suitability of the methods, procedures and techniques they have learned about in the lecture for a specic problem.

Content
Based on the quality philosophies Total Quality Management (TQM) and Six Sigma, the lecture deals with the requirements of modern quality management. Within this context, the process concept of a modern enterprise and the process-specic elds of application of quality assurance methods are presented. The lecture covers the current state of the art in preventive and non-preventive quality management methods in addition to manufacturing metrology, statistical methods and service-related quality management. The content is completed with the presentation of certication possibilities and legal quality aspects.
Main topics of the lecture:

- The term “quality”
- Total Quality Management (TQM) and Six Sigma
- Universal methods and tools
- QM during early product stages – product denition
- QM during product development and in procurement
- QM in production – manufacturing metrology
- QM in production – statistical methods
- QM in service
- Quality management systems
- Legal aspects of QM

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Quantitative Methods for Supply Chain Risk Management [2118090]

Coordinators: A. Cardeneo
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
presumably oral, duration 20 minutes, in each case at the beginning and at the end of the lecture-free time

Conditions
None.

Recommendations
Basic knowledge in operations research, statistics and logistics are recommended.

Learning Outcomes
The student knows mathematical models and methods to control the various kinds of risks.

Content
The planning and the enterprise of logistics systems are connected in large measure with uncertainty: It is the unknown demand, varying transportation times, unexpected delays, irregularly production yield or volatile rates of exchange: Quantities, times, qualities and prices are uncertain values. Therefore it is necessarily to deal with particular these uncertain values to avoid negative effects.
That logistics systems should be efficiently operated is obvious. But their function must also be reliably. In this lecture we concern with mathematical models and methods with which most different kinds of risks can be controled. Risk analysis, durable location planning, durable transportation networks, Multi Sourcing strategies, Capacity options, infrastructure protection and flexible production planning are parts of it. Topics of the lectures are supplemented and deepened during the exercises.

Media
presentations, black board

Literature
ILIAS-System: https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_crs_7817.html

Remarks
none

Course: Radar Systems Engineering [23405]

Coordinators: W. Wiesbeck
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	en

Learning Control / Examinations
Written Exam

Conditions
None.

Learning Outcomes
The goal is to understand the Radar principles and gain knowledge about modern Radar systems.
Based on Electromagnetic field theory, the lecture provides fundamentals of radar principles, system parameters and advanced techniques related to the system hardware and processing. From this lecture students are expected to learn how system engineering practically contributes to a radar system implementation.

Content
Subjects dealt in this lecture are closely related to the ongoing research works in the institute. The lecture starts with a short historical review of the development in radar systems. The further contents of this lecture are categorized into three major parts.
The first part of this lecture focuses on the fundamental disciplines required for understanding radar principles. The propagation phenomena of electromagnetic waves, such as reflection, diffraction, and scattering fundamentals, are important subject to understand the radar signal propagation and delivered target information. This subject is related to the derivation of the radar equation that is the most critical formula in radar system engineering. It is expected that the students develop the skill to derive the radar equation for various configurations and scenarios. The basic radar principles are introduced in this part as well as system parameters. A radar system performance is quantified by several system parameters like accuracy, false alarm rate, sensitivity, and noise parameter of the system. These system parameters are mathematically derived and the theoretical relation (trade-off) between parameters is addressed in this part.
The second part deals with radar system configurations and system features. The system configuration depends on the purposes and applications. This part introduces various radar system configurations from a pulse radar system to advanced radar concepts, such as Moving Target Indicator (MTI) and Synthetic Aperture Radar (SAR) and analyzes the system functionality. Furthermore, the details about system hardware and the subjects related to the system implementation are dealt, for example Radar Cross Section (RCS) measurement technique for system calibration. In addition, students are supposed to learn basic radar signal processing techniques that conduct the pulse compression. It is worth since the system performance can be evaluated by the quality of data efficiently recovered by the signal processing techniques.
The last part dedicates to introducing emerging techniques for future radar systems. A promising system concept with Digital Beam Forming (DBF) will be the main stream in this part. Compared to a conventional radar system based on the phased array antenna, the advantages and disadvantages are addressed at diverse angles. This advanced system concept is applicable to automotive radar systems and High Resolution Wide Swath (HRWS) SAR system. The lecture provides not only the technical description for the DBF radar system concept, but also challenges waiting for solutions, so that students could be encouraged to involve their master thesis on those topics.

Literature
Werner Wiesbeck, Lecture script „Radar Systems Engineering.“

Remarks
Current information can be found on the IHE (http://www.ihe.kit.edu) webpage.

Course: Space Electronics and Telemetry [23093]

Coordinators: H. Kaltschmidt
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Written Exam

Conditions
None.

Recommendations
Attending lectures about high frequency technology and information transmission technology is helpful.

Learning Outcomes
By means of system design problems it will be demonstrated how theoretical knowledge of the basic lectures of Electrical Engineering is used to get solutions for system design and component design.

Content
Aerospace Engineering especially Space Elektronics having regard to Space Sensorics is highly complex and a most challenging technology.
Operational satellite systems for communication navigation and remote sensing show the benefit based on aerospace research and development. Among other items the lecture deals with imaging sensorics in the infrared, visible and radiofrequent spectrum. Originally telemetry systems have been developed for testing aerospace systems. Today their application is manifold for example in aeronautics, mechanical engineering, (automotiv engineering) and biomedical engineering.
By means of system design problems it will be demonstrated how theoretical knowledge of the lectures of high frequency engineering, system optimisation, measurement technology, communication engineering, information processing automatic control engineering and materials in electrical engineering is used to get solutions for system design and component design. Besides the technically scientifically conditioning there are examples of industrial applied methods for finding solutions of complex problems on the basis of integration sales and marketing, development, manufacturing financing, financial management and human resource management (man in charge, colleagues, cooperaters etc.)

Course: Reactor Safety I: Fundamentals [2189465]

Coordinators: V. Sánchez-Espinoza
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral
Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
None.

Learning Outcomes

- Knowledge of fundamentals of nuclear safety (technology, atomic law, principles)
- Gain understanding of safety features and systems of a nuclear power plant
- Ability to understand the interactions of different areas e.g. thermal hydraulics, neutronics, materials, human factors, organisation and management of a nuclear power plant

Content
The goal of the lecture is to impart the fundamentals of nuclear safety that is needed to assess the safety of nuclear facilities. Nuclear safety is inherently of multidisciplinary character and is based on the following pillars: technology, man, organisation and measures; all together named "Safety Culture".The nuclear facilities, coal-fired power plants, aerospace industry and gen technology for example are connected with a certain risk for the environment and society. Consequently, the erection and operation of nuclear installations needs must undergo a licensing process and a continuous surveillance by the regulatory body. This lecture will be concentrated on the following topics:

- Historical development of nuclear safety
- Risk evaluation for nuclear power plants compared to other technologies
- Scope, principles and structure of the atomic Law (national and international context)
- Fundamentals of nuclear safety
- Safety features and systems of nuclear power plants with Light Water Reactors (Generation 2)
- Safety analysis and methods for safety assessment
- Validation of numerical simulation tools for safety demonstration
- Introduction to probabilistic safety assessment (PSA)
- Nuclear events and accidents
- Safety concepts of reactors of generation 3 and 4

Literature
Lecuture notes

Course: Computational Dynamics [2162246]

Coordinators: C. Proppe
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	

Learning Control / Examinations
Oral examination, no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
The lecture teaches the ability to compute solutions for problems in structure dynamics. For this purpose differential equations for the vibration of structure elements are presented and solved by means of numerical methods.

Content
1. Fundamentals of elasto-kinetics (Equations of motion, principle of Hamilton and principle of Hellinger-Reissner)
2. Differential equations for the vibration of structure elements (bars, plates)
3. Numerical solutions of the equations of motion
4. Numerical algorithms
5. Stability analyses

Literature
1. Lecture notes (in German) will be provided!
2. M. Géradin, B. Rixen: Mechanical Vibrations, Wiley, Chichester, 1997

Remarks
The course takes place every two years (in pair years).

Course: Computational Vehicle Dynamics [2162256]

Coordinators: C. Proppe
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination, no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
This course serves as an introduction to the computational modelling and simulation of the technical system road/vehicle. A method based perspective is taken, which allows for a unified treatment of various kinds of vehicles. The vehicle model is obtained by dividing the system into functional subsystems and defining interfaces between these subsystems. In the first part of the course, vehicle models will be developed based on models of the suspensions, the road, and the contact forces between road and vehicle. The focus of the second part of the course is on computational methods for linear and non-linear models of vehicle systems. The third part of the course discusses design criteria for stability, safety and ride comfort.The multi body dynamics software Simpack will be used.

Content
1. Introduction
2. Models of load bearing systems
3. Contact forces between wheels and roadway
4. Simulation of roadways
5. Vehicle models
6. Methods of calculation
7. Performance indicators

Literature
1. K. Popp, W. Schiehlen: Fahrzeugdynamik, B. G. Teubner, Stuttgart, 1993
2. H.-P. Willumeit: Modelle und Modellierungsverfahren in der Fahrzeugdynamik, B. G. Teubner, Stuttgart, 1998
3. H. B. Pacejka: Tyre and Vehicle Dynamics. Butterworth Heinemann, Oxford, 2002
4. K. Knothe, S. Stichel: Schienenfahrzeugdynamik, Springer, Berlin, 2003

Remarks
The course takes place every two years (impair years only).

Course: Computerized Multibody Dynamics [2162216]

Coordinators: W. Seemann
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
Knowledge of EM III, EM IV

Learning Outcomes
Goal of the course is to demonstrate the students that many tasks which are necessary to derive the equations of motion can be done by computers and corresponding software. This enables the user to focus both on mechanics and on modelling. This includes both kinematics as well as dynamcis and different methods to derive the equations of motion. The numerical integration is known and the students realize that the result of the simulation does not only depend on the physical model but also on the type of integration scheme and the corresponding parameters. Application of software without detailed knowledge of the principles which are behind this software is therefore dangerous.

Content
Description of the orientation of a rigid body, angular velocity, angular acceleration, derivatives in different referrence frames, derivatives of vectors, holonomic and nonholonomic constraints, derivation of the equations of motion using d'Alembert's principle, the principle of virtual power, Lagrange's equations or Kane's equations. Structure of the equations of motion, foundations of numerical integration.

Media
Following Programs are used: AUTOLEV, MATLAB, MATHEMATICA/MAPLE

Literature
Kane, T.: Dynamics, Theory and Applications, McGrawHill, 1985
AUTOLEV: User Manual

Course: Computer Aided Circuit Design [23060]

Coordinators: H. Wolf
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Verbal exam

Conditions
Mathematical basics, basic knowledge in circuit design and semiconductor technology

Learning Outcomes
The goal is to relay theoretical fundamentals.
Main topics of this lecture are the network analysis and the topological design (layout). After introduction of mathematical, formal and methodical fundamentals the basic types of network analysis are discussed and several deterministic and stochastic algorithms for solving the Np complete layout problem are given.

Content
This lecture presents an introduction to the theoretical fundamentals of computer aided design of integrated circuits. Practical hints from engineering view are given.
First the development of the integration of integrated circuit over the years is given. The network analysis and layout as basic steps of the design process of integrated circuits are discussed in depth in the further lecture. The general layout problem belongs to the class of NP complete problems, therefore an introduction of a design methodology especially for VLSI circuits is needed.
After an introduction of the set theory the graph theory is formulated. This graph theory is needed as theoretical fundamental for the network analysis and layout.
For the network analysis a suitable description for the computer of the concerning circuit is presented. Next the classical network analysis methods and furthermore the analysis with state variables are discussed. For solving the network equations the well known procedures based on matrix inversion are discussed and then the here advantageous solution with LU factorisation is presented. After a short discussion of the analysis of nonlinear circuits the statistical tolerance analysis finishes the chapter of the network analysis.
In the next chapter layout, first the general layout problem is formulated. This is a typical combinatorical optimization problem which belongs to the class of NP complete problems. For this problem goal functions or cost functions and limiting boundary conditions are formulated. After introduction of a design methodology the design styles for integrated circuits are presented. According the principle “divide and conquer” the general layout problem is divided into placement and routing. For both of this two subproblems suitable deterministic and stochastic algorithms are presented after giving the concerning problem formulation for placement and routing.

Literature
AT the ITE a script for this lecture is available.

Course: Computer Integrated Planning of New Products [2122387]

Coordinators: R. Kläger
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination
Duration:
30 minutes

No tools or reference materials may be used during exam.

Conditions
None.

Recommendations
None.

Learning Outcomes
The students got a basic understanding of relations, procedures and structure elements of standard processes in product planning and are capable of using these as guidelines for planning of new products.
They acquired knowledge of requirements and options in choosing and applying the right methods and tools for an efficient and reasonable assistance for specific use cases.
The students are familiar with elements and methods of computer aided idea and innovation management. They acquired knowledge of simultaneous assistance to the product planning process by using the technologies of rapid prototyping during development phases.

Content
The increase in creativity and the strength of innovation for the planning and development of new products has become a key factor for the competitiveness of the industry. Shorter innovation cycles, an overwhelming flood of information and an increasing demand for information and communication makes the use of computer absolutely necessary. Against this background this lecture discusses the success factors for new products, and introduces a product innovation process in conjunction with planning of new products based on the concepts of system engineering. In the following the methodological assistance to this process is being discussed by introducing innovation management, idea management, problem solving strategies, creativity and rapid prototyping for instance.

Literature
Handouts during lecture

Course: Computer Organization [24502]

Coordinators: T. Asfour, J. Henkel, W. Karl, Ömer Terlemez
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF], Informatik (Technische Informatik) (p. 27)[BSc-MIT - B-PI1]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1/2	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes
The students are to be enabled to

- gain fundamental knowledge of computer organization, i.e. the architecture and the operation principle of computer systems,
- understand the relationship between hardware concepts and their effects on the software, in order to build efficient programs,
- comprehend the fundamental principles of the design process and being able to apply them, based on the understanding of the interdependencies of technology, computer concepts and applications,
- build up a computer from basic components.

Content
This course deals with the fundamentals of computer organisation; the instruction set architecture in conjunction with the discussion RISC – CISC; pipelining, pipeline constraints and methods for the resolution of pipeline conflicts; memory organization, cache memory; I/O system and interface modules; interrupt handling; bus systems; support of operating system functions: virtual memory management and protection mechanisms.

Media
slides, practice sheets

Literature
Elective literature:

- D. Patterson, J. Hennessy: Rechnerorganisation und -entwurf; Deutsche Auflage. Herausgegeben von Arndt Bode, Wolfgang Karl und Theo Ungerer, Spektrum Verlag, 2006
- Th. Flick, H. Liebig: Mikroprozessortechnik; Springer-Lehrbuch, 5. Auflage 1998
- Y.N. Patt & S.J. Patel: Introduction to Computing Systems: From bits & gates to C & beyond; McGrawHill, August 2003

Course: Computer Lab for Computer Science in Mechanical Engineering [2121392]

Coordinators: J. Ovtcharova
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
0	2	Winter term	de

Learning Control / Examinations
Programming assignments, that are to be implemented at the computer, are given every two weeks. The students are supervised by tutors while they work on the assignments. Therefore online tests must be solved by the students to assess the understanding of the tasks and the lecture material. All assignments have to be handed in, before they can take part in the exam.

Conditions
None

Recommendations
None

Learning Outcomes
In the computer science workshop for the lecture Computer Science in Engineering, students are given several practical assignments, through which they develop a program containing the subject areas covered in the tutorial.

Content
Introduction to programming using JAVA

Course: Computer Architecture [24570]

Coordinators: J. Henkel, W. Karl
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Media
slides, work sheets

Literature
Elective literature:

-
- Hennessy, J.L., Patterson, D.A.: Computer Architecture: A Quantitative Approach. Morgan Kaufmann, 3.Auflage 2002
- U. Bringschulte, T. Ungerer: Microcontroller und Microprozessoren, Springer, Heidelberg, 2. Auflage 2007
- Theo Ungerer: Parallelrechner und parallele Programmierung, Spektrum-Verlag 1997

Course: Reduction methods for the modeling and the simulation of combustion processes [2166543]

Coordinators: V. Bykov, U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
After completing this course students will be able to:

- explain the fundamental mathematical concepts in model reduction for reacting flows,
- perform an analysis of kinetic models of reacting flows,
- analyse ideal and reduced models used to describe different combustion regimes,
- understand and asses the predominant methods for the mathematical analysis of reduced models.

Content
The course will introduce the principles of model reduction of chemical kinetic models of combustion processes. The basic mathematical concepts and methods of analysis of chemical reaction mechanisms will be outlined in the context of model reduction. The detailed implementation scheme of model reduction will be introduced. The course will cover simplified and idealized models of combustion (e.g. auto-ignition, explosion, deflagration etc.), which will be analyzed and reduced. The main analytical methods and numerical tools will be presented, evaluated and illustrated by using these simple examples.

Literature
N. Peters, B. Rogg: Reduced kinetic mechanisms for aplication in combustion systems, Lecture notes in physics, 15, Springer Verlag, 1993.

Course: Control of Electrical Drives [23312 + 23314]

Coordinators: M. Braun
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Recommendations
Knowledge from Electrical Machines and Power Electronics

Learning Outcomes
The goal is to relay the fundamental methods of the closed loop control of electrical drives.
Quality intensification and energy saving are achieved by fast, precise and motor adapted control of electric energy. In this lecture the closed loop control methods are presented, which allow the high dynamical control of position, speed and torque. The application of this methods and their impact on system dynamics are discussed on drive solutions with dc machines, synchronous and asynchronous machines.
Supporting the lecture, assignments to the curriculum are distributed. Their solution is presented and discussed during lecture hall exercises.

Content
Lecture
This lecture starts with the definition of the function of drive system.
The modelling of the mechanical subsystem is the basis for the design of the closed loop speed control circuit. The modelling of the electrical subsystem at the dc machine enables the design of the current controller. Hereby the fundamental layout of the cascade control structure with subordinate current and the superimposed speed controller is shown.
After the introduction into the description of three phase systems by space vectors the current control in a rotating coordinate system is described.
In a further chapter the closed loop control methods on basis of the dynamical description of the permanent magnet synchronous machine are explained.
Controlling asynchronous machines is in the focus of this lecture. Different kinds of open loop control methods are presented. By means of the model of the asynchronous machine in a rotor flux orientated coordinate system the derivation of various methods for closed loop control of the aysnchronous machine is carried out.
A one day excursion to a manufacturer or a user of electric drive systems shall deepen the connection to the industrial practice.
Exercises
To accompany the lecture material, assignments will be given out and discussed during lecture hall exercises. Practical demonstations of electrical drives systems complete this exercise.

Literature
The lecture notes are available at the secretary's office of the ETI. Assignments will be given out and are available online.

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the webpage of the ETI (www.eti.kit.edu).

Course: Renewable Energy – Resources, Technology and Economics [2581012]

Coordinators: R. McKenna
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3,5	2/0	Winter term	en

Learning Control / Examinations
The assessment consists of a written exam according to Section 4(2), 1 of the examination regulation.

Conditions
None.

Learning Outcomes
The student:

- understands the motivation and the global context of renewable energy resources.
- gains detailed knowledge about the different renewable resources and technologies as well as their potentials.
- understands the systemic context and interactions resulting from the increased share of renewable power generation.
- understands the important economic aspects of renewable energies, including electricity generation costs, political promotion and marketing of renewable electricity.
- is able to characterize and where required calculate these technologies.

Content
1. General introduction: Motivation, Global situation
2. Basics of renewable energies: Energy balance of the earth, potential definition
3. Hydro
4. Wind
5. Solar
6. Biomass
7. Geothermal
8. Other renewable energies
9. Promotion of renewable energies
10. Interactions in systemic context
11. Excursion to the "Energieberg" in Mühlburg

Media
Media will be provided on the e-learning platform ILIAS.

Literature
Elective literature:

- Kaltschmitt, M., 2006, Erneuerbare Energien : Systemtechnik, Wirtschaftlichkeit, Umweltaspekte, aktualisierte, korrigierte und ergänzte Auflage Berlin, Heidelberg : Springer-Verlag Berlin Heidelberg.
- Kaltschmitt, M., Streicher, W., Wiese, A. (eds.), 2007, Renewable Energy: Technology, Economics and Environment, Springer, Heidelberg.
- Quaschning, V., 2010, Erneuerbare Energien und Klimaschutz : Hintergründe - Techniken - Anlagenplanung – Wirtschaftlichkeit München : Hanser, Ill.2., aktualis. Aufl.
- Harvey, D., 2010, Energy and the New Reality 2: Carbon-Free Energy Supply, Eathscan, London/Washington.
- Boyle, G. (ed.), 2004, Renewable Energy: Power for a Sustainable Future, 2nd Edition, Open University Press, Oxford.

Course: Robotics I – Introduction to robotics [24152]

Coordinators: R. Dillmann, S. Schmidt-Rohr
Part of the modules: Informatik (Robotik) (p. 29)[BSc-MIT - B-PI3], Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
It is recommended to visit LV "Robotik II" and LV „Robotik III" in conjunction with „Robotik I".

Learning Outcomes
Students master
- the essential principles of sensors that are common in robotics
- the data flow, starting from the physical measurement, over digitization, application of the sensor model to image processing, feature extraction and the integration of the information in an environment model.
In particular, students understand the functional principles of internal and external sensors in robotics. They understand distance measuring via time off light and triangulation. Furthermore, they understand the function of visual sensors like CCD/CMOS. Students master proposing of suitable sensor concepts for simple tasks and justifying their choice.
Related to data flow, five different core topics are mastered by students:
In sensor modeling, students master defining a specific model in order to describe the characteristics of a sensor in data acquisition.
Students understand calibration of visual sensors, in particular automatic color adjustment und calculation of hdr images. They understand the basic principles of signal processing like sampling, quantization, Fourier transform and sampling theorem.
In machine vision, students master methods for color segmentation, edge extraction, Hough transform and feature extraction.
Students understand different environment models, like geometric, topologic and semantic models.
In multisensor data fusion, students master architectures of multisensor systems, Kalman filter, Dempster-Shafer methods and fuzzy set theory.

Content
The lecture gives an overview of the research field of robotics. Robotic systems in industrial manufacturing as well as service robots are covered. The key aspects consist in modelling of robots as well as methods for robot control. First, the different system and control components of a robotic platform are discussed. Methods for robot modelling such as kinematics and dynamics modelling are covered. Based on these models, approaches for control, planning and collision avoidance are discussed. Finally, robot architectures are introduced which comprise the previously studied approaches and models.

Media
Slides

Literature
Elective literature:
Fu, Gonzalez,Lee: Robotics - Control, Sensing, Vision, and Intelligence
Russel, Norvig: Artificial Intelligenz - A Modern Approach, 2nd. Ed.

Course: Robotik III - Sensors in Robotics [24635]

Coordinators: R. Dillmann, Meißner, Gonzalez, Aguirre
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
Previous attendance of the lecture „Robotik I" is helpful, but not mandatory.

Learning Outcomes
The student has to understand the principles of sensors that are essential and common in robotics. The student has to understand the data flow, starting from the physical measurement, over digitization, application of the sensor model to image processing, feature extraction and the integration of the information in an environment model. The student has to be able to propose suitable sensor concepts for simple tasks and to justify them.

Content
The lecture Robotics III complements the lecture Robotics I with a broad overview over sensors used in robotics and the interpretation of their data. One focus of the lecture is on the topic of computer vision, which is being dealt with from data aquisition, over calibration to object recognition and localization.
Sensors are important subcomponents of control circuits and enable robots to perform their tasks safely. Furthermore sensors serve to capture the environment as well as dynamical processes and actions in the surroundings of the robots. The topics that are addressed in the lecture, are as follows: Sensor technology for a whole taxonomy of sensor systems (including image and 3D sensors), sensor modeling (including color calibration and hdr imaging), theory and practice of digital signal processing, machine vision, multi-sensor integration and fusion.
Among others, sensor systems such as relative position sensors (optical encoders, potentiometer), velocity sensors (encoder, tachometer), acceleration sensors (piezo-resistive, piezo-electric, optical and others), inertial sensors (gyroscope, gravitometer and others), tactile sensors (foil sensors, pressure sensitive materials and others), proximity sensors, distance sensors (ultrasonic, laser, time-of-flight, interferometry, structured light, stereo camera systems and others), image sensors (photodiode, CCD and others), absolute position sensors (GPS, fiducial markers). Laser sensors as well as image sensors are dealt with priority.

Media
Slides, script.

Course: Medical Robotics [24681]

Coordinators: J. Raczkowsky, Raczkowsky
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes
The student should understand the specific demands of surgical treatments on automation using robot. Additionally he/she should become acquainted with basic methods of registration of image data and how to use them. This includes also also physical registration. Generally, the course should enable the student to design a work flow for a robot assisted treatment.

Content
In the motivation, varies scenario of robot assisted usage in surgical environment will be described and by examples categorized. The basics of robotics will be entertained by the classic kinematic configurations. The characteristic indicators like degree of freedom, kinematic chain, work space and work load will be introduced. Then, the different modules of the robot assisted surgical work flow will be figured out. This starts with the description of all relevant tomographical modalities. They will be explicated by their physical basics and their measurement evidence for anatomical and pathological information. Data formats and communication play an important role in this context. This will be followed by medical image processing with the focus on segmentation. The next step ist the geometrical 3D reconstruction of anatomical structures. This lead to an attributed patient model using the processed data of different tomographical modalities. This will be completed by different approaches for the modelling of tissue parameters. The usage of the attributed patient model for reasons of visualisation and operation planning is the next issue. The differing concepts of planning by medical doctors and engineers will be shown in this frame. Beside geometrical planning the role of work flow planning will be worked out. This becomes a more and more important topic in clinical routine. Simulation could be seen as a verification instrument of operation planning. Sub topics in this context is functional anatomical simulation, robot simulation with positioning verification and training systems. The intraoperative part of the robot aided work flow comprises physical registration, navigation, augmented reality and surgical robot systems. They will exemplified by basic principles and examples of applications. Important topics in this frame are techniques of tissue cutting and approaches for micro and nano surgery. The lecture closes with a short discourse on specific safety matters and legal aspects of medical products.

Media
PowerPoint-slides online

Literature
Elective literature:
- Springer Handbook of Robotics, Siciliano, Bruno; Khatib, Oussama (Eds.) 2008, LX, 1611 p. 1375 illus., 422 in color. With DVD., Hardcover, ISBN:978-3-540-23957-4
- Heinz Wörn, Uwe Brinkschulte "Echtzeitsysteme", Springer, 2005, ISBN: 3-540-20588-8
- Proccedings of Medical image computing and computer-assisted intervention (MICCAI ab 2005)
- Proccedings of Computer assisted radiologiy and surgery (CARS ab 2005)
- Tagungsbände Bildverarbeitung für die Medizin (BVM ab 2005)

Course: Special Areas in Communications [23509]

Coordinators: F. Jondral
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
Communications Engineering I

Learning Outcomes
The main goal of this series of lectures is to communicate basic knowledge about systems. Another important topic is the fact that a modern practically working engineer should think interdisciplinary.
This series of lectures is designed as an introduction to the interdisciplinary area of satellite communications and explains why apart from communications engineering knowledge about mechanics, propagation physics, antenna technology etc. are helpful to understand systems.

Content
1. Introduction
1.1 History and development of satellite communications
1.2 The archoitecture of a SATCOM system
1.3 The ground segment
1.4 Orbits
1.5 Technological developments
1.6 The development of services
1.7 Outlook
2. Evaluation of SATCOM links: Link budgets
2.1 The most important link budget parameters
2.2 Short forms of link budgets
2.3 The carrier-to-noise ratio of a ground - satellite - ground link
3. Multiple access
3.1 Routing
3.2 The multiple access principle
3.3 Frequency division multiple access (FDMA)
3.4 Time division multiple access (TDMA)
3.5 Code multiple access (CDMA)
4. Channel allocation and access protocols
4.1 Deterministic channel allocation
4.2 Random access
5. Intersatellite links
5.1 Links between geostationary and low erarth orbiting satellites (GEO – LEO)
5.2 Links between geostationary satellites (GEO – GEO)
5.3 Links between low earth orbiting satellites
5.4 Frequencies
6. Satellites employing regenerative transponders
6.1 Comparison of link budgets
6.2 On-board processing
6.3 Impact on the ground system
6.4 Conclusions
7. Frequencies, Systems, Applications
7.1 Frequency allocations
7.2 SATCOM systems in mobile communications
7.3 Satellite navigation (GPS and Gallileo)

Literature
The figures shown during the lectures will be made available to the audience via the web site of the Communications Engineering Lab. Students are encouraged to elaborate their own lectures notes.

Remarks
The lectures' contents partially reflect actual research performed at INT. The lecturer reserves the right to alter the contents of the course without prior notification.

Course: Industrial circuitry [23327]

Coordinators: A. Liske
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral Exam

Conditions
Lecture 23307 - Electrical Machines and Power Electronics

Learning Outcomes
Knowledge about industrial circuitry
The lector describes the attributes of electrical devices and the procedure in industrial circuitry.

Content
Steps in circuit design
assignment of tasks
conception
wiring diagram
design of a printed circuit board
dimensioning of the components
mechanical layout
modularity
connections
heat dissipation
heating sources and sinks
thermal equivalent circuit diagram
thermal capacity
puls- and periodic stress
cooling elements
passive elements
resistors
capacitors
inductors
discrete semiconductors
diodes
transistors
integrated semiconductors
operation amplifiers
logic circuits
special circuits
A/D converters
D/A converters
switch controllers

Literature
lecture notes available at the institute

Remarks
Current information can be found on the ETI (www.eti.kit.edu) webpage.

Course: Rail Vehicle Technology [2115996]

Coordinators: P. Gratzfeld
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
The students learn about advantages and disadvantages of different types of traction drives and judge which one fits best for each application.
They understand brakes from a vehicular and an operational point of view. They assess the fitness of different brake systems.
They know about the basics of running dynamics and bogies.
They define suitable vehicle concepts based on requirements for modern rail vehicles.

Content
Vehicle system technology: structure and main systems of rail vehicles
Drives: Electric and non-electric traction drives
Brakes: Tasks, basics, principles, brake control
Bogies: forces, running gears, axle configuration
Vehicle concepts: trams, metros, regional trains, double deck coaches, locomotives
Examples of existing rail vehicles were discussed.

Media
All slides are available for download (Ilias-platform).

Literature
A bibliography is available for download (Ilias-platform).

Remarks
None.

Course: Welding Technology [2173571]

Coordinators: M. Farajian
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary material

Conditions
basics of material science (iron- and non-iron alloys), of electrical engineering, of production processes.

Learning Outcomes
The students have knowledge and understanding of the most important welding processes and its industrial application.

They are able to recognize, understand and handle problems occuring during the application of different welding processes relating to design, material and production.

They know the classification and the importance of welding technonolgy within the scope of connecting processes (advantages/disadvantages, alternatives).

Content
definition, application and differentiation: welding,
welding processes,
alternative connecting technologies.
history of welding technology
sources of energy for welding processes

Survey: fusion welding,
pressure welding.
seam preparation/design
welding positions
weldability
gas welding, thermal cutting

manual metal-arc welding
submerged arc welding
IV characteristics: arc/sources of energy
gas-shielded metal-arc welding

Literature
Handbuch der Schweißtechnik I bis III
Werkstoffe
Verfahren und Fertigung
Konstruktive Gestaltung der Bauteile
Jürgen Ruge
Springer-Verlag GmbH & Co, Berlin

Schweißtechnische Fertigungsverfahren 1 bis 3
Schweiß- und Schneidtechnologien
Verhalten der Werkstoffe beim Schweißen
Gestaltung und Festigkeit von Schweißkonstruktionen

Ulrich Dilthey (1-3), Annette Brandenburger(3)
Springer-Verlag GmbH & Co, Berlin

Fachbuchreihe Schweißtechnik Band 76/I und II
Killing, R.; Böhme, D.; Hermann, F.-H.
DVS-Verlag

DIN/DVS -TASCHENBÜCHER
Schweißtechnik 1,2 ff...
Beuth-Verlag GmbH, Berlin

Course: Fatigue of Metallic Materials [2173585]

Coordinators: K. Lang
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
Duration: 30 minutes
none

Conditions
none, basic knowledge in Material Science will be helpful

Learning Outcomes
The students are able to recognise the deformation and the failure behaviour of metallic materials under cyclic loading and to assign it to the basic microstructural processes. They know the sequence and the development of fatigue damages and can evaluate the initiation and the growth of fatigue cracks.
The students can assess the cyclic strength behaviour of metallic materials and components both qualitatively and quantitatively and know the procedures for the assessment of single-stage, multistage and stochastic cyclical loadings. Furthermore, they can take into account the influence of residual stresses.

Content
Introduction: some interesting cases of damage
Cyclic Stress Strain Behaviour
Crack Initiation
Crack Propagation
Lifetime Behaviour under Cyclic Loading
Fatigue of Notched Components
Influence of Residual Stresses
Structural Durability

Literature
Lecture notes that include a list of current literature
will be distributed.

Course: Sensors [23231]

Coordinators: W. Menesklou
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment consits of a written exam according to Section 4(2), 1 of the examination regulation.
The examination takes place in every winter semester. Re-examinations are offered at every ordinary examination date.

Conditions
See module description.

Learning Outcomes
The student should acquire fundamental principles in material science and device technology of sensors to be able to apply materials and sensors from the viewpoint of an application or development engineer.

Content
Mechanical Sensors (strain gauges, piezoelectric sensors),Thermal Sensors, Optical Sensors, Magnetic sensors, Acoustic Sensors, Gas Sensors (Lambda Probes, Taguchi, Electronic Nose), Bio and Chemical Sensors.

Media
Online material is available.

Literature
Elective literature:
Schaumburg, H.: Sensoren. Stuttgart, Teubner 1992
Tränkler, H.-R., Obermeier, E. (Hrsg.): Sensortechnik. Springer, Berlin Heidelberg 1998

Course: Sensor Systems (Integrated Sensor Actuator Systems) [23240]

Coordinators: W. Wersing
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment consits of an oral exam (20 min) according to Section 4(2), 2 of the examination regulation.
The examination takes place in every summer semester. Re-examinations are offered at eyery ordinary examination date.

Conditions
None.

Recommendations
It is recommended to attend the courses *Material Science II* [21782] and *Electrical Engineering II* [23224] beforehand.

Learning Outcomes
See German version.

Content

Literature
Elective literature:

- Piezoelectricity: Evolution and Future of a Technology (Springer Series in Materials Science), W. Heywang, K. Lusitz, W. Wersing; Springer 2008
- Principles and Applications of Ferroelectrics and Related Materials, M.E. Lines, A.M. Glas, Clarendon Press, Oxford, 1977.
- Einführung in die Ferroelektrizität, A.S. Sonin, B.A. Strukow, Vieweg Verlag, Braunschweig, 1974
- Piezoelectricity, G.W. Taylor, Gordon Breach Verlag, London, 1977

Course: Safe mechatronic systems [2118077]

Coordinators: M. Golder
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH], Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter / Summer Term	

Learning Control / Examinations
oral / written depending on number of participants in accordace with present SPO

Conditions
none

Recommendations
none

Learning Outcomes
The students are capable to

- describe the general meaning of safety and safety technology
- name and apply the technical rules and standards in the area of machine safety
- define the term „risk“ in a safety-related context
- describe and apply the approach of risk assessment
- distinguish and apply relevant approaches to quantify safety
- demonstrate well-established safety concepts
- describe safety functions and to validate them
- name examples of different safety-related aspects

Content
This course provides in-depth knowledge on safety technology, in particular safety-related terminology and their definitions will be discussed and distinguished from each other. Besides an introduction on relevant technical rules and standards, the emphasis will be on their application in order to be capable to identify and assess risks. Thus, the quantification of safety with the help of mathematical models will be studied in details. In this respect, this course will discuss and highlight the importance of the parameters Performance Level (PL) vs. Safety Integrity Level (SIL). Especially the application of PL and SIL on real-life cases will be emphasized. Furthermore, safety concepts and their possible implementation in design will be discussed as well as safety functions of mechatronic systems. In particular, safe bus systems, safe sensors, safe actuators and safe controls will be highlighted and in this respect, a differentiation between safety systems and assistance systems will be conducted. Further examples of safe mechatronic systems from the area of material handling, drive technology, control technology or even signal transmission and processing will demonstrate the safety aspects as described above and show possible implementation approaches of integrated safety in an industrial environment.

Media
presentations

Literature
recommendations along the lessons

Remarks
The lessons will be held in german language during winter semester and english language during summer semester

Course: Security [24941]

Coordinators: J. Müller-Quade
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Summer term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes
The student

- knows the theoretic background and the basic mechanisms of computer security and cryptography
- understands the mechanisms of computer security and can explain them,
- can read and understand the current scientific papers,
- can evaluate the safety procedures and can recognize hazards,
- can adapt mechanisms of computer security to new environment.

Content

- Theoretical and practical aspects of computer security
- Development of safety goals and classification of threats
- Presentation and comparison of different formal access control models
- Formal description of authentication systems, presentation and comparison of different authentication methods (passwords, biometrics, challenge-response protocols)
- Analysis of typical vulnerabilities in programs and web applications and development of appropriate protective protection methods / avoidance strategies
- Introduction to key management and Public Key Infrastructure
- Presentation and comparison of current safety certifications
- Block ciphers, hash functions, digital signature, public key encryption and digital signatures (RSA, ElGamal), and various methods of key exchange (e.g., Diffie-Hellman)
- Furthermore, an introduction to provable security is provided, which presents some of the key security concepts (e.g. IND-CCA).
- Presentation of combinations of cryptographic modules using currently used protocols such as Secure Shell (SSH) and Transport Layer Security (TLS).

Media
Presentation slides (available online)
Blackboard presentation

Literature
Lecture notes (available online)

Course: Safety Engineering [2117061]

Coordinators: H. Kany
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral / written (if necessary) => (see “Studienplan Maschinenbau”, version of 29.06.2011)
examination aids: none

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to:

- Name and describe relevant safety conceps of safety engeneering,
- Discuss basics of health at work and labour protection in Germany,
- Evaluate the basics for the safe methods of design of machinery with the national and european safety regulations and
- Realize these objectives by using examples in the field of storage and material handling systems.

Content
The course provides basic knowledge of safety engineering. In particular the basics of health at the working place, job safety in Germany, national and European safety rules and the basics of safe machine design are covered. The implementation of these aspects will be illustrated by examples of material handling and storage technology. This course focuses on: basics of safety at work, safety regulations, basic safety principles of machine design, protection devices, system security with risk analysis, electronics in safety engineering, safety engineering for storage and material handling technique, electrical dangers and ergonomics. So, mainly, the technical measures of risk reduction in specific technical circumstances are covered.

Media
presentations

Literature
Defren/Wickert: Sicherheit für den Maschinen- und Anlagenbau, Druckerei und
Verlag: H. von Ameln, Ratingen, ISBN: 3-926069-06-6

Remarks
none

Course: Signals and Systems [23109]

Coordinators: F. Puente, F. Puente León
Part of the modules: Automation Technology (p. 19)[BSc-MIT - B7]

ECTS Credits	Hours per week	Term	Instruction language
6	2/2	Winter term	de

Learning Control / Examinations
Written exam (see actual document "Studienplan" and notice of the examination office ETIT).
Grades result from the written examination.

Conditions
Knowledge of higher mathematics and probability theory (1305) is required.

Recommendations
Advanced Mathematics I + II

Learning Outcomes
The goal is to relay theoretical fundamentals of signal representation and system theory.

Content
This lecture presents an introduction to the important theoretical fundamentals of signal processing, which is scheduled for the students in the third semester of Electrical Engineering. After an introduction to functional analysis, research methods for signals are presented. Furthermore properties, description and design of systems are discussed. These considerations are made for continuous and discrete variation of time.
At first a common survey of the whole topic is given. Based on the lectures in further mathematics, more terms and definitions of functional analysis are introduced in the second chapter. Beginning with a repetition of linear vector spaces the important description of Hilbert spaces is established. Beyond that, we consider linear operators. These considerations help to get a general idea of the afterwards used methods.
In the following chapter we give attention to the consideration and description of continuous-time signals. The properties are regarded and the different ways of description are illustrated. Resources presented in the previous chapter are used to affiliate mathematical relations. Particularly considering the possibilities of spectral analysis, we respond to the description of signals by Fourier series or Fourier transform.
At the beginning of the forth chapter, general properties of systems are defined by means of the operator notation. Subsequently, system dynamics are described based on differential equations. To solve these equations, the Laplace transform can be used. To this end, the Laplace transform is derived from the Fourier transform, and its properties are presented. The treatment of windowing and the design of filters for continuous-time signals are two important sections. At the end of the chapter, the Hilbert transform is introduced.
Afterwards, time-discrete signals are discussed. The transfer is necessary, because in digital technology only discrete values can be used. At first, different conditions, essential for sampling and reconstructing analogue signals, are derived. Subsequent different methods for spectral analysis are regarded. Especially the Discrete Fourier Transform (DFT) plays a major role.
The last chapter focuses on time-discrete systems. At first, common properties of continuous-time systems are assigned to time-discrete systems. The specific features of discretization are discussed in detail. Afterwards, the mathematical description of time-discrete systems using difference equations and the z-Transform is presented. Further topics include the time-discrete representation of continuous systems and the effects of windowing. Finally, the introduced terms and definitions are illustrated based on several examples.

Media
Slides
work sheets

Literature
Prof. Dr.-Ing. Kiencke: Signale und Systeme; Oldenbourg Verlag, 2008
Elective literature:
Will be announced in the lecture.

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the IIIT (www.iiit.kit.edu) webpage. The contents of the course described in this document are subject to modification without prior announcement.

Course: Signal Processing in Communications [23534]

Coordinators: H. Jäkel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Summer term	de

Learning Control / Examinations

Conditions
Communications 1, Probability Theory

Learning Outcomes

Content
The lecture focuses on the practical use of vectors and matrices in the description of telecommunication systems. Digital transmission is based on the transformation of physical signals into matrices. This may be done by using a sampling operation or by applying a bank of correlators. Simple preliminaries presented within the lecture result in mathematical descriptions which simplify and explain some of the algorithms used in telecommunications.
The methods discussed in the first part of the lecture are the basis for multiple algorithms in digital communication. Many methods can be reduced to the same mathematical principle, e.g., detection, multi-user separation and filter optimization. Thus, for a deeper understanding, the basic ideas are more important than a detailed knowledge of individual realizations. In order to demonstrate the elaborated principles, the simplified methods resulting from the mathematical description are applied to up-to-date topics in communications, e.g., problems arising in estimation theory, matched filter whitening, diversity techniques, multiuser detection, MIMO transmission and equalization.

Literature
Script is provided. Those topics which are not extensively elaborated in the script are taught according to well-established communication textbooks. Further reading is recommended in the lecture.

Course: Simulation of Coupled Systems [2114095]

Coordinators: M. Geimer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
It is recommended to have:

- Knowledge of ProE (ideally in current version)
- Basic knowledge of Matlab/Simulink
- Basic knowledge of dynamics of machines
- Basic knowledge of hydraulics

Learning Outcomes
After completion of the course, students are able to:

- building a coupled simulation
- parameterize models
- Perform simulations
- do Troubleshooting
- check results for plausibility

Content

- Knowledge of the basics of multi-body and hydraulic simulation programs
- Possibilities of coupled simulations
- Development of a simulation model by using the example of a wheel loader
- Documentation of the result in a short report

Literature
Elective literature:

- miscellaneous guides according the software-tools pdf-shaped
- information to the wheel-type loader

Course: Simulation in product development process [2185264]

Coordinators: T. Böhlke
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Not graded:
term paper in group work

- written part: 10 pages per person
- presentation: 15 minutes per group

Conditions
Compulsory preconditions: none

Recommendations
None.

Learning Outcomes
The students learn the connections between simulation methods, the necessary IT technique and the integration of such methods within the product development process. They know the basic approximation methods in mechanics and methods of modelling material behaviour using the finite-element-method. The students learn the integration within the product development process as well as the necessity of coupling different methods and systems. They master the modelling of heterogeneous technical systems and know the foundations of virtual reality.

Content

- approximation methods of mechanics: FDM, BEM, FEM, MBS
- material modelling using the finite-element-methode
- product life cycle
- coupling of methods and system integration
- modelling heterogeneous technical systems
- functional Digital Mock-Up (DMU), virtual prototypes

Literature
sildes of lectures will be available

Course: Simulation of production systems and processes [2149605]

Coordinators: K. Furmans, V. Schulze
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Winter term	de

Learning Control / Examinations
The assessment is carried out as a written exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None.

Recommendations
Regular attendance in the exercises.

Learning Outcomes
The students . . .

- can explain the procedure of a simulation study and the respective steps.
- are able to explain the different modeling approaches that are available to describe production systems in matters of production technology, systems of work and material flow, to analyze and evaluate the results.
- are able to define the different modeling approaches for the description of machining processes and their advantages and disadvantages.
- are able to specify methods for simulation of plants and factories and classify them according to their capabilities.
- are able to define basics in statistics.
- are able to both calculate performance indicators of material flow systems and evaluate real systems according to these performance indicators.
- are able to use the basic tools of a discrete-event simulation software and can evaluate simulation results.
- are able to describe how real systems can be modeled as well as how models can be used and their results can be evaluated.
- are able to perform a personnel-oriented simulation study and can evaluate its results concerning different key figures.
- are able to apply common techniques for verification and simulation and can evaluate the validity of a simulation study with these techniques.

Content
The aim of the lecture is to present the different aspects and possibilities of application of simulation technologies in the field of production systems and processes. Various simulations methods in the fields of production und manufacturing technology, work systems and the material flow for the production systems will be presented.
The following topics will be covered:

- Statistical basics (probability distribution and random numbers and their applications in the Monte Carlo simulation)
- Simulation of factories, machinery and processes (analysis of single manufacturing processes, machine tools and a digital plant)
- Simulation of work systems (personnel and oriented simulation of the digital plant)
- Design and validation of the simulations study (the procedure of a simulations study with the preparation work, the selection of the tools, the validation and the analysis/evaluation)

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Scaling in fluid dynamics [2154044]

Coordinators: L. Bühler
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral
Duration: 30 minutes
no auxiliary means

Conditions
none

Learning Outcomes
The student can extract non-dimensional number from the characteristic properties of flows. From the insights on scaling laws, the students are qualified to identify the influencing quantities from generic experiments and transfer these to real applications. The students can simplify the governing equations of fluid mechanic appropriately and can interpret the achieved results as a basis for efficient solution strategies.

Content

- Introduction
- Similarity rules (examples)
- Dimensional analysis (Pi-theorem)
- Scaling in differential equations
- Scaling in boundary layers
- Self-similar solutions
- Scaling in turbulent shear layers
- Rotating flows
- Magnetohydrodynamic flows

Literature
G. I. Barenblatt, 1979, Similarity, Self-Similarity, and Intermediate Asymptotics, Plenum Publishing Corporation (Consultants Bureau)
J. Zierep, 1982, Ähnlichkeitsgesetze und Modellregeln der Strömungsmechanik, Braun
G. I. Barenblatt, 1994, Scaling Phenomena in Fluid Mechanics, Cambridge University Press

Course: Software Engineering [23611]

Coordinators: C. Reichmann
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
Knowledge from Systems and Software Engineering (course 23605)

Learning Outcomes
Consolidation and enhancement of knowledge and comprehension about methods and tool in software engineering. Based on the course Systems and Software Engineering (SSE) software-specific knowledge are deepened. For competence evolvement of students a deepened comprehension of necessity and application of approaches, aids and tools from all areas of software development is aspired.

Content
The lecture Software Engineering addresses all students wanting to deal with design and development of complex software systems. It is aimed to provide techniques, methods, and tools that allow for a well structured and targeted solution of even complex problems. Addressed is the complete lifecycle of software products from requirements to maintenance and further development.
At first the lecture covers basics and background like terms, processes, general methods and process models for software design. Hereby special emphasis is laid on comprehension of emergence and necessity of the engineering approach in software development. This is based on knowledge provided in the lecture Systems and Software Engineering (SSE), especially knowledge about the unified modeling language UML.
As a starting point of the considered development process, collection and management of requirements is covered (Requirements Engineering, Requirements Management). Concretely introduced are methods and tools like SysML and EEKT.
To empower students to execute complex projects on their own, a next focus is on project management, considering especially software development. The necessity of accurate planning and targeted execution is depicted and methods for organization, surveillance and structuring are given.
Looking at the topic of software design different approaches like modular design and object-oriented design are introduced, compared and rated according to their benefits and drawbacks. Students shall be able to select appropriate approaches depending on the project.
As an important aid for design and realisation of software systems design pattern are presented and discussed that provide possible solution structures based on longtime worldwide experience. Students shall so be provided a toolbox of adaptable solution ideas. Subsequently implementation and according tools are concretely discussed.
As an additional crucial point in designing systems a focus is laid on refactoring and programming quality. Here criteria are given to identify and improve potential problems, so-called bad code smells.
An essential area in software engineering and also in the lecture is reuse of software. The lecture details alternatives and potentials for software reuse on various levels (e.g. libraries, frameworks, modules, pattern, . . .).
Finally meta modelling and model based development is a topic with UML as an example. Discussed are among other things different meta models, MDA and XMI. Also model transformations and different techniques for model-to-model transformations are given.

Literature
Online material is available on: ILIAS

Remarks
Current information can be found on the ITIV (www.itiv.kit.edu) webpage and within ILIAS.

Course: Software Radio [23510]

Coordinators: F. Jondral
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
Communications Engineering I

Learning Outcomes
Extensive knowledge about mobile communications, about the appertaining standards and about recent developments in the fields of Software Defined Radio, Cognitive Radio and Cognitive Networking is presented
The lectures present extensive knowledge about mobile communications, about the appertaining standards and about recent developments in the fields of Software Defined Radio, Cognitive Radio and Cognitive Networking.

Content
The lectures present extensive knowledge about mobile communications, about the appertaining standards and about recent developments in the fields of Software Defined Radio, Cognitive Radio and Cognitive Networking.
The lectures present extensive knowledge about mobile communications, about the appertaining standards and about recent developments in the fields of Software Defined Radio (SDR), Cognitive Radio (CR) and Cognitive Networking (CN).
Chapter one retraces the development of mobile communication systems from the fifties of the twenties century. Multiple access modes are examined with respect to the SDR paradigm. Modeling of mobile communications channels within the framework of different standards is discussed.
Chapter two covers the architecture of software radios. Here, the principles of the superhet as well as of the direct mixing (zero IF) receiver are elaborated in great detail. The most important processing component of digital radio structures is their analog-to-digital converter. These components are also extensively discussed. Moreover, starting from the application scenarios, distinctions and similarities of military and civil SDRs found.
The third chapter covers essential radio components. Following a detailed discussion of the mobile communication channel's properties, different modulation and demodulation modes are introduced. Afterwards, direct sequence spread spectrum as well as code division multiple access (CDMA) are examined. After a short review concerning channel equalization, several important channel (forward error correction) coding methods are discussed with respect to a possible unification of their signal processing. Source coding is exemplified by GSM. The chapter closes with a summary about RAKE receivers and multi user detectors.
The fourth chapter lumps together the most popular mobile communication standards. First of all, the second generation standards (DECT, GSM, IS-136, IS-95) are discussed. Then the third generation standards (cdma2000, UMTS) as well as the wireless local area network standards IEEE 802.x are introduced.
The hardware underlying a SDR or a CR is subject of chapter five. Properties of general purpose processors (GPPs), digital signal processors (DSPs) and field programmable gate arrays are extracted. Additionally, reconfigurable hardware is presented.
Chapter six explains the configuration of a SDRs. Here, special attention is paid to the simulation tools used as well as to harmonization of standards.

Literature
The power point presentations shown during the lectures will be available to the participants via the web site of the Institut für Nachrichtentechnik.

Remarks
The lectures' contents partially reflect actual research performed at INT. The lecturer reserves the right to alter the contents of the course without prior notification.

Course: Software Technology I [24518]

Coordinators: W. Tichy, T. Karcher
Part of the modules: Informatik (Softwareentwicklung) (p. 28)[BSc-MIT - B-PI2], Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	6	Summer term	de

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Software Engineering II [24076]

Coordinators: R. Reussner, W. Tichy, A. Koziolek
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Winter term	de

Learning Control / Examinations
The assessment consists of a written exam (approx. 60 minutes) according to section 4 subsection 2 no. 1 study and examination regulations.

Conditions
None.

Recommendations
The lecture *Software engineering I* should have been attended before.

Learning Outcomes
Software Processes: Students understand the evolutionary and incremental development and they can describe the advantage over a sequential process. They can describe the phases and disciplines of the Unified Process.
Requirements Engineering: Students can describe the terms and activities of Requirements Engineering. They can classify and assess requirements according to the facets "kind" and "representation". They can apply fundamental guidelines on specifying natural language requirements and they can describe requirements prioritization approaches. The can describe the purpose and the elements of Use Case Models. They can classify use cases according to their level and goal. They can create use case diagrams and use cases. They can derive system sequence diagrams and operation contracts and they can describe their role in the software development process.
Software architecture: Students can reproduce and describe the definitions of software architecture and software components. They can explain the difference between software architecture and software architecture documentation. They can describe the advantages of explicit architecture and the influences on architecture decisions. They can assign design decisions and elements to architectural layers. They can describe what component models define. They can describe the elements of the Palladio component model and explain some of the made design decisions.
Enterprise Software Patterns: Students can characterize enterprise systems and decide which characteristics a given application has. They know patters of structuring the domain logic, data source architectural patterns, and object-relational structural patterns. They can select an appropriate pattern for a given design problem and justify their selection with respect to advantages and disadvantages of the patterns.
Software design: Students can assign responsibilities that result from system operations to classes and objects in an object oriented design using the GRASP patterns and thus design object-oriented software.
Software quality: Students know the principles for well-readable program code and they can identify violations and make suggestions for improvement.
Model-driven software development (MDSD): Students can describe the goals and envisioned labour division of MDSD. They can reproduce and explain the definitions of "model" and "metamodel". They can discuss the goals of modelling. They can describe the Model-driven Architecture and they can express constraints in the Object Constraint Language. They can express simple transformation fragments of model-to-text transformations in a template language. They can discuss the advantages and disadvantages of MDSD.
Embedded systems: Students can explain the principles of real time systems and why these are usually implemented as parallel processes. They can describe a rough development process for real time systems. They can describe the role of a real time operating system. They can distinguish between different types of real time systems.
Dependability: Students can describe the different dimensions of dependability and assign a given requirement to the related dimension. They can explain why Unit tests are not sufficient to assess software reliability and they can describe what influence the usage profile and realistic failure data have. They can assess the reliability of a system based on statistical tests.
Security: Students can describe the fundamental ideas and challenges of software security. They can detect common security problems and make solution proposals.

Content
The students learn approaches and techniques for systematic software engineering. The lecture covers advanced topics. Topics are requirements engineering, software development processes, software quality, software archi-

tectures, MDD, Enterprise Software Patterns software maintainability, software security, dependability, embedded software, middleware, statistic testing

Media
Slides, secondary literature

Literature
Will be announced in the lecture.

Course: Solar Energy [23745]

Coordinators: B. Richards
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	en

Learning Control / Examinations
The examination results from the chosen module.

Conditions
Semiconductor fundamentals

Learning Outcomes
Students will be provided a comprehensive and detailed knowledge about solar energy conversion and related applications and technology. A profound knowledge of the technology will allow the students to carry out their own research on solar energy conversion. The lecture includes exercises on selected topics to deepen insight into the field.

Content
This course addresses different technical and scientific aspects of photovoltaic light conversion such as silicon 3rd generation, thin film and organic photovoltaics, tandem and concentrator solar cells and measurement techniques. Installation requirements and financial considerations for small and large size photovoltaic power plants for on-grid and off-grid solutions will be discussed. An introduction into solar thermal power plants and the respective technology will be given. Both solar energy harvesting technologies will be discussed as part of a greater concept for a reliable future energy supply.

Remarks
The lecture number for the tutorial of this class is 23750

Course: Space-born Microwave Radiometry - Advanced Methods and Applications [23448]

Coordinators: H. Süß
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	en

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
Fundamentals of passive microwave sensing, applications of microwave radiometry on ground based, air and space borne platforms; presentation of modern methods in security applications.

Content
The focal points of the lecture are:
Propagation of electromagnetic waves
Radiation properties of matter and radiation laws
Description of radiometers
Measurements and technologies
Imaging line scanners
Aperture synthesis radiometer
Fully polarimetric radiometers
Application examples for imaging of the earth surface, oil spill detection, imaging of infrastructures
Detection of hidden objects e.g. anti-personal-mines, weapons and explosives

Literature
B. Vowinkel „Passive Mikrowellenradiometrie“ Vieweg-Verlag
F.T. Ulaby, et al „Microwave Remote Sensing“ Vol 1

Remarks
Actual information can be found at the internet page of the IHE (www.ihe.kit.edu).

Course: Spaceborne SAR Remote Sensing [23424 + 23426]

Coordinators: A. Moreira
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	en

Learning Control / Examinations
Written exam

Conditions
None.

Learning Outcomes
Fundamentals, Theory and Applications of spaceborne Radar systems
The lecture is very interdisciplinary and well suited to students interested in learning different aspects of the entire end-to-end system chain of spaceborne radar systems. Today, synthetic aperture radar (SAR) systems are generating images of the Earth surface with a resolution better than 1 meter. Due to the their ability to produce high-resolution radar images independent of sunlight illumination and weather conditions, SAR systems have demonstrated their outstanding capabilities for numerous applications, ranging from environmental and climate monitoring, generation of three-dimensional maps, hazard and disaster monitoring as well as reconnaissance and security related applications. Only recently we entered a new era of spaceborne and airborne SAR systems. New satellite systems like TerraSAR-X and TanDEM-X provide radar images with a resolution cell of more than a hundred times better than the one of conventional SAR systems. The lecture will cover all aspects of spaceborne radar systems as well as an overview of new technologies and future developments.

Content
Contents of the lecture are: Introduction to Synthetic Aperture Radar (SAR), theory and basic signal processing, system design and performance estimation, advanced SAR imaging modes, spaceborne SAR missions, technology development, applications (land, vegetation, sea, ice/snow, disaster monitoring, etc.), innovative SAR concepts and future developments. The contents of this lecture are closed related to the projects and research activities being performed at the Microwaves and Radar Institute of the German Aerospace Center (DLR, for more information please refer to www.dlr.de/HR).

Literature
Material to the lecture can be found online at www.ihe.kit.edu or ftp://sar-lectures@www.microwaves-and-radar.dlr.de

Remarks
Current information can be found at the internet page of the IHE (www.ihe.kit.edu).

Course: Spectrum Management [23547]

Coordinators: D. Löffler
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
Communications 1, Fundamentals of Microwave Engineering

Learning Outcomes
The intention is to convey an overview
The lecture discusses the technical, political, administrative and economical aspects of spectrum management.

Content
Radio frequencies are a natural resource. Luckily they are occupied but not consumed by use. Nevertheless, the various parts of the spectrum are not equally useful. Some parts are good for some purposes, other parts are technically preferable for other purposes. Hence there are technical reasons for selecting one or the other frequency for a given application. On the other hand the Titanic disaster around a hundred years ago showed to the public the profit of standardizing frequency usage what fortunately started around six years before. At an international radiotelegraph convention the SOS distress signal was adopted.
Today allocating frequencies for certain usages still has an eye on the distress and safety applications but is has become much more. Today it is a fundamental basis for the interoperability of devices, networks and services everywhere. It is also the essential basis for all communication companies to sell their products all around the world. This allocation of frequencies is the core of spectrum management.
The lecture starts with basic technical aspects. Wave propagation within different frequency ranges is discussed and popular models are presented. Antennas are introduced; their properties at different frequency ranges and for different applications are highlighted. The signals transmitted and received as well as filters are presented together with basic calculation methods. Link budgets for the useful and the interfering signal path are examined. Interference accumulation algorithms as well as decision thresholds like C/N, C/I, C/(I+N) are discussed.
In a second part the lecture presents fundamental political and administrative aspects. Organisations and groups active in the spectrum management area are presented. The concept of services as a basis for the allocation of spectrum is introduced. Different methods for the subdivision of the electromagnetic frequency spectrum are shown.
The third area revisits topics discussed in the first and second part and shows their utilization within the frequency planning and assignment processes. The two basic ideas “first come, first serve” and the planning approach are compared. Financial aspects (fees, auction processes) for the steering of frequency use are presented. Last but not least - as part of enforcement procedures - monitoring techniques and location finding methods are described.

Literature
Paper copies of the presentation (slides) are provided during the lecture. All slides are in English. Further references as well as internet-links are announced during the lecture.

Course: Special Topics in Information Engineering & Management [2540498]

Coordinators: C. Weinhardt
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter / Summer Term	de

Learning Control / Examinations
The assessment of this course is according to §4(2), 3 SPO in form of a written documentation, a presentation of the outcome of the conducted pracitical components and an active participation in class.
Please take into account that, beside the written documentation, also a practical component (such as a survey or an implementation of an application) is part of the course. Please examine the course description for the particular tasks.
The final mark is based on the graded and weighted attainments (such as the written documentation, presentation, practical work and an active participation in class)

Conditions
None.

Learning Outcomes
Students are able to

- do literature search based on a given topic: identify relevant literature, find, assess and evaluate this literature.
- do additional practical components in order to apply scientific methods (e.g., case studies, software implementations, surveys, or experiments).
- write the seminar thesis (and later the Bachelor-/Masterthesis) with a minimal learning curve by using format requirements such as those recommended by well-known publishers.
- give presentations in a scientific context in front of an auditorium. These techniques are presented and learned during the seminar.
- present results of the research in written form generally found in scientific publications.

Content
In this course the student should learn to apply the search methods to a predefined topic area. The topics are based on research questions in Information Engineering and Management across different industry sectors. This problem analysis requires an interdisciplinary examination. Experiments, case studies or software development can be part of the practical work that offers the students an opportunity to get a deeper insight into the field of Information Engineering and Management. The course also encompases a documentation of the implemented work.

Media

- PowerPoint
- E-learning platform ILIAS
- Software tools for development, if needed

Literature
The basic literature will be made available to the student according to the respecitive topic.

Remarks
All the practical seminars offered at the chair of Prof. Dr. Weinhardt can be chosen in the Special Topics in Information Engineering & Management course. The current topics of the practical seminars are available at the following homepage: www.iism.kit.edu/im/lehre
The Special Topics Information Engineering and Management is equivalent to the practical seminar, as it was only offered for the major in “Information Management and Engineering” so far. With this course students majoring in

“Industrial Engineering and Management“ and “Economics Engineering” also have the chance of getting practical experience and enhance their scientific capabilities.
The Special Topics Information Engineering and Managementcan be chosen instead of a regular lecture (see module description). Please take into account, that this course can only be accounted once per module.

Course: Theory of Stability [2163113]

Coordinators: A. Fidlin
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions
None.

Recommendations
Vibration theory, mathematical methods of vibration theory

Learning Outcomes

- to learn the most important methods of the stability analysis
- to apply the stabiliy analysis for equilibria
- to apply the stabiliy analysis for periodic solution
- to apply the stabiliy analysis for systems with feedback control

Content

- Basic concepts of stability
- Lyapunov's functions
- Direct lyapunov's methods
- Stability of equilibria positions
- Attraction area of a stable solution
- Stability according to the first order approximation
- Systems with parametric excitation
- Stability criteria in the control theory

Literature

- Pannovko Y.G., Gubanova I.I. Stability and Oscillations of Elastic Systems, Paradoxes, Fallacies and New Concepts. Consultants Bureau, 1965.
- Hagedorn P. Nichtlineare Schwingungen. Akademische Verlagsgesellschaft, 1978.
- Thomsen J.J. Vibration and Stability, Order and Chaos. McGraw-Hill, 1997.

Course: Control Technology [2150683]

Coordinators: C. Gönnheimer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester twice. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students ...

- are able to name the electrical controls which occur in the industrial environment and explain their function.
- can explain fundamental methods of signal processing. This involves in particular several coding methods, error protection methods and analog to digital conversion.
- are able to choose and to dimension control components, including sensors and actors, for an industrial application, particularly in the field of plant engineering and machine tools. Thereby, they can consider both, technical and economical issues.
- can describe the approach for projecting and writing software programs for a programmable logic control named Simatic S7 from Siemens. Thereby they can name several programming languages of the IEC 1131.

Content
The lecture control technology gives an integral overview of available control components within the field of industrial production systems. The first part of the lecture deals with the fundamentals of signal processing and with control peripherals in the form of sensors and actors which are used in production systems for the detection and manipulation of process states. The second part handles with the function of electric control systems in the production environment. The main focus in this chapter is laid on programmable logic controls, computerized numerical controls and robot controls. Finally the course ends with the topic of cross-linking and decentralization with the help of bus systems.
The lecture is very practice-oriented and illustrated with numerous examples from different branches.
The following topics will be covered

- Signal processing
- Control peripherals
- Programmable logic controls
- Numerical controls
- Controls for industrial robots
- Process control systems
- Field bus
- Trends in the area of control technology

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Steuerungstechnik für Roboter [24151]

Coordinators: H. Wörn
Part of the modules: Informatik (Robotik) (p. 29)[BSc-MIT - B-PI3], Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature
Heinz Wörn, Uwe Brinkschulte 'Echtzeitsysteme', Springer, 2005, ISBN: 3-540-20588-8
Manfred Weck, Christian Brecher 'Werkzeugmaschinen 4, Automatisierung von Maschinen und Anlagen', Springer, 2006, ISBN: 10 3-540-22507-2

Course: Stochastic Control Systems [23171]

Coordinators: M. Kluwe
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral exam (20 min.) according to § 4(2), 2 of the examination regulation). The examination is offered at several dates every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Recommendations
Knowledge of the basics of system dynamics and control engineering is assumed. Therefore it is recommended to attend for example the course 23155 System dynamics and Control Engineering beforehand.

Learning Outcomes
The goal is to relay theoretical and practical fundamentals on the field of optimal estimation of stochastic process signals.
This course prepares the students to solve the optimal state estimation problem in dynamic systems, which is a demanding engineering task in industrial control applications. Starting with the fundamentals of stochastics, the broad theory of Wiener Filters and Kalman(-Bucy) Filters is presented, so that the student is enabled to design and analyze such filters. Moreover, nonlinear filter concepts are discussed.

Content

- Stochastic Processes: random variables, probability distribution and density, conditional probability distribution and density, independent stochastic processes, Markov processes, mean values: correlation and covariance function, stationary and ergodic processes, power spectrum, normal processes and white noise;
- Systems with stochastic inputs and outputs: time-invariant systems and stationary processes, time-variant systems and instationary processes;
- Optimization of linear systems with stochastic inputs and outputs: general estimation problem, structure of the optimization problem, filtering, prediction and interpolation;
- Optimal state estimation by Wiener Filters: optimization by structure optimization, Wiener-Hopf equation, orthogonality principle;
- Optimal State Estimation by Kalman Filters: maximum-a-posteriori and minimalvariance estimation, filtering and prediction equations of Kalman Filters, structure and features of Kalman Filters, application examples and computer demonstration, comparison with deterministic least-squares-optimization;
- Optimal State Estimation by Kalman-Bucy Filters: estimation equations of Kalman- Bucy Filters, structure and features of Kalman-Bucy Fiters, examples;
- Outlook: Nonlinear Filters: Extented Kalman Filter, Sigma-Point Kalman Filter

Literature

- Papoulis, A.: Probability, Random Variables and Stochastic Processes, 3rd edition, McGraw-Hill, 1991

Elective literature:

- Krebs, V.: Nichtlineare Filterung (available in the IRS as a reprint of the book published 1980 by Oldenbourg)

Remarks
Supplemental sheets for the lecture are available on the IRS webpage.
Furthermore, the demonstrations in Matlab/Simulink used in the lecture for visualization of the presented topics can be downloaded from the IRS webpage (http://www.irs.kit.edu/) for own experiments.

Course: Interference-resistant Communication [23136]

Coordinators: K. Dostert
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Basic knowledge of information and communication system theory as well as RF engineering

Learning Outcomes
Advanced theoretical knowledge and practical approaches for the design of robust communication systems to exploit unusual channels, such as energy distribution grids.

Content
The lecture is based on the knowledge acquired with the Bachelor degree at the KIT. At the beginning, continuous time-domain signals are considered, as well as the behavior of LTI systems under the influence of such signals. The continuous time convolution is introduced in order to describe the relation between the output signal of a system, the system's impulse response, and the input signal. All these relations are then transferred to time-discrete signals and systems. Furthermore, correlation is introduced for determinate (energy) signals, and the relation between correlation and convolution is explained.
In a next step methods to describe stochastic signals are presented, and the corresponding parameters which are relevant for such signals are introduced. The relevance of the correlation function for stochastic signals is explained. Based on this theoretical background, the principle of correlation-based matched filter receivers is illustrated.
A further step within the lecture describes the behavior of transmission lines when high frequency time-continuous signals are applied. The underlying model of transmission line theory is explicated and parameters such as characteristic impedance, attenuation and reflection are introduced as a general base. Then modifications are elaborated, in order to extend and adapt the theory to unusual wiring structures, which were not designed for communication purposes, but e.g. solely for transmission of electrical energy. As an analytical treatment of such wiring structures will usually not be possible in practice, special and dedicated measuring methods are investigated for parameter acquisition and modeling of the line properties.
Important additional steps toward the analysis of data transmission quality are the evaluation of 'throughput' (i.e. data rate) and bit error rate (BER). In order to treat this topic, it is necessary to revisit the basics of probability theory, i.e. distribution function, density function, statistical independence etc.
Starting from this common base, the behavior of LTI systems influenced by Gaussian random processes is investigated, leading to results for BER figures in matched filter receivers. Eventually these considerations represent an essential step toward the explanation of the term 'channel capacity'. Then, in advanced studies the mentioned unusual channels are thoroughly examined, defining possibilities limitations of their usability.
As typical and highly challenging examples, energy distribution grids are considered as channels for reliable data transmission. Such aspects are currently of special interest for the realization of so-called 'Smart Grid' and 'Smart Metering' issues. The general goals are improvements of efficiency for the usage of electrical energy, especially for the optimal distribution of energy from renewable sources (wind, photo-voltaic), as well as permanent supervision and surveillance of the power grid.
For various reasons, the power lines themselves are the first choice for data transmission. Therefore, in the final part of the lecture the whole theoretical background acquired during the previous sections is now evaluated in order to select the best methods for the exploitation of these unusual channels. In this context multicarrier signaling in the form of OFDM is considered and judged, as well as different spread spectrum technologies.

Literature
The lecture script, supplements, and additional material are available online under http://www.iiit.kit.edu/sri.php. On this webpage also literature for further reading can be found.

Remarks
Current information can be found on the IIIT webpage (www.iiit.kit.edu). Due to the rapid progress in the development of modern hardware, the content of this lecture has to be continuously updated. Thus, the description given

above can be considered as a framework, for which ongoing modifications and supplements will be provided.

Course: Strategic product development - identification of potentials of innovative products [2146198]

Coordinators: A. Siebe
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam
duration: 20 minutes

Conditions
none

Learning Outcomes
After listening to this lecture the students is able to ...

- describe the importance and goals of future management in product planning.
- to evaluate the different approaches of strategic product planning under consideration of the particular application.
- describe the approaches of a strategic szenario-based product planning.
- illustrate the strategic szenario-based product planning based on examples.

Content
Introduction into future management, Development of scenarios, scenariobased strategy development, trendmanagement, strategic early detection, innovation- and technologymanagement, scenarios in product development, from profiles of requirements to new products, examples out of industrial praxis.

Course: Flows in rotating systems [2154407]

Coordinators: R. Bohning, B. Frohnapfel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes (optional subject), 20 minutes (major subject)

No tools or reference materials may be used during the exam

Conditions
None.

Learning Outcomes
The students can describe the fundamental phenomena involved as well as the mathematical and physical aspects of rotating fluid flows, which occur in a wide variety of technical contexts and in geophysics, particularly in the atmosphere and in the oceans. They are qualified to transfer the obtained knowledge for characteristic flow problems of this field to practical examples.

Content

- Introduction
- Governing equations in a rotating System
- Exact solutions (circular flows)
- Dynamic similarity (Rossby Number Ekman Number)
- Hyperbolicity (Inertia waves, Rossby waves)
- Taylor Proudman theorem
- Ekman-layer
- Instabilities in rotating systems

Literature
Greenspan, H. P.: The Theory of Rotating Fluids

Lugt, H. J.: Wirbelströmungen in Natur und Technik, Braun Verlag, Karlsruhe, 1979

Lugt, H. J.: Vortex Flow in Rotating Fluids (with Mathematical Supplement),
Wiley Interscience

Pedlovsky, J.: Geophysical Fluid Dynamic

Course: Flows with chemical reactions [2153406]

Coordinators: A. Class
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 min
as WF NIE
written homework

Lecture

Conditions
Mathematics

Learning Outcomes
The students can describe flow scenarios, where a chemical reaktion is confined to a thin layer. They can choose simplifying approaches for the underlying chemistry and discuss the problems with focus on the fluid mechanic aspects. The students are able to solve simple problems analytically. Furthermore, they are qualified to discuss simplifications as relevant for an efficent numerical solution of complex problems.

Content
In the lecture we mainly consider problems, where chemical reaktion is confined to a thin layer.
The problems are solved analytically or they are at least simplified allowing for efficent numerical
sollution procedures. We apply simplified chemistry and focus on the fluid mechanic aspects of the problems.

Media
Black board

Literature
Lecture

Buckmaster, J.D.; Ludford, G.S.S.: Lectures on Mathematical Combustion, SIAM 1983

Course: Flows and Heat Transfer in Energy Technology [2189910]

Coordinators: X. Cheng
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination; duration: 20min

Conditions
None.

Learning Outcomes
This lecture is dedicated to students of mechanical engineering and other engineering Bachelor or Master degree courses. Goal of the lecture is the understanding of major processes in fluid dynamics and heat transfer in energy engineering. The corresponding phenomena and the methods to analyse are described and explained. In addition the lecture will be supplemented by convenient examples.

Content

1. collection of sample applications
2. heat transfer and its application
3. convective fluid dynamics and heat transfer
4. thermal radiation and its application
5. special cases

Literature

- Bahr, H.D., Stephan, K., Wärme- und Stoffübertragung, 3. Auflage Springer Verlag, 1998
- Mueller, U., Zweiphasenströmung, Vorlesungsmanuskript, Februar 2000, TH Karlsruhe
- Mueller, U., Freie Konvektion und Wärmeübertragung, Vorlesungsmanuskript, WS1993/1994, TH Karlsruhe
- W. Oldekop,„Einführung in die Kernreaktor und Kernkraftwerktechnik,“Verlag Karl Thiemig, München, 1975
- Cacuci, D.G., Badea, A.F., Energiesysteme I, Vorlesungsmanuskript, 2006, TH Karlsruhe
- Jones, O.C., Nuclear Reactor Safety Heat Transfer, Hemisphere Verlag, 1981
- Herwig, H., Moschallski, A., Wärmeübertragung, 2. Auflage, Vieweg + Teubner, 2009

Course: Fluid Mechanics [2153412]

Coordinators: B. Frohnapfel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH], Thermodynamik (MACH) (p. 25)[BSc-MIT - B-PM2]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Winter term	de

Learning Control / Examinations
written

duration: 3 hours

Aux. Means: tables and formulas, electronic calculator

Conditions
None.

Recommendations
Successfully completed Advanced Mathematics I-III
basic knowledge about physics and ordinary linear differential equations

Learning Outcomes
After having completed this module the student is capable of deriving the mathematical equations that describe the motion of fluids and can determine flow quantities for generic problems.

Content
Introduction to the fundamentals of fluid mechanics for students of mechanical engineering and related fields, physics and mathematics. The lecture is complemented by a tutorial.

- Introduction
- Flows in Nature and Technologie
- Fundamentals of Fluid Mechanics
- Properties of Fluids and Characteristic Fluid Regimes
- Fundamental Equations of Fluid Mechanics (Conservation of Mass, Momentum and Energy)
  - Continuity equation
  - Navier-Stokes equations (Euler Equations)
  - Energy equation
- Hydro- und Aerostatics
- Flows without dissipation (lossless)
- Technical Flows with Losses
- Introduction to Similarity Analysis
- Two-Dimensional Viscous Flows
- Integral Form of the Governing Equations
- Introduction to Gas Dynamics

Media
Blackboard, Power Point, Experiments

Literature
Kundu, P.K., Cohen, K.M.: Fluid Mechanics, Elsevier, 4th Edition, 2008
Durst, F.: Fluid Mechanics: An Introduction to the Theory of Fluid Flows, Springer 2008
Batchelor, G.K.: An Introduction to Fluid Dynamics, Cambridge Mathematical Library

Course: converter control technique [23330]

Coordinators: A. Liske
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral Exam

Conditions
Lecture 23307 - Electrical Machines and Power Electronics

Learning Outcomes
Knowledge about analogue and digital principles for controlling converters
The lecture presents several controllers for converters. The theoretical aspects are described as well as the practical implementation is described.

Content
fundamental terms of electromagnetism
mmf, flux and flux linkage
law of induction
system equations
equivalent circuit
calculation of inductance
main- and leakage flux
main- and leakage inductance
Rogowski-factor
steady-state operation
load characteristic
efficiency
dynamic responce
inrush
short circuit
force

Remarks
Current information can be found on the ETI (www.eti.kit.edu) webpage.

Course: Structural and phase analysis [2125763]

Coordinators: S. Wagner
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
20 min
auxiliary means: none

Conditions
None.

Learning Outcomes
The students know the fundamentals of crystallography, the generation and detection of x-rays as well as their interaction with the microstructure of crystalline materials. They have detailed knowledge about the different methods of x-ray diffraction measurements and are able to analyse x-ray spectra using modern methods of x-ray analysis both qualitatively and quantitatively.

Content
The course gives an overview to generation and detection of x-rays as well as their interaction with matter. It provides an introduction to crystallography and describes modern measurement and analysis methods of x-ray diffraction.
It is arranged in the following units:

- Generation and properties of X-Ray's
- Crystallography
- Fundamentals and application of different measuring methods
- Qualitative and quantitative phase analysis
- Texture analysis (pole figures)
- Residual stress measurements

Media
Slides for the lecture:
available unter http://ilias.studium.kit.edu

Literature

1. Moderne Röntgenbeugung - Röntgendiffraktometrie für Materialwissenschaftler, Physiker und Chemiker, Spieß, Lothar / Schwarzer, Robert / Behnken, Herfried / Teichert, Gerd B.G. Teubner Verlag 2005
2. H. Krischner: Einführung in die Röntgenfeinstrukturanalyse. Vieweg 1990.
3. B.D. Cullity and S.R. Stock: Elements of X-ray diffraction. Prentice Hall New Jersey, 2001.

Course: Structural Ceramics [2126775]

Coordinators: M. Hoffmann
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at a specific date.
Auxiliary means: none
The re-examination is offered at a specific date.

Conditions
none

Recommendations
Basics of the course “Introduction to Ceramics” should be known.

Learning Outcomes
The students know the most relevant structural ceramics (silicon carbide, silicon nitride, alumina, boron nitride, zirconia, fibre-reinforced ceramics) and their applications. They are familar with the microstructural features, fabrication methods, and mechanical properties.

Content
The lecture gives an overview on structure and properties of the technical relevant structural ceramics silicon nitride, silicon carbide, alumina, zirconia, boron nitride and fibre-reinforced ceramics. All types of structural ceramics will be discussed in detail in terms of preparation methods of the raw materials, shaping techniques, densification, microstructural development, mechanical properties and application fields.

Media
Slides for the lecture:
available under http://ilias.studium.kit.edu

Literature
W.D. Kingery, H.K. Bowen, D.R. Uhlmann, “Introduction to Ceramics”, John Wiley & Sons, New York, (1976)

E. Dörre, H. Hübner, “Aluminia”, Springer Verlag Berlin, (1984)

M. Barsoum, “Fundamentals of Ceramics”, McGraw-Hill Series in Material Science and Enginewering (2003)

Remarks
The course will not take place every year.

Course: Superconducting Materials for Energy Applications [23682]

Coordinators: F. Grilli
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	en

Learning Control / Examinations
The examination results from the chosen module, otherwise:
Oral exam, about 25 min.

Conditions
None.

Learning Outcomes
After attending this course, the students will have

- Received an introduction to superconductivity, with an overview of its main features and of the theories developed to explain it;
- Learned about superconducting materials and their properties, especially those currently employed in energy applications (niobium-based superconductors, cuprates, MgB2) and promising recently discovered ones (pnictides);
- Familiarized with the wide range of superconducting energy applications (magnets, cables, fault current limiters, motors, transformers, etc.), and learned about the advantages they offer with respect to their conventional counterparts.

Content

- Introduction of the course
- Basics of superconductivity
- Materials I (low-T_c superconductors)
- Materials II (high-T_c superconductors)
- Stability
- AC losses
- Simulation and modeling
- Cables
- Fault current limiters
- Magnets, motors, transformers
- Smart-grids
- Lab tour

Media
Blackboard, PowerPoint slides, script written by the teacher (100+ pages)

Literature
Various. It will be provided on a lecture-by-lecture basis.

Remarks
Current information can be found on the IMS (www.ims.kit.edu) webpage. At the end of the course an excursion is planned to KIT Campus North (ITEP).

Course: Supply chain management [2117062]

Coordinators: K. Alicke
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
oral examination

No tools or reference materials may be used during the exam.

Conditions
limited number: application necessary

Recommendations
none

Learning Outcomes
Students are able to:

- Discuss the requirements on modern supply chains,
- Use the basic concepts of demand forecast, stock optimization and supply in practical exercises,
- Analyse the typical questions of dimensioning a supply chain and evaluate a supply chain with the results.

Content

- Bullwhip-Effect, Demand Planning & Forecasting
- Conventional planning processes (MRP + MRPII)
- Stock keeping strategy
- Data acquisition and analysis
- Design for logistics (Postponement, Mass Customization, etc.)
- Logistic partnerships (VMI, etc.)
- Distribution structures (central vs. distributed, Hub&Spoke)
- SCM-metrics (performance measurement) e-business
- Special sectors as well as guest lectures

Media
presentations

Literature
Alicke, K.: Planung und Betrieb von Logistiknetzwerken

Simchi-Levi, D., Kaminsky, P.: Designing and Managing the Supply Chain

Goldratt, E., Cox, J.: The Goal

Remarks
this course is not offered at the moment
this course is a block course

Course: Superconducting Systems of Energy Technologies [23681]

Coordinators: B. Holzapfel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
The lecture contains the basics of superconductivity for engineers and a state-of-the-art overview about superconducting materials and their characteristics. For the most relevant superconducting applications in power systems the function and the state-of-the-art is given.

Content

- Basics of superconductivity
- Superconducting phenomena
- Stability of superconductors and loss mechanism
- Characteristics and manufacturing of superconductors
- Superconducting energy transmission
- Superconducting motors and generators
- Superconducting transformers
- Superconducting magnetic energy storage
- Superconducting magnets
- Superconducting electronic applications
- Basics of cryogenics

Literature
Online material is available on: www.ims.kit.edu

Remarks
Current information can be found on the IMS (www.ims.kit.edu) webpage. At the end of the course an excursion is planned to KIT Campus North (ITEP).

Course: Superconductive Technologies [23676]

Coordinators: M. Noe
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
Understand basic phenomena of superconductivity Understand cause of AC loss and estimate AC loss in superconductors Understand basic stability of superconductors Geometry, characteristic and fabrication routes of technical superconductors To understand principle of nuclear fusion and fusion magnet technology Set-up and principle of high field magnets Understand basics of current leads to low temperatures

Content

-
- Basics of superconductivity
- Superconducting phenomena
- AC loss in superconductors
- Electrical and thermal stability of superconductors
- Manufacturing and Characteristics of superconductors
- Electro-mechanical characteristics of superconductors
- Fusion magnet technology
- High field magnet technology
- Design of current leads
- Excursion

Literature
Online material is available on: www.ims.kit.edu

Remarks
Current information can be found on the IMS (www.ims.kit.edu) webpage. At the end of the course an excursion is planned.

Course: Sustainable Product Engineering [2146192]

Coordinators: K. Ziegahn
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	

Learning Control / Examinations
The type of examination (written or oral) will be announced at the beginning of the lecture.
written examination: 60 min duration
oral examination: 20 min duration

Conditions
none

Learning Outcomes
The goal of the lecture is to convey the main elements of sustainable product development in the economic, social and ecological context.
The students are able to ...

- identify und describe the sustainability objectives and their role in product development, the interaction between technical products and their environment, the holistic approach and the equality of economic, social and environmental aspects and environmental aspects.
- discuss the skills for life-cycle product design using the example of complex automotive components such as airbag systems and other current products.
- understand the product environmental stresses with relevancy to praxis at the example of technology-intensive components, robustness and durability of products as the basis for a sustainable product development, development of skills for the application of environmental simulationduring the process of developement of technical products.
- develop skills such as team skills / project / self / presentation based on realistic projects.

Content
understanding of sustainability objectives and their role in product development, the interaction between technical products and their environment, the holistic approach and the equality of economic, social and environmental aspects and environmental aspects
skills for life-cycle product design using the example of complex automotive components such as airbag systems and other current products
understanding of product environmental stresses with relevancy to praxis at the example of technology-intensive components, robustness and durability of products as the basis for a sustainable product development, development of skills for the application of environmental simulationduring the process of developement of technical products
delivery of key skills such as team skills / project / self / presentation based on realistic projects

Course: System Analysis and Design [23606]

Coordinators: E. Sax
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
Basic knowledge of embedded systems is beneficial

Learning Outcomes
Understanding methodologies for analysis and design of heterogeneous electronic systems with hard real time constraints. Understanding design for X techniques. Understanding of CMOS technology.
Focuses of the lecture are processes and methods for the analysis and design of embedded electronic systems. Further focuses are the various alternative technologies available for realisation of such systems.

Content
Lecture
This course provides methods of analysis and design of embedded electronic systems.
First the lecture repeats important basics in the field of embedded electronic systems. The concept of embedded electronic system is repeated with the help of the example of ECUs in vehicles. Thereafter, the requirements for such systems are shown by the topics real-time requirements and reliability. It is shown what possibilities operating systems provide for the realization of distributed embedded systems. It identifies various technologies and criteria for their selection for the individual control units as well as the communications architecture of the entire system are available.
The next chapter addresses the systems engineering process. First, the necessity of processes in system development is outlined. Thereafter, the process of the V-model and the process according to Hunger are presented.
The following chapters are devoted to the various aspects of the Design for X concept. Starting with the Design for Performance in which students gain skills for the determination of performance and energy consumption of CMOS circuits. This is supported by knowledge about packaging and interconnection.
The next chapter deals with the topics quality, safety and reliability. The students are taught methods are like Fault Tree Analysis, Failure Mode and Effect Analysis and more which allow the estimation and reduction of risk.
Design for Testability covers techniques and methods for reliable and efficient detection of faults in electronic systems. This covers both manufacturing errors and defects due to aging. The finale is the topic of Design for Manability dealing with the ergonomics of electronic systems. It takes different aspects of the human body and perception into account.

Literature
Online material is available on: ILIAS

Remarks
Current information can be found on the ITIV (www.itiv.kit.edu) webpage and within ILIAS.

Course: System Analysis and Dynamic Operation of Three-Phase-Machine [23344]

Coordinators: J. Becker
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
Oral Exam

Conditions
None.

Recommendations
Basic study knowledge of mathematics

Learning Outcomes
Methodical approach for the mathematical description of electrical machines with rotating magnetic field as a necessity for understanding the stationary operation as well as for the realization of highly dynamic drive systems. Starting with the magnetic coupling of the two-coil-model the self-inductance and mutual inductance of a three-phase winding are calculated and the voltage equation system for the induction machine as well as for the synchronous machine are deduced. The inductance matrix, describing the coupling of the 6 winding strings to each other, is fully occupied and, furthermore, for the stator-rotor coupling time-variant. Therefore the voltage equation system is transformed with a unitary algorithm to the so called "space-vector" form which simplifies the system description dramatically. This is then the starting basis for the investigation of following themes: Steady-state operation by feeding with a symmetrical sinusoidal voltage supply as well as with a symmetrical non-sinusoidal supply and with a sinusoidal but unsymmetrical supply, too, dynamic behavior, explanation of the control structure as necessity for a highly dynamic drive with so called "field orientated control". The learned modeling is the essential scientific base for the (open and closed loop) control of precise, robust and highly dynamic drives.

Content
0. Introduction
Mechanical construction – design types, assets and drawbacks, derivation of mutual inductance, calculation of torque.
1. Inductance of the air-gap field
General calculation of mutual inductance with a Two-Coil-Model with current density pulses. Example of use: Resolver.
2. Windings in machines with rotating magnetic field
Design of distributed windings and explanation of specific characterization factors.
Construction of the air-gap field curve from the zone-plan and mathematical description with Fourier series.
3. System equations of the induction machine with slip ring rotor (ASM-SL) in the stator-orientated reference system with matrix-notation.
4. Power-invariant transformation
In general and specific for the ASM-SL with following goal: Replacement of the 3 real equations for both stator and rotor by two complex equations (description with so called "space-vectors") with the following benefits:
Conversion of the fully occupied and furthermore for the stator-rotor coupling also time-variant 3x3 inductance-matrices to time-invariant diagonal matrices. Additionally: Conversion of the rotor winding number to the value of the stator and description in any rotating reference system.
5. Voltage equation system in the transformed form
Physical exemplification of "space vectors", special case of the symmetrical and sinusoidal voltage system, inverse transformation , general calculation of the torque with "space vectors".
6. Influence of the selected reference system
stator-orientated, rotor-orientated and flux-orientated.
7. Steady-state operation of the ASM-SL at a symmetrical sinusoidal supply
derivation of the equivalent circuit and the phase vector diagram.
8. Calculation of string values
for delta- and star-connection, with and without neutral point connection.
9. Space vectors for the supply with a symmetrical non-sinusoidal voltage system

Example of use: Two point converter with three output legs.
10. Steady-state operation of the ASM-SL at a symmetrical non-sinusoidal three-phase voltage supply.
Equivalent circuit for harmonics, generalization of the slip definition, influence to the torque.
11. Steady-state operation of the ASM-SL at an unsymmetrical sinusoidal supply
Symmetrical components, equivalent circuits, influence to torque and machine losses, generalized formula of Kloss.
Examples of use: Single phase motor, interruption of a stator string.
12. Dynamic structure of the ASM
Feeding with voltage- and current-system, selection of the reference system, field-orientated operation, decoupling.
13. Synchronous machine (SM)
design types.
14. System equations of the magnetic unsymmetrical electrically excited SM with orthogonal damper winding
Calculation of the mutual inductance.
15. SM in space vector description
Calculation of the torque.

Media
Blackboard notes during lectures
„MathCad“ examples

Literature
Supplementary sheets are distributed during lectures.
Math-Cad examples (on institute computers available).
Amendatory: Späth, H.: Elektrische Maschinen, Springer Späth, H.: Steuerverfahren für Drehstrommaschinen, Springer

Remarks
Current information can be found on the ETI (www.eti.kit.edu) webpage.

Course: System Dynamics and Control Engineering [23155]

Coordinators: M. Kluwe, S. Hohmann
Part of the modules: Automation Technology (p. 19)[BSc-MIT - B7]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam (120 min) taking place in the recess period (according to §4 (2), 1 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Recommendations
Knowledge of integral transformations is assumed. There it is recommended to attend the course *Complex Analysis* and *Integral Transformations* beforehand.

Learning Outcomes
The goal is to relay theoretical fundamentals in control theory. The students can recognize control theory problem statements and treat them systematically. They can name basic control structures and describe the behavior of time continuous and discrete control circuit elements as well as elements of digital control circuits.
The students can describe real processes formally and derive requirements of control structures. They can analyze the dynamic of systems using graphic and algebraic methods.
The students can name controller design methods for single input single output systems select them according to appropriate criteria as well as conduct the design steps and evaluate the designed control system. Furthermore they can compensate disturbances through appropriate control structures.

Content
Introduction: overview and definitions, open-loop and closed-loop control, design process for control systems;
Classification and Description of control circuit elements: introduction and basic concepts, block diagram, behaviour of elementary control circuit elements, standard control circuit and block diagram transformations, simulation of time continous control circuits, structure of digital control circuits, description of digital control circuits discretization of time continuous control circuit elements;
Analysis of linear control circuits in continous time: steady-state behaviour and characteristic signals, polar plot (Nyquist diagram), Bode diagram, basic concepts of stability, algebraic stability criteria, graphic stability criteria;
Analysis of linear control circuits in discrete time: steady-state behaviour, polar plot (Nyquist diagram) and Bode diagram, basic concepts of stability, algebraic stability criteria, graphic stability criteria;
Synthesis of linear control circuits in continous time: control circuit requirements, heuristic controller design, direct methods, controller design using the Bode diagram, controller design using the root locus, simple optimality-based controller design, feed forward control, secondary control and cascaded control;
Synthesis of linear control circuits in discrete time: fast sampling design, direct methods, controller design using the Bode diagram and the root locus.

Media
Online material is available on:www.irs.kit.eduand can be downloaded using a password.

Literature

- O. Föllinger unter Mitwirkung von F. Dörrscheidt und M. Klittich:
  Regelungstechnik, Einführung in die Methoden und ihre Anwendung
  10. Auflage, Hüthig-Verlag, 2008
- J. Lunze:
  Regelungstechnik I
  7. Auflage, Springer-Verlag, 2008
- R. Dorf - R. Bishop:
  Modern Control Systems
  11th edition, Addison-Wesley, 2007

- C. Phillips - R. Harbor:
  Feedback Control Systems
  4th edition, Prentice-Hall, 2000
- O. Föllinger:
  Lineare Abtastsysteme
  5. Auflage, R. Oldenbourg Verlag, 1993
- K. Ogata:
  Discrete-Time control systems
  Prentice Hall Verlag, 1987
- G.C. Goodwin:
  Control System Design
  Prentice Hall Verlag,

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the IRS webpage.

Course: System Design under Industrial Constraints [23641]

Coordinators: M. Nolle
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Written exam

Conditions
Basic knowledge of hardware and software design

Learning Outcomes
The goal of this lecture is to provide a realistic picture of realisable methods and techniques.
The lecture provides knowledge of the phase-oriented development process on one side and tools of project management on the other side.

Content
The two focal points of the lecture are the phase-oriented procedure for development of computer systems for safety-critical real-time applications and the organizational implementation, the project management of such developments. The avionics serves as an example of increased demands for quality, cost-conscious and timely implementation of the development of such systems.
The first part of the lecture will start with the explanation of typical requirements for avionics systems. The development process is divided into phases: what are the activities and goals of each phase, how to close a phase, which documents are to create, and how to complete the development. First, the life cycle of a product is presented. This leads to the requirements for a product development, taking into account superior rules and regulations. Next, the concept of quality in the context of a hardware / software development process and the resulting quality management is introduced. Based on this the phased development process is presented, which is specified in regards of the number and content of the phases, the required reviews and documentation.
The second focus "project management" covers in detail the project-oriented implementation of a development with the following themes, with the tasks of the project manager in the foreground. Building on the introduction of the term project the task of the project organization to solve the conflict between the goals of quality, cost and schedule is presented. The techniques and time management for planning, management and control are in the foreground. Finally, the issues of communication and intercultural project management are covered.
The topics are based on numerous examples and experience reports from the field shown.

Literature
Online material is available on ILIAS.

Remarks
The course takes place as a block lecture. Current information can be found on the ITIV (www.itiv.kit.edu) webpage and within ILIAS.

Course: Systems Engineering for Automotive Electronics [23642 + 23644]

Coordinators: J. Bortolazzi
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	en

Learning Control / Examinations
Written exam

Conditions
None.

Recommendations
Participation in the lectures SAE (23606) and SE (23611) is advised

Learning Outcomes
The goal of the lecture are knowledge and insight in the systematic development process of electric and electronic systems and architectures in the field of automotive technology and car industry as well as the utilized tools which support the systematic development. A further goal is the tool supported modeling of electric and electronic architectures in the domains functional modeling and physical modeling.
The lecture conveys knowledge concerning methods, techniques and procedures supporting the development phases of electric and electronic systems for cars.
In the laboratory / tutorial, a simple and customer related function of a modern car is modeled using a state of the art tool for the modeling of electric and electronic architectures for cars. This involves the modeling of a functional and physical proposal as well as the evaluation of this proposal.

Content
Lecture
At the beginning, the development of electric and electronic systems of cars is facilitated based on technological and brand specific trends, development processes, process requirements, methods and tools, overview of approaches for solving problems, as well as an overview of further lectures and events.
Dealing with the intended architecture in the car, is presented by the architecture development process, the description of intended car architectures, the hardware- and software-architecture, the networking, the bus systems CAN, Lin, MOST and FlexRay, processor types, standard software modules, the operating system OSEK, standards for diagnosis as well as constraints for the development of architectures (topology, cost, assembly, wiring harness).
An essential part of the lecture is the presentation of development tools which are classified into tools for system development and tools for software development. The tools for system development contain general development processes, requirements for tools, models of computation, requirements engineering, methods and tools for the design of controller as well as methods and tools for the design of distributed systems (TITUS). The tools for software development contain automatic code generation (processes, procedures and tools) as well as automated testing.
The relevance of quality assurance is discussed based on the software quality management system of an OEM.
The topics system design and project management are described by the composition of a development project, the interaction of project management, tools and processes, the risk management as well as the management of suppliers.
Laboratory / Tutorial
During the laboratory, which interleaved to the lecture concerning schedule and content, students work with a state of the art tool for modeling electric and electronic architectures. They model the architecture of a simple function of a modern car. The developed model offers different perspectives to the function. Complexity of modern electric and electronic architectures is facilitated as well as possibilities and methods to stay on top of the complexity.

Literature
Online material is available on ILIAS.

Course: Technical Acoustics [2158107]

Coordinators: M. Gabi
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 30 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
Students get to know the basics of technical acoustics in general. Application of the knowledge in different fields of engineering.
Students learn physical basics of acoustics and human perception. Physical-empirical laws for determination of sound and noise levels of various emission and immission situations will be worked out or derived. Furtheron general sound measurement methods of machinery will be taught.
Students are able to understand mechanisms of sound origin, propagation and reduction, as well as measuring technics

Content
Basics of acoustics
Perception and weighting of noise (human hearing)
Description of acoustic parameters, level notation
Noise propagation
Acoustical measurement techniques

Literature
1. Lecture notes (downloadable from institute's homepage).
2. Heckl, M.; Müller, H. A.: Taschenbuch der Technischen Akustik, Springer-Verlag.
3. Veit, Ivar: Technische Akustik. Vogel-Verlag (Kamprath-Reihe), Würzburg.
4. Henn, H. et al.: Ingenieurakustik. Vieweg-Verlag.

Course: Computer Engineering [2106002]

Coordinators: M. Lorch, H. Keller
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
Written examination

Duration: 2 hours (compulsory subject)

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students possess essential knowledge about information processing in digital computers. Based on information representation and calculations of complexity, students are capable to design algorithms efficiently. The students are able to apply the knowledge about efficient algorithm design to important numerical computation methods in mechanical engineering. Students have basic knowledge of real-time systems and their development. Students can use the knowledge to develop real-time systems for reliable automation of technological systems in mechanical engineering.

Content
Introduction: definitions, basic concepts, introductory examples

Information coding on finite automata: numbers, characters, commands, examples

Algorithm design: definitions, complexity of algorithms, complexity classes P and NP, examples

Sorting algorithms: relevance, algorithms, simplifications, examples

Software quality assurance: terms and measures, errors, phases of quality assurance, constructive measures, analytical measures, certification

Lectures are complemented by an exercice course.

Literature
Lecture Notes (Ilias)

Becker, B., Molitor, P.: Technische Informatik : eine einführende Darstellung. München, Wien : Oldenbourg, 2008.

Hoffmann, D. W.: Grundlagen der Technischen Informatik. München: Hanser, 2007.

Balzert, H.: Lehrbuch Grundlagen der Informatik : Konzepte und Notationen in UML, Java und C++, Algorithmik und Software-Technik, Anwendungen. Heidelberg, Berlin : Spektrum, Akad. Verl., 1999.

Trauboth, H.: Software-Qualitätssicherung : konstruktive und analytische Maßnahmen. München, Wien : Oldenbourg, 1993.
Ada Reference Manual, ISO/IEC 8652:2012(E), Language and Standard Libraries. Springer Heidelberg
Benra, J.; Keller, H.B.; Schiedermeier, G.; Tempelmeier, T.: Synchronisation und Konsistenz in Echtzeitsystemen. Benra, J.T. [Hrsg.] Software-Entwicklung für Echtzeitsysteme Berlin [u.a.] : Springer, 2009, S.49-65

Färber, G.:Prozeßrechentechnik. Springer-Lehrbuch. Springer; Auflage: 3., überarb. Aufl. (7. September 1994)
Leitfaden Informationssicherheit, IT-Grundschutz kompakt. Bundesamt für Sicherheit in der Informationstechnik – BSI53133 Bonn, 2012, BSI-Bro12/311
Cooling, J.: Software Engineering for Real Time Systems. Addison-Wesley, Pearson, Harlow, 2002.
Stallings, W.: Betriebssysteme. 4. Auflage. Pearson Studium, München, 2003.
Summerville, I.: Software Engineering. Pearson Studium, München, 2007.

Course: Integrated Information Systems for engineers [2121001]

Coordinators: J. Ovtcharova
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
Depending on choice according to acutal version of study regulations

Conditions
None

Recommendations
None

Learning Outcomes
Students can:

- illustrate the structure and operating mode of information systems
- explain different goals of specific IT systems in product development (CAD, CAP, CAM, PPS, ERP, PDM) and assign product development processes
- describe the fundamentals of knowledge management and its application in engineering and deploy ontology as knowledge representation
- describe different types of process modelling and their application and illustrate and execute simple work flows and processes with selected tools

Content

- Information systems, information management
- CAD, CAP and CAM systems
- PPS, ERP and PDM systems
- Knowledge management and ontology
- Process modeling

Literature
Lecture slides

Course: Engineering Mechanics I [2161245]

Coordinators: T. Böhlke, T. Langhoff
Part of the modules: Engineering Mechanics (p. 14)[BSc-MIT - B2]

ECTS Credits	Hours per week	Term	Instruction language
6	5	Winter term	de

Learning Control / Examinations
written, 90 min. Permitted resources in the exam will be announced.
Prerequisites by solving homework problems and attestations during the associated lab course.

Conditions
Mandatory participation in the assciated lab course.

Recommendations
None.

Learning Outcomes
The students can

- analyse different equilibrium systems based on the notion of forces and moments, e.g. plane and spatial force systems on a rigid body
- compute internal forces and moments for linear structures and as a result analyse and evaluate the internal load
- compute systems under the influence of friction
- determine the center of lines, areas, masses and volumes
- apply the principal of virtual displacements
- evaluate the stability of equilibrium positions
- compute and evaluate the load of straight bars in the framework of thermoelasticity
- list elastic-plastic material laws
- solve worksheet problems about topics of the lecture using the computer algebra system MAPLE

Content

- basics of vector calculus
- force systems
- statics of rigid bodies
- internal forces and moments in bars and beams
- friction
- centre of gravity, centre of mass
- work, energy, principle of virtual work
- statics of inextensible ropes
- elastostatics of tension-compression- bars

Literature
lecture notes
Hibbeler, R.C: Technische Mechanik 1 - Statik. Prentice Hall. Pearson Studium 2005.
Gross, D. et al.: Technische Mechanik 1 - Statik. Springer 2006.
Gummert, P.; Reckling, K.-A.: Mechanik. Vieweg 1994.
Parkus, H.: Mechanik der festen Körper. Springer 1988.

Course: Engineering Mechanics II [2162250]

Coordinators: T. Böhlke, T. Langhoff
Part of the modules: Engineering Mechanics (p. 14)[BSc-MIT - B2]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Summer term	de

Learning Control / Examinations
written, 90 min. Additives as announced
Prerequisites by solving homework problems and attestations during the associated lab course.

Conditions
Mandatory participation in the assciated lab course.

Recommendations
None.

Learning Outcomes
The students can

- compute stresses and strains in beams in case of straight and unsymmetric bending
- compute stresses and strains in bodies under torsional load
- compute stresses and strains in beams in case of shear force loading
- compute and evaluate 3D stress and strain states
- apply energy methods for computing
- compute approximate solutions using the methods of Ritz and Galerkin
- analyse the stability of straight bars under compressive loads and evaluate on the basis of the buckling forces
- can solve worksheet problems to topics of the lecture using the computer algebra system MAPLE

Content

- bending
- shear
- torsion
- stress and strain state in 3D
- Hooke's law in 3D
- elasticity theors in 3D
- energy methods in elastostatics
- approximation methods
- stability
- inelastic material behaviour

Literature
lecture notes
Hibbeler, R.C: Technische Mechanik 2 - Festigkeitslehre. Prentice Hall. Pearson Studium 2005.
Gross, D. et al.: Technische Mechanik 2 - Elastostatik. Springer 2006.
Gummert, P.; Reckling, K.-A.: Mechanik. Vieweg 1994.
Parkus, H.: Mechanik der festen Körper. Springer 1988.

Course: Engineering Mechanics III [2161203]

Coordinators: W. Seemann, Assistenten
Part of the modules: Engineering Mechanics (p. 14)[BSc-MIT - B2]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Winter term	de

Learning Control / Examinations
written exam

Duration: 3h (including TM III and TM IV) for engineering mechanics and for Techno-mathematics
1,5 h (only TM III) for mechatronics und information technicians
Resources allowed during exam: onw lecture notes and notes from tutorial, books in 'Engineering Mechanics'

Conditions
Homework is mandatory and a precondition for participation in the exam "Engineering Mechanics III/IV" (Engineering mechanics, techno-mathematics) and for participation in the exam "Engineering Mechanics III" (Mechatronics and information technicians)

Recommendations
None.

Learning Outcomes
The students are able to derive models of systems for a plain motion. This includes both kinematics as well as dynamics. They know how to describe the motion of particles in reference systems and may derive kinematic quantities like velocity or acceleration. The derivation of equations of motion for systems of particles and rigid bodies with Newton-Euler's axioms can be done. The students know the dependence of the kinetic energy on the kinematic quantities and the inertia parameters of the system and can apply the principle of work or the principle of the conservation of mechanical energy for conservative systems. Applications include impact problems as well as systems with increasing or decreasing mass.

Content
Kinematics: Cartesian, cylindrical and natural coordinates. Time derivatives in moving reference frames, angular velocities of reference frames.

Kinetics of a particle:
Newton's axiom, Principle of d'Alembert, work of a force, kinetic and potential energies, principle of linear momentum, principle of moment of momentum, kinetics in moving reference systems

Systems of particles:
Principle of center of mass, Principle of moment of momentum, impacts between particles, systems with variable mass, applications.

Plain motion of rigid bodies:
Pure translation, pure rotation, general plain motion. Instantaneous center of rotation, Kinetics, moment of momentum, principle of work and principle of energy conservation for a rotation around a space-fixed axis. Mass moment of inertia, parallel-axis-theorem.Principle of linear momentum and principle of moment of momentum for arbitrary plain motion. Principle of d'Alembert for plain motion. Principles of linear and moment of momentum in integral form. Applications for impact problems.

Literature
Hibbeler: Technische Mechanik 3, Dynamik, München, 2006

Gross, Hauger, Schnell: Technische Mechanik Bd. 3, Heidelberg, 1983

Lehmann: Elemente der Mechanik III, Kinetik, Braunschweig, 1975

Göldner, Holzweissig: Leitfaden der Technischen Mechanik.

Hagedorn: Technische Mechanik III.

Course: Engineering Mechanics IV [2162231]

Coordinators: W. Seemann, Assistenten
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Summer term	de

Learning Control / Examinations
written exam: 3h (together with TM III)

Conditions
Homework is mandatory and a precondition to take part in the exam “Engineering Mechanics III/IV”.

Learning Outcomes
The students know some possibilities to describe the position and orientation of a rigid body for an arbitrary 3D motion. They realize that the rotational velocity is a vector which may change both magnitude and orientation. They can apply the principle of linear momentum and the principle of moment of momentum to a spatial motion of a rigid body and notice that this is much more complicated compared to a plain motion. The students can calculate the coordinates of the inertia tensor. They see that many effects which may be seen with gyroscopes can be explained by the principle of moment of momentum. For systems with many particles or bodies but only few degrees of freedom the students know that the application of analytical methods like the principle of D’Alembert in Lagrangian form or the Lagrange equations may be advantageous. They can apply these principles to simple problems. For vibration problems the students can interprete the most important expressions like eigenfrequency, resonance or eigenvalue problem. Forced vibration of systems with one degree of freedom can be investigated by the students.

Content
Spatial kinematics of a rigid body, Euler angles, angular velocity using Euler angles, Euler’s equations, inertia tensor, kinetic energy of a rigid body, free gyroscopes, forced gyroscopes, systems of rigid bodies, principle of d’Alembert, Lagrange’s equations of the first and second kind, generalized coordinates, free and forced vibration of one degree of freedom systems, frequency response, vibration of multi degree of freedom systems, vibration absorption

Literature
Hibbeler: Technische Mechanik 3, Dynamik, München, 2006
Marguerre: Technische Mechanik III, Heidelberger Taschenbücher, 1968
Magnus: Kreisel, Theorie und Anwendung, Springer-Verlag, Berlin,
1971 Klotter: Technische Schwingungslehre, 1. Bd. Teil A, Heidelberg

Course: Vibration Theory [2161212]

Coordinators: A. Fidlin
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Winter term	de

Learning Control / Examinations
Written exam
If course is chosen as optional subject or part of major subject:
Oral exam, 30 minutes (optional subject), 20 minutes (major subject), no means

Conditions
None.

Recommendations
Examen in Engineering Mechanics 3 + 4

Learning Outcomes
The course gives an introduction into the vibration theory of linear systems. First, general vibration in form of harmonic signals is considered. One degree of freedom systems are treated in detail for free and forced vibration, especially for harmonic, periodic and arbitrary excitation. This is the foundation for systems with many degrees of freedom as these may be transformed with the help of modal coordinates. For multiple dof systems the eigenvalue problem is solved. Then forced vibration is treated. Finally, wave propagation problems and eigenvalue problems for systems with distributed parameters are discussed. As an application an introduction into rotor dynamics is given.

Goal of the course is to see the similarities for systems with one dof and with multiple dof. Besides typical phenomena like resonance a systematic mathematical approach to vibration problems and an interpretation of the mathematical results should be obtained.

Content
Concept of vibration, superposition of vibration with equal and with different frequencies, complex frequency response.

Vibration of systems with one dof: Free undamped and damped vibration, forced vibration for harmonic, periodic and arbitrary excitation. Excitation of undamped vibration in resonance.

Systems with many degrees of freedom: Eigenvalue problem for undamped vibration, orthogonality of eigenvectors, modal decoupling, approximation methods, eigenvalue problem for damped vibration. Forced vibration for harmonic excitation, modal decomposition for arbitrary forced vibration, vibration absorber.

Vibration of systems with distributed parameters: Partial differential equations as equations of motion, wave propagation, d'Alembert's solution, Ansatz for separation of time and space, eigenvalue problem, infinite number of eigenvalues and eigenfunctions.

Introduction to rotor dynamics: Laval rotor in rigid and elastic bearings, inner damping, Laval rotor in anisotropic bearings, synchronous and asynchronous whirl, rotors with asymmetric shaft.

Literature
Klotter: Technische Schwingungslehre, Bd. 1 Teil A, Heidelberg, 1978

Hagedorn, Otterbein: Technische Schwingungslehre, Bd 1 and Bd 2, Berlin, 1987

Wittenburg: Schwingungslehre, Springer-Verlag, Berlin, 1995

Course: Technical Thermodynamics and Heat Transfer I [2165501]

Coordinators: U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH], Thermodynamik (MACH) (p. 25)[BSc-MIT - B-PM2]

ECTS Credits	Hours per week	Term	Instruction language
7	3	Winter term	de

Learning Control / Examinations
Written exam: 2 hours

Conditions
Prerequisite: attestation each semester by weekly homework assignments

Recommendations
None

Learning Outcomes
After completing the course students can:

- describe the correlations between the thermodynamic properties of pure substances.
- setup the balance equations for mass and energy for different processes.
- determine the direction of a process.
- understand the fundamental processes in phase transitions.
- explain the basics of ideal thermodynamic cycles.

Content
System, properties of state
Absolute temperature, model systems
1st law of thermodynamics for resting and moved systems
Entropy and 2nd law of thermodynamics
Behavior of real substances described by tables, diagrams and equations of state
Machine processes

Media
Blackboard and Powerpoint presentation

Literature
Course note packet
Elsner, N.; Dittmann, A.: Energielehre und Stoffverhalten (Grundlagen der technischen Thermodynamik Bd. 1 und 2), 8. Aufl., Akademie-Verlag, 680 S. 1993.
Baehr, H.D.: Thermodynamik: eine Einführung in die Grundlagen und ihre technischen Anwendungen, 9. Aufl., Springer-Verlag, 460 S., 1996.

Course: Technical Thermodynamics and Heat Transfer II [2166526]

Coordinators: U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Summer term	de

Learning Control / Examinations
Written exam: 2 hours

Conditions
Prerequisite: attestation each semester by weekly homework assignments

Recommendations
None

Learning Outcomes
After attending the course students are able to:

- describe the correlation between the thermodynamic properties in mixtures of different substances.
- explain the characteristics of real substances.
- define the major concepts in gas kinetics.
- determine the composition of a reacting mixture in the thermodynamic equilibrium.
- discuss the various influences on the reaction equilibrium.
- describe the fundamental laws of heat transfer.

Content
Repetition of the topics of “Thermodynamics and Heat Transfer I”
Mixtures of ideal gases
Moist air
Behaviour of real substances described by equations of state
Applications of the laws of thermodynamics to chemical reactions

Media
Blackboard and Powerpoint presentation

Literature
Course notes
Elsner, N.; Dittmann, A.: Energielehre und Stoffverhalten (Grundlagen der technischen Thermodynamik Bd. 1 und 2), 8. Aufl., Akademie-Verlag, 680 S. 1993.
Baehr, H.D.: Thermodynamik: eine Einführung in die Grundlagen und ihre technischen Anwendungen, 9. Aufl., Springer-Verlag, 460 S., 1996.

Course: Technical Design in Product Development [2146179]

Coordinators: M. Schmid
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
For the reason of high sutdent number the exam is a written exam.
Only dictionnary is allowed.

Conditions
Authorisation by the Examination Office.

Recommendations
None

Learning Outcomes
After listening the module „technical design“ the students should have knowledge about the basics of technical oriented design as an integral part of the methodical product development
The students have knowledge about ...

- the interface between engineer and designer.
- all relevant human-product requirements as f. exp. demographic/ geographic and psychographic features, relevant perceptions, typical content recognition as well as ergonomic bases.
- the approaches concerning the design of a product, product program or product system with focus on structure, form-, color- and graphic design within the phases of the design process.
- the design of functions and supporting structures as well as the important interface between human and machine.
- relevant parameters of a good corporate design.

Content
Introduction
Relevant parameters on product value in Technical Design
Design in Methodical Development and Engineering and for a differentiated validation of products
Design in the concept stage of Product Development
Design in the draft and elaboration stage of Product Development

Literature
Hexact (R) Lehr- und Lernportal

Course: Technology of steel components [2174579]

Coordinators: V. Schulze
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral
duration 20 minutes
No tools or reference materials may be used during the exam

Conditions
Materials Science and Engineering I & II

Learning Outcomes
The students have the background to evaluate the influence of manufacture processes on the compound state of metallic compounds. The students can assess the influence and the stability of compound state under mechanical load. The students are capable to describe the individual aspects of interaction of the compound state of steel components due to forming, heat treatment, mechanical surface treatment and joining processes.

Content
Meaning, Development and characterization of component states
Description of the influence of component state on mechanical properties
Stability of component states
Steel manufacturing
Component states due to forming
Component states due to heat treatments
Component states due to surface hardening
Component states due to machining
Component states due to mechanical surface treatments
Component states due to joining
Summarizing evaluation

Literature
Script will be distributed within the lecture
VDEh: Werkstoffkunde Stahl, Bd. 1: Grundlagen, Springer-Verlag, 1984
H.-J. Eckstein: Technologie der Wärmebehandlung von Stahl, Deutscher Verlag Grundstoffindustrie, 1977
H.K.D.H. Badeshia, R.W.K. Honeycombe, Steels - Microstructure and Properties, CIMA Publishing, 3. Auflage, 2006
V. Schulze: Modern Mechanical Surface Treatments, Wiley, Weinheim, 2005

Course: Telematics [24128]

Coordinators: M. Zitterbart
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Knowledge of the lecture *Introduction in Computer Networks* [24519] or similar lectures is required.

Learning Outcomes
This course details selected protocols, architectures, techniques, and algorithms, which were already presented in the course *Introduction in Computer Networks*. Thus, overall knowledge and knowledge about problems that occur within a world-wide and dynamic network as well as solutions that are applied in order to avoid these problems is imparted in this course.

Content
This course addresses protocols, architectures, techniques, and algorithms that are used, e.g., for Internet routing and establishing of reliable end-to-end communication associations. In addition to different media access control mechanisms in local area networks further communication systems, e.g. line-switched ISDN, are detailed. It is intended that students additionally understand which possibilities for network management and administration currently exist.

Media
Slides.

Literature
S. Keshav. *An Engineering Approach to Computer Networking*. Addison-Wesley, 1997

J.F. Kurose, K.W. Ross. *Computer Networking: A Top-Down Approach Featuring the Internet*. 4rd Edition, Addison-Wesley, 2007

W. Stallings. *Data and Computer Communications*. 8th Edition, Prentice Hall, 2006
Elective literature:

- D. Bertsekas, R. Gallager. *Data Networks*. 2nd Edition, Prentice-Hall, 1991
- F. Halsall. *Data Communications, Computer Networks and Open Systems*. 4th Edition, Addison-Wesley Publishing Company, 1996
- W. Haaß. *Handbuch der Kommunikationsnetze*. Springer, 1997
- A.S. Tanenbaum. *Computer-Networks*. 4th Edition, Prentice-Hall, 2004
- Internet standards
- Selected journal arcticles

Course: Ten lectures on turbulence [2189904]

Coordinators: I. Otic
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
oral examination; duration: 20 minutes

Conditions
None.

Recommendations

- Fundamentals of fluid dynamics

Learning Outcomes
After completing the course students should be able to establish a connection between theory and numerical modeling of turbulent flows.

Content
This course is specified for Master students of Mechanical, Power and Nuclear Engineering. The problem of turbulence is of key importance in many fields of science and engineering. It is an area which is vigorously researched across a diverse range of disciplines. This course is aimed of giving the fundamentals of turbulence theory and modelling. Starting from the basic physical phenomena and governing equations the quantitative and statistical description of turbulence is introduced. An overview on computational methods for turbulent flows and turbulence modelling is given.

Course: Theoretical Foundations of Computer Science [24005]

Coordinators: J. Müller-Quade, D. Wagner
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1/2	Winter term	de

Learning Control / Examinations
The assessment consists of a written exam according to sec. 4 subsec. 2 no. 1 study and examination regulations.
It is possible to aquire a certificate for the exercise (assessment according to sec. 4 subsec. 2 no. 3 study and examination regulations). For this bonus points will be awarded that can be counted towards a passed exam.
The grade of the module corresponds to the grade of the written exam.

Conditions
None.

Learning Outcomes
The student

- has a deeper insight into the fundamentals of theoretical computer science and knows the computation models and proof techniques,
- understands the limits and possibilities of computer science in relation to the solution of definable but only partially predictable problems
- knows basic aspects of computer science in contrast to specific circumstances, such as specific computers or programming languages, and also can phrase general statements about the solvability of problems
- is able to apply the proof techniques learned for the specification of systems of computer science and for the systematic design of programs and algorithms

Content
There are important problems whose solutions can clearly be defined but one will never be able to calculate such a solution systematically. Other problems are “likely” to be solved only through trial and error. Other topics of the module provide the basis for circuit design, design of compilers, and many others. Most results are rigorously proved. The proof techniques learned by the way are important for the specification of systems of computer science and for the systematic design of programs and algorithms.

The module provides a deep insight into the principles and methods of theoretical computer science. In particular, this will be discussed on the basic properties of Formal Languages as foundations of programming languages and communication protocols (regular, context-free Chomsky hierarchy), machine models (finite automata, pushdown automata, Turing machines, nondeterminism, and relations to families of formal languages), equivalence of sufficiently powerful computational models (Church’s thesis), non computationable important functions (halting problem,...), Gödel’s incompleteness theorem and introduction to complexity theory, NP-complete problems and polynomial reductions.

Media
Slides (pdf), lecture notes, practice sheets.

Literature
Elective literature:

- Uwe Schöning: Theoretische Informatik - kurz gefasst. Sprektrum (2001).
- Ingo Wegener: Theoretische Informatik. Teubner (1999)
- Ingo Wegener: Kompedium theoretische Informatik. Teubner (1996).

Course: Computational methods for the heat protection of a full vehicle [2157445]

Coordinators: H. Reister
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination, 30 minutes, no aids

Conditions
basics in fluid mechanics and thermodynamics recommended

Recommendations
none

Learning Outcomes
The students have basic equations to understand thermal situation in vehicles.
They can evaluate thermal situation in vehicles.
The students can utilize methods.

Content
In the lecture computational methods for the heat protection of the full vehicle are presented. For this the basic conservation equations are introduced and the applied computational programs are discussed in detail. The aspects concerning fluid mechanics are treated extensively. For this the underhood flow as well as the flow around the vehicle, at the underbody and at the rear of the car are considered. The computation of the temperature in the components of the vehicle is illustrated. For this mainly local approaches for the classical and electronic components are used. Finally a new overall approach for the heat protection is exlpained whre also detailed compuations at the engine, at the exhaust system and at the transmission are integrated.
Content
1. Introduction
2. Theoretical fundamentals
3. Computational methods
4. Numerical simulation of the flow in and around the vehicle
5. Computation of the temperature in components
6. Overall approach for the hat protection

Course: Thermal Solar Energy [2169472]

Coordinators: R. Stieglitz
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
Duration: approximately 25 minutes

no tools or reference materials may be used during the exam

Conditions
Basics in heat and mass transfer, material science and fluid mechanics

Recommendations
desirbale are reliable knowledge in physics in optics and thermodynamics

Learning Outcomes
The lecture elaborates the basics of the solar technology and the definition of the major wordings and its phyical content such as radiation, thermal use, insulation etc.. Further the design of solar collectors for different purposes is discussed and analyzed. The functional principle of solar plants is elaborated before at the ende the ways for solar climatization is discussed.
The aim of the course is to provide the basic physical principles and the derivation of key parameters for the individual solar thermal use. This involves in addition to the selective absorber, mirrors, glasses, and storage technology. In addition, a utilization of solar thermal energy means an interlink of the collector with a thermal-hydraulic circuit and a storage. The goal is to capture the regularities of linking to derive efficiency correlations as a function of their use and evaluate the performance of the entire system.

Content
Baiscs of thermal solar energy (radiation, heat conduction, storage, efficiency ....) Active and passive use of solar energy. Solar collectors (design types, efficiency, system technology). Solar plants (heliostats etc.). Solar climatization.
In detail:

1 Introduction to energy requirements and evaluation of the potential use of solar thermal energy.

2 Primary energy sources SUN: sun, solar constant, radiation (direct, diffuse scattering, absorption, impact angle, radiation balance).

3 Solar panels: schematic structure of a collector, fundamentals of efficiency, meaning of concentration and their limitations.

4 Passive solar mechanisms: heat conduction in solids and gases, radiation heat transfer in transparent and opaque bodies, selective absorber - typical materials and manufacturing processes.

5 Momentum and heat transport: basic equations of single and multiphase transport, calculation methods, stability limits.

optional

6 Low temperature solar thermal systems: Collector variants, methods for system simulation, planning and dimensioning of systems, system design and arrest scenarios.

6 High temperature solar thermal systems: solar towers and solar-farm concept, loss mechanisms, chimney power plants and energy production processes

end

- Memory: energy content, storage types, storage materials, cost
- Solar Air Conditioning: Cooling capacity determination, climate, solar cooling method and evaluation of air conditioning.

Literature
supply of lecture material in printed and electronic form
Stieglitz & Heinzel; Thermische Solarenergie -Grundlagen-Technologie- Anwendungen. Springer Vieweg Verlag. 711 Seiten. ISBN 978-3-642-29474-7

Course: Thermal Turbomachines I [2169453]

Coordinators: H. Bauer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	de

Learning Control / Examinations
oral
Duration: approximately 30 min

no tools or reference materials may be used during the exam

Conditions
None.

Recommendations
Recommended in combination with the lecture 'Thermal Turbomachines II'.

Learning Outcomes
The students are able to explain and comment on the design and operation of thermal turbomachines in detail. Moreover, they can evaluate the range of applications for turbomachinery. Therefore, students are able to to describe and analyse not only the individual components but also entire assemblies. The students can asses and evaluate the effects of physical, economical and ecological boundary conditions.

Content
Basic concepts of thermal turbomachinery

Steam Turbines - Thermodynamic process analysis

Gas Turbines - Thermodynamic process analysis

Combined cycle and cogeneration processes

Overview of turbomachinery theory and kinematics

Energy transfer process within a turbine stage

Types of turbines (presented through examples)

1-D streamline analysis techniques

3-D flow fields and radial momentum equilibrium in turbines

Compressor stage analysis and future trends in turbomachinery

Literature
Lecture notes (available via Internet)

Bohl, W.: Strömungsmaschinen, Bd. I, II; Vogel Verlag, 1990, 1991

Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993

Traupel, W.: Thermische Turbomaschinen Bd. I, II, Springer-Verlag, 1977, 1982

Course: Thermal Turbomachines II [2170476]

Coordinators: H. Bauer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Summer term	en

Learning Control / Examinations
oral (can only be taken in combination with 'Thermal Turbomachines I')
Duration: 30 min (–> 1 hour including Thermal Turbomachines I)

Auxiliary: no tools or reference materials may be used during the exam

Conditions
None.

Recommendations
Recommended in combination with the lecture 'Thermal Turbomachines I'.

Learning Outcomes
Based on the fundamental skills learned in 'Thermal Turbomachines I' the students have the ability to design turbines and compressors and to analyse the operational behavior of these machines.

Content
General overview, trends in design and development

Comparison turbine - compressor

Integrating resume of losses

Principal equations and correlations in turbine and compressor design, stage performance

Off-design performance of multi-stage turbomachines

Control system considerations for steam and gas turbines

Components of turbomachines

Critical components

Materials for turbine blades

Cooling methods for turbine blades (steam and air cooling methods)

Short overview of power plant operation

Combustion chamber and environmental issues

Literature
Lecture notes (Available via internet)
Bohl, W.: Strömungsmaschinen, Bd. I,II, Vogel Verlag 1990, 1991
Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993
Traupel, W.: Thermische Turbomaschinen, Bd. I,II, Springer-Verlag, 1977, 1982

Course: Tractors [2113080]

Coordinators: M. Kremmer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination

Conditions
basic knowledge in mechanical engineering

Learning Outcomes
After completion of the course the Students know:

- important problems in agritechnological developments
- Customer requirements and their implementation in tractors
- Tractor technology in width and depth

Content
Tractors are one of the most underestimated vehicles in regard to performance und technics. Almost none vehicle is as multifunctional and fullfilled with high-tec as a tractor. Automatic guidance, special chassis suspension or special concepts of power trains are one of the topics where tractors are in leading position in technologies

During the lecture an overview about the design and construction and application area is given. A close look will be taken on the historical backround, legal requirements, ways of development, agricultural organizations and the proces of development itself.

In detail the following topics will be dealt with:

- agricultural organization / legal requirements
- history of tractors
- tractor engineering
- tractor mechanics
- chassis suspension
- combustion engine
- transmission
- interfaces
- hydraulics
- wheels and tyres
- cabin
- electrics and electronics

Literature

- K.T. Renius: Traktoren - Technik und ihre Anwendung; DLG Verlag (Frankfurt), 1985
- E. Schilling: Landmaschinen - Lehr- und Handbuch für den Landmaschinenbau; Schilling-Verlag (Köln), 1960

Course: Tribology [2181114]

Coordinators: M. Scherge, M. Dienwiebel
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter term	de

Learning Control / Examinations
oral examination (30 to 40 min)

no tools or reference materials

Conditions
None.

Recommendations
preliminary knowlegde in mathematics, mechanics and materials science

Learning Outcomes
The student can

- describe the fundamental friction and wear mechanisms, which occur in tribologically stressed systems
- evaluate the friction and wear behavior of tribological systems
- explain the effects of lubricants and their most important additives
- identify suitable approaches to optimize tribological systems
- explain the most important experimental methods for the measurement of friction and wear, and is able to use them for the characterisation of tribo pairs
- choose suitable methods for the evaluation of roughness and topography from the nm-scale to the mm-scale and is able to interpret the determined values in respect to their effect on the tribological behavior
- describe the most important surface-analytical methods and their physical principles for the characterization of tribologically stressed sliding surfaces

Content

- Chapter 1: Friction
  adhesion, geometrical and real area of contact, Friction experiments, friction powder, tribological stressing, evironmental influences, tribological age, contact models, Simulation of contacts, roughness.
- Chapter 2: Wear
  plastic deformation at the asperity level, dissipation modes, mechanical mixing, Dynamics of the third body, running-in, running- in dynamics, shear stress.
- Chapter 3: Lubrication
  base oils, Stribeck plot, lubrication regimes (HD, EHD, mixed lubrication), additives, oil characterization, solid lubrication.
- Chapter 4: Measurement Techniques
  friction measurement, tribometer, sales performance, conventional wear measurement, continuous wear measurement(RNT)
- Chapter 5: Roughness
  prolometry, prole parameters, measuring ranges and lters, bearing ratio curve, measurement error
- Chapter 6: Accompanying Analysis
  multi-scale topography measurement, chemical surface analysis, structural analysis, mechanical analysis

Literature

1. Fleischer, G. ; Gröger, H. ; Thum: Verschleiß und Zuverlässigkeit. 1. Auflage. Berlin : VEB-Verlag Technik, 1980
2. Persson, B.J.N.: Sliding Friction, Springer Verlag Berlin, 1998
3. M. Dienwiebel, and M. Scherge, Nanotribology in automotive industry, In:Fundamentals of Friction and Wear on the Nanoscale; Editors: E. Meyer and E. Gnecco, Springer, Berlin, 2007.
4. Scherge, M., Shakhvorostov, D., Pöhlmann, K.: Fundamental wear mechanism of metals. Wear 255, 395–400 (2003)
5. Shakhvorostov, D., Pöhlmann, K., Scherge, M.: An energetic approach to friction, wear and temperature. Wear 257, 124–130 (2004)

Course: Turbine and compressor Design [2169462]

Coordinators: H. Bauer, A. Schulz
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
Thermal Turbomachines I+II

Learning Outcomes
The students have the ability to:

-
- describe special types of components, such as e.g. radial machines and transonic compressors
- explain and evaluate the operation of components and machines
- interpret and apply the the physical principles
- design individual components in a practical approach

Content
The lecture is intended to expand the knowledge from Thermal Turbomachines I+II.
Thermal Turbomaschines, general overview

Design of a turbomachine: Criteria and development

Radial machines

Transonic compressors

Combustion chambers

Multi-spool installations

Literature
Münzberg, H.G.: Gasturbinen - Betriebsverhalten und Optimierung, Springer Verlag, 1977

Traupel, W.: Thermische Turbomaschinen, Bd. I-II, Springer Verlang, 1977, 1982

Course: Turbo Jet Engines [2170478]

Coordinators: H. Bauer, A. Schulz
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral
Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
None.

Learning Outcomes
The students have the ability to:

-
- compare the design concepts of modern jet engines
- analyse the operation of modern jet engines
- apply the thermodynamic and fluidmechanic basics of jet engines
- choose the main components intake, compressor, combustor, turbine and thrust nozzle based on given criteria
- comment on different methods for the reduction of pollutant emissions, noise and fuel consumption

Content
Introduction to jet engines and their components

Demands on engines and propulsive efficiency

Thermodynamic and gas dynamic fundamentals and design calculations

Components of air breathing engines

Jet engine design and development process

Engine and component design

Current developments in the jet engines industry

Literature
Hagen, H.: Fluggasturbinen und ihre Leistungen, G. Braun Verlag, 1982
Hünnecke, K.: Flugtriebwerke, ihre Technik und Funktion, Motorbuch Verlag, 1993
Saravanamuttoo, H.; Rogers, G.; Cohen, H.: Gas Turbine Theory, 5th Ed., 04/2001
Rolls-Royce: The Jet Engine, ISBN:0902121235, 2005

Course: Tutorial - Electromagnetic Fields and Waves [23057]

Coordinators: G. Trommer
Part of the modules: Electronics Basics II (p. 17)[BSc-MIT - B5]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content
This course provides an introduction to the major theoretical foundations of electric and magnetic fields for students of the 3rd semester. In addition, the lecture is intended to be the basis for other application-related lectures.
Basis of the lecture is the presentation of the electromagnetic field theory and the necessary mathematical methods. This is done on the basis of Maxwell's equation, which are presented and explained in detail in this lecture.
Using this equation, the basic phenomena of electric and magnetic phenomena are calculated and explained. This includes the electrostatics, the stationary flow fields, strictly stationary magnetic fields, the inductive effects, quasistationary fields, the energy and energy flux density of fields, wave phenomena of fast varying fields up and finally the basics of antenna theory of the Hertzian dipole.

Course: Tutorial - Linear Electronic Networks [23617]

Coordinators: G. Lenis
Part of the modules: Electronics Basics I (p. 15)[BSc-MIT - B3]

ECTS Credits	Hours per week	Term	Instruction language
1.5	1	Winter term	de

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

- Methods to analyse complex linear electric circuits
- Definitions U, I, R, L, C, independent sources, dependent sources
- Kirchhoff's laws, node-voltage method, mesh-current method
- Thevenin and Norton equivalents, Delta to Wye transformation, maximum power
- operational amplifier, inverting amplifier, summing amplifier, emitter follower, noninverting amplifier, difference amplifier
- sinusoidal currents, differential equations for L- and C-circuits, complex numbers,
- complex RLC-circuits, impedance, complex power, maximum power transfer
- bridge circuits, Wheatsone, Maxwell-Wien, Wien bridge
- series and parallel resonance
- two-port circuits, Z, Y, A-matrix, impedance transformation, phasor-diagrams, Bode
- diagrams, high pass, low pass, band pass
- operational amplifier and RLC-circuits
- transformer, mutual inductance, transformer equations, equivalent circuits
- three-phase-circuits, power calculations in balanced circuits

Course: Tutorial - System Dynamics and Control Engineering [23157]

Coordinators: S. Hohmann
Part of the modules: Automation Technology (p. 19)[BSc-MIT - B7]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations

Conditions
None.

Recommendations
Integral Transformations

Learning Outcomes
The goal is to relay theoretical fundamentals.
This lecture familiarizes students with the basic elements, structures and the behaviour of dynamic systems. It gives them insight into the problems of control and intuition about methods available to solve such problems. Both frequency response and state space methods for analysis and design of dynamic systems are considered.

Content
To accompany the lecture material, assignments will be given out and discussed during lecture hall exercises. Furthermore tutorials in small study groups will be held to deepen the understanding of the curriculum and methods taught.

Literature
Supplemental sheets for the lecture are available on the IRS webpage. Literature: a) Föllinger, Otto: Regelungstechnik, 10. Auflage, Hüthig-Verlag 2008 b) Lunze, Jan: Regelungstechnik I, 7. Auflage, Springer-Verlag 2008. Furthermore computer demonstrations in Matlab/Simulink used in the lecture for visualization of the presented topics can be downloaded from the IRS webpage for own experiments.

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the IRS webpage.

Course: Tutorial Information Technology [23624]

Coordinators: K. Müller-Glaser
Part of the modules: Basics of Information Technology (p. 16)[BSc-MIT - B4]

ECTS Credits	Hours per week	Term	Instruction language
1.5	1	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes
Accompanying the lecture the exercise procures the fundamentals of the programming language C++ by providing exercises to C++ and the lecture material, as well as showing the solutions in detail. The exercises focus on the design, development and analysis of programs, as well as the implementation of algorithms.

Content
In the beginning of the exercise, an introduction to the programming language C++ is presented. This will be done step by step using theory, practical examples and exercises.
First the layout of a C++ program and the fundamentals about variables and operators are introduced. Based on these, pointers, references and arrays are discussed. Subsequently, handling and structuring of major problems, based on the principle of "divide and conquer", is shown. Furthermore, header files, the area of validity and dynamic memory allocation are explained.
The next block deals with advanced data structures and object oriented programming, which has been discussed in the lecture. For reading, processing and storing information, file processing and strings are introduced.
As part of the exercise in different contexts, algorithms are discussed and implemented in C++ source code. Also the efficiency, runtime and behavior of programs and algorithms are analyzed and visualized. Besides, testing following the quality criteria shown in the lecture is part of the exercise.

Literature
Online material is available on: www.estudium.org; Literature: Kirch-Prinz, U.; Prinz, P.: C++ lernen und professionell anwenden; 4. Auflage 2007; Cormen T. H., Leiserson C. E., Rivest R. L., and Stein C.: Introduction to Algorithms, Second Edition. 2001.

Remarks
The course comprises the interleaved blocks: lecture, exercises and lab. Current information can be found on the ITIV (www.itiv.kit.edu) webpage.

Course: Übungen zu Maschinendynamik [2161225]

Coordinators: C. Proppe
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
0	1	Summer term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes
Students are able to solve problems related to the lecture.

Content
Excercises related to the lecture

Course: Mathematical methods of vibration theory (Tutorial) [2162242]

Coordinators: W. Seemann, C. Baum
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
1	1	Summer term	de

Learning Control / Examinations

Conditions
Technische Mechanik III, IV / Engineering Mechanics III, IV

Learning Outcomes
Deepen understanding of the course by solving corresponding problems

Content
Seven tutorials with examples of the contents of the course

Literature
Riemer, Wedig, Wauer: Mathematische Methoden der Technischen Mechanik

Course: Tutorial in Digital System Design [23617]

Coordinators: J. Heißwolf
Part of the modules: Basics of Information Technology (p. 16)[BSc-MIT - B4]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Metal Forming [2150681]

Coordinators: T. Herlan
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students

- are able to reflect the basics, forming processes, tools, Machines and equipment of metal forming in an integrated and systematic way.
- are capable to illustrate the differences between the forming processes, tools, machines and equipment with concrete examples and are qualified to analyze and assess them in terms of their suitability for the particular application.
- are also able to transfer and apply the acquired knowledge to other metal forming problems.

Content
At the beginning of the lecture the basics of metal forming are briefly introduced. The focus of the lecture is on massive forming (forging, extrusion, rolling) and sheet forming (car body forming, deep drawing, stretch drawing). This includes the systematic treatment of the appropriate metal forming Machines and the corresponding tool technology.
Aspects of tribology, as well as basics in material science and aspects of production planning are also discussed briefly. The plastic theory is presented to the extent necessary in order to present the numerical simulation method and the FEM computation of forming processes or tool design. The lecture will be completed by product samples from the forming technology.
The topics are as follows:

- Introduction and basics
- Hot forming
- Metal forming machines
- Tools
- Metallographic fundamentals
- Plastic theory
- Tribology
- Sheet forming
- Extrusion
- Numerical simulation

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Corporate Governance in Energy Economics [2581005]

Coordinators: H. Villis
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3,5	2/0	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam (60 min) according to Section 4(2), 1 of the examination regulation. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
See German version.

Content

Course: Management and Strategy [2577900]

Coordinators: H. Lindstädt
Part of the modules: Elective Subjects INF (p. 44)[BSc-MIT - B-W-INF]

ECTS Credits	Hours per week	Term	Instruction language
3.5	2/0	Summer term	de

Learning Control / Examinations
The assessment consists of a written exam (60 min) taking place at the beginn of the recess period (according to §4 (2), 1 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
After passing this course students are able to

- prepare strategic decisions along the ideal-typical strategy process in practice ("strategic analysis").
- assess strategic options.
- explain the portfolio management (Parental advantage and best owner of business entities).
- discuss price and capacity decisions in oligopolies and explain them in examples.

Content
The participants learn about central concepts of strategic management along the ideal-typical strategy process: internal and external strategic analysis, concept and sources of competitive advantages, their importance when establishing competitive and corporate strategies as well as strategy assessment and implementation. This aims in particular to provide a summary of the basic concepts and models of strategic management, i.e. to provide in particular an action-oriented integration. Thereby a focus is on imparting knowledge about how price developments in oligopolistic markets can be understood, modeled and forecasted based on game theory.

Media
Slides.

Literature

- Grant, R.M.: *Contemporary Strategy Analysis.* Blackwell, 5. Aufl. Massachusetts 2005.
- Lindstädt, H.; Hauser, R.: *Strategische Wirkungsbereiche von Unternehmen.* Gabler, Wiesbaden 2004.

The relevant excerpts and additional sources are made known during the course.

Remarks
The credits for the course "Management and Strategy" have been changed from 4 to 3,5 from summer term 2015 on.

Course: Vacuum and Tritium Technology [2190499]

Coordinators: C. Day, B. Bornschein, D. Demange
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Combustion diagnositics [2167048]

Coordinators: R. Schießl, U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
After completing this course students can:

- understand the specific requirements for diagnostic techniques in combustion applications.
- explain the physical fundamentals of diagnostic techniques, in particular of laser diagnostics.
- assess the potentials and the limits of the different diagnositc methods.

Content
Diagnostical methods: Laser induced fluorescence, Rayleigh-scattering, Raman-scattering
Chemoluminescence.
Reduced description of combustion processes and measurements.
Discussion of the potential and limits of specific strategies in different combustion systems.

Literature
Lecture notes
A.C. Eckbreth, Laser Diagnostics for Combustion Temperature and Species,
Abacus Press, 2nd ed. (1996)
W. Demtröder, Laser Spectroscopy: Basic Concepts and Instrumentation,
Springer, 3rd ed., 2003
Hollas J.M. Modern Spectroscopy, Wiley, 3rd ed., 1996
K. Kohse-Höinghaus, J. B. Jeffries (ed.), Applied Combustion Diagnostics,
Taylor and Francis
Atkins P., Paula, J., Physical Chemistry, 8th ed., Oxford University Press,
2006

Course: Combustion Engines I [2133113]

Coordinators: H. Kubach, T. Koch
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination, Duration: 25 min., no auxiliary means

Conditions
None.

Recommendations
None.

Learning Outcomes
The student can name and explain the working princile of combustion engines. He is able to analyse and evaluate the combustion process. He is able to evaluate influences of gas exchange, mixture formation, fuels and exhaust gas aftertreatment on the combustion performance. He can solve basic research problems in the field of engine development.

Content
Introduction, History, Concepts
Working Principle and Termodynamics
Characteristic Parameters
Air Path
Fuel Path
Energy Conversion
Fuels
Emissions
Exhaust Gas Aftertreatment

Course: Error-Control Coding [23546]

Coordinators: B. Friedrichs
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral exam

Conditions
None.

Recommendations
Basic skills in communications engineering recommended, background in basic mathematics required

Learning Outcomes
Introduction to basic theory and applications.
The focus is on the formal and mathematical fundamentals for the design of error-control systems in digital communication systems and on the Shannon information theory. Practical aspects and implementation issues are addressed in the context of various real-world applications.

Content
Overview
This lecture presents an introduction to the important theoretical fundamentals, practical aspects and applications of error-control coding in modern digital communication systems. This includes also some basic facts from Shannon information theory.
Coding and information theory is actually based on a rich field of various mathematics disciplines (statistics and stochastic processes, linear algebra and matrix theory, polynomials, finite state machines, Galois fields, etc.), however, the use of theory is kept to the required minimum in order to have also time for covering implementation aspects and important applications.
Some examples of coding performance are highlighted using Matlab / Simulink live demonstrations.
Contents
1) Introduction to Coded Digital Communications (Coding for Reliable Digital Transmission and Storage; Elements of Digital Communication Systems; Discrete Channel Models; Block Coding; Hamming Distance and Minimum Distance; Maximum-Likelihood Decoding; Asymptotic Coding Gains; The Basic Idea of Error-Correcting Codes)
2) Shannon Information Theory (Channel Capacity of Discrete Memoryless Channels; Channel Coding Theorems; Capacity Limits and Coding Gains for the Binary AWGN Channel; C and R_0 for AWGN Channels with High-Level Modulation; Band-Limited AWGN Channels)
3) Linear block codes (Structure of Linear Block Codes; Error Detection and Correction and Their Geometric Representations; Bounds on Minimum Distance; Asymptotic Bounds on Minimum Distance; The Weight Distribution; Error-Detection Performance; Error-Correction Performance)
4) Matrix Description for Linear Block Codes (The Generator Matrix; The Parity-Check Matrix; Hamming Codes and Applications; Simple Modifications to a Linear Code; Simple Decoding Techniques)
5) Cyclic Block Codes (Polynomial Description of Cyclic Codes; The Generator Polynomial; The Parity-Check Polynomial; Systematic Encoders; The Syndrome Polynomial; Burst-Error and Single-Error Detection Coding; Burst-Error and Single-Error Correction Coding)
6) The Arithmetic of Galois Fields and Fourier Transforms (only some basic ideas)
7) Reed-Solomon and Bose-Chaudhuri-Hocquengham Codes (Representation and Performance of RS and BCH Codes; Some Basics of Decoding; Error-and-Erasure Decoding with RS Codes; Modifications to RS Codes)
8) Description and Properties of Convolutional Codes (Linear Encoders and Shift Registers; Polynomial Description; Truncated Convolutional Codes; Punctured Convolutional Codes; Catastrophic Codes and Encoder Inverse; Distance Properties and Optimum Convolutional Codes; The Trellis Diagram; State Diagrams and Weight Enumerators)
9) Maximum-Likelihood Viterbi Decoding and Performance of Convolutional Codes (Maximum-Likelihood-Decoding and the Viterbi Metric; The Viterbi Algorithm; Calculation of Error Probabilities and Performance Results; Concatenated Codes and Requirements on Soft-Decision Output; Comparison of Block and Convolutional Codes)
10) Trellis Coded Modulation (only some basic ideas)

11) Selected Applications (Satellite Communications; Modems for Data Transmission over the Voice-Band Telephone Channel; The GSM Standard for Mobile Radio; Source and Channel Coding for Future Mobile Radio; Broadband Wireless Point-to-Multipoint Access Networks as an example for adaptive coding and burst operation; The Compact Disc)

Literature
Based on the textbook: Bernd Friedrichs: Kanalcodierung - Grundlagen und Anwendungen in modernen Kommunikationssystemen. Berlin: Springer-Verlag 1995. Weitere Infos auf www.berndfriedrichs.de

Course: Behaviour Generation for Vehicles [2138336]

Coordinators: C. Stiller, M. Werling
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

no reference materials

Conditions
None.

Recommendations
Fundamentals in measurement, system and control theory, e.g. from the lecture "Measurement and Control Systems"

Learning Outcomes
Modern vehicle control systems like ABS or ESP transform the intention of the driver into a corresponding behaviour of the vehicle. This is achieved by compensating disturbances like a varying traction for example. Within the recent years, vehicles have been increasingly equipped with sensors that gather information about the environment (Radar, Lidar and Video for example). This enables the vehicles to generate an 'intelligent' behaviour and transform this behaviour into control signals for actors. Several so called 'driver assistance systems' have already achieved remarkable improvements as far as comfort, safety and efficiency are concerned. But nevertheless, several decades of research will be required to achieve an automated behaviour with a performance equivalent to a human operator ('the driver'). The lecture addresses students in mechanical engineering and related subjects who intend to get an interdisciplinary knowledge in a state-of-the-art technical domain. Information technology, control theory and kinematic aspects are treated to provide a broad overview over vehicle guidance. Application examples from cutting-edge and future driver assistance systems illustrate the discussed subjects.

Content
1. Driver assistance systems
2. Driving comfort and safety
3. Vehicle dynamics
4. Path and trajectory planning
5. Path control
6. Collision avoidance

Literature
TBA

Course: Failure of Structural Materials: Fatigue and Creep [2181715]

Coordinators: O. Kraft, P. Gumbsch, P. Gruber
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes
no tools or reference materials

Conditions
compulsory preconditions: none

Recommendations
preliminary knowlegde in mathematics, mechanics and materials science

Learning Outcomes
The student

- has the basic understanding of mechanical processes to explain the relationships between externally applied load and materials strength.
- can describe the main empirical materials models for fatigue and creep and can apply them.
- has the physical understanding to describe and explain phenomena of failure.
- can use statistical approaches for reliability predictions.
- can use its acquired skills, to select and develop materials for specific applications.

Content
1 Fatigue
1.1 Introduction
1.2 Statistical Aspects
1.3 Lifetime
1.4 Fatigue Mechanisms
1.5 Material Selection
1.6 Thermomechanical Loading
1.7 Notches and Shape Optimization
1.8 Case Study: ICE-Desaster

2 Creep
2.1 Introduction
2.2 High Temperature Plasticity
2.3 Phänomenological DEsciption of Creep
2.4 Creep Mechanisms
2.5 Alloying Effects

Literature

- Engineering Materials, M. Ashby and D.R. Jones (2nd Edition, Butterworth-Heinemann, Oxford, 1998); worth reading, relatively simple but comprehensive
- Mechanical Behavior of Materials, Thomas H. Courtney (2nd Edition, McGraw Hill, Singapur); classic on the mechanical behavior of materials, extensive and good
- Bruchvorgänge in metallischen Werkstoffen, D. Aurich (Werkstofftechnische Verlagsgesellschaft Karlsruhe), relatively simple but yet comprehensive overview of metallic materials
- Fatigue of Materials, Subra Suresh (2nd Edition, Cambridge University Press); standard work on fatigue, all classes of materials, extensive, for beginners and advanced student

Course: Failure of structural materials: deformation and fracture [2181711]

Coordinators: P. Gumbsch, O. Kraft, D. Weygand
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes
no tools or reference materials

Conditions
compulsory preconditions: none

Recommendations
preliminary knowlegde in mathematics, mechanics and materials science

Learning Outcomes
The student

- has the basic understanding of mechanical processes to explain the relationship between externally applied load and materials strength.
- can explain the foundation of linear elastic fracture mechanics and is able to determine if this concept can be applied to a failure by fracture.
- can decribe the main empirical materials models for deformation and fracture and can apply them.
- has the physical understanding to describe and explain phenomena of failure.

Content

1. Introduction
2. linear elasticity
3. classification of stresses
4. Failure due to plasticity
    - tensile test
    - dislocations
    - hardening mechanisms
    - guidelines for dimensioning
5. composite materials
6. fracture mechanics
    - hypotheses for failure
    - linear elasic fracture mechanics
    - crack resitance
    - experimental measurement of fracture toughness
    - defect measurement
    - crack propagation
    - application of fracture mechanics
    - atomistics of fracture

Literature

- Engineering Materials, M. Ashby and D.R. Jones (2nd Edition, Butterworth-Heinemann, Oxford, 1998); worth reading, relatively simple but comprehensive
- Mechanical Behavior of Materials, Thomas H. Courtney (2nd Edition, McGraw Hill, Singapur); classic on the mechanical behavior of materials, extensive and good
- Bruchvorgänge in metallischen Werkstoffen, D. Aurich (Werkstofftechnische Verlagsgesellschaft Karlsruhe), relatively simple but yet comprehensive overview of metallic materials

Course: Verteilte ereignisdiskrete Systeme [23106]

Coordinators: Puente León
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4.5	3/0	Summer term	de

Learning Control / Examinations
Written Exam (see current document “Studienplan” and notice of the examination office ETIT).
Grades result from the written examination.

Conditions
None.

Recommendations
Probability theory
Signals and Systems

Learning Outcomes

Content
The lecture gives an introduction to the description and analysis of discrete event systems. The development towards industrial controllers demands for tools which help engineers to get analytical descriptions of automation systems and to handle with discrete event systems. In contrast to classical control, which is based on a unified system theory, discrete event systems are usually described in a variety of ways, such as queuing systems, Petri nets or automata, depending on the specific problem.
The content of the course is divided into three parts. In the first section, the theory of Markov chains is presented. Markov theory is a classical framework for stochastic state model representation. Based on this theory, queuing systems or stochastic Petri nets can be described. Event processes, Markov processes, discrete time, and continuous time Markov chains are covered here in detail, among other topics.
Next, the theory of queuing systems is presented. The queue theory handles the loading by customers with random arrival and service times of a limited capacity resource or server.
Finally, the Max-plus Algebra is treated. If stochastic state transitions are assumed, discrete event systems can be successfully described with Markov chains. There are many other technical applications whose behaviour can also be described by state graphs, but in this case the state transitions need to be considered as deterministic. It is used for example in worst-case analysis, such as the maximum computing time of parallel and dependent programs, or the calculation of the minimum sum of path weights between two nodes within a digraph, e.g. the shortest travel time on a traffic network. The Max-plus algebra is a mathematical tool which permits to deal with such problems.

Literature
Online material is available on www.iiit.kit.edu/ves.php.
Literature: Uwe Kiencke: Ereignisdiskrete Systeme; Oldenbourg Verlag, 2. Auflage, 2006, ISBN 3-486-58011-6.

Remarks
Current information can be found on the IIIT (www.iiit.kit.edu) webpage. The contents of the course described in this document are subject to modification without prior announcement.

Course: Gear Cutting Technology [2149655]

Coordinators: M. Klaiber
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral examination. The examination is offered every winter semester in agreement with the Lecturer.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- can describe the basic terms of gearings and are able to explain the imparted basics of the gearwheel and gearing theory.
- are able to specify the different manufacturing processes and machine technologies for producing gearings. Furthermore they are able to explain the functional principles and the dis-/advantages of these manufacturing processes.
- can apply the basics of the gearing theory and manufacturing processes on new problems.
- are able to read and interpret measuring records for gearings.
- are able to make an appropriate selection of a process based on a given application
- can describe the entire process chain for the production of toothed components and their respective influence on the resulting workpiece properties.

Content
Based on the gearing theory, manufacturing processes and machine technologies for producing gearings, the needs of modern gear manufacturing will be discussed in the lecture. For this purpose, various processes for various gear types are taught which represent the state of the art in practice today. A classification in soft and hard machining and furthermore in cutting and non-cutting technologies will be made. For comprehensive understanding the processes, machine technologies, tools and applications of the manufacturing of gearings will be introduced and the current developments presented. For assessment and classification of the applications and the performance of the technologies, the methods of mass production and manufacturing defects will be discussed. Sample parts, reports from current developments in the field of research and an excursion to a gear manufacturing company round out the lecture.
The following topics will be covered:

- Sample applications
- Basics of gearing geometry
- Need of gearboxes
- Soft machining processes
- Hardening processes
- Hard machining processes
- Bevel gear production
- Measurement and testing

- Manufacturing of gearbox components
- Special gearings

Media
Lecture slides will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Slides

Remarks
None

Course: Virtual Engineering I [2121352]

Coordinators: J. Ovtcharova
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
6	5	Winter term	de

Learning Control / Examinations
Depending on choice according to acutal version of study regulations
Duration: 30 min
Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can:

- rename and explain the basic methods of virtual engineering and the typical problems in product development.
- associate the methods and problems of the corresponding phases of the product life cycle and derive the necessary interfaces.
- select the appropriate IT systems for given problems and evaluate their suitability for the support of management's approach PLM.
- apply CAD/CAx/PLM-Systems using simple exercises.

Content
The lecture presents the informational interrelationship required for understanding the virtual product development process. For this purpose, an emphasis and focus will be placed on IT-systems used in the industrial sector as support for the process chain of virtual engineering:

- Product Lifecycle Management refers to the entire lifecycle of the product, beginning with the concept phase up through disassembling and recycling.
- CAx-systems for the virtual product development allow the modeling of a digital product in regards to design, construction, manufacturing and maintenance.
- Validation Systems allow the checking of the product in regard to static, dynamics, safety and build ability.

The goal of the lecture is to clarify the relationship between construction and validation operations through the usage of virtual prototypes and VR/AR/MR visualisation techniques in connection with PDM/PLM-systems. This will be achieved through an introduction to each particular system along with praxis-oriented exercises.

Literature
Lecture slides

Course: Virtual Engineering II [2122378]

Coordinators: J. Ovtcharova
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
Depending on choice according to acutal version of study regulations
Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students will be able to:

- describe virtual reality, how the stereoscopic effect occurs and compare the technologies to simulate this effect.
- describe how to model a scene in VR, store the VR graph on a computer and explain the inner workings of the VR pipeline for visualizing the scene.
- name various systems for interacting with the VR scene and assess the advantages and disadvantages of various manipulation and tracking devices.
- compare validation tests that can be carried through in the product development process with the aid of a virtual mock-up (VMU) and describe the difference between a VMU, a physical mock-up (PMU) and a virtual prototype (VP).
- point out the vision of an integrated virtual product development and which challenges need to be resolved towards that vision.

Content
The lecture presents the informational interrelationship required for understanding the virtual product development process. For this purpose, an emphasis and focus will be placed on IT-systems used in the industrial sector as support for the process chain of virtual engineering:

- The corresponding models can be visualized in Virtual Reality Systems, from single parts up through a complete assembly.
- Virtual Prototypes combine CAD-data as well as information about the remaining characteristics of the components and assembly groups for immersive visualisation, functionality tests and functional validations in the VR/AR/MR environment.
- Integrated Virtual Product Development explains exemplified the product development process from the point of view of Virtual Engineering.

The goal of the lecture is to clarify the relationship between construction and validation operations through the usage of virtual prototypes and VR/AR/MR visualisation techniques in connection with PDM/PLM-systems. This will be achieved through an introduction to each particular IT-system along with praxis-oriented exercises.

Literature
Lecture slides

Course: Visuelle Wahrnehmung im KFZ [23717]

Coordinators: C. Neumann
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Remarks
You will find the newest Information online on https://studium.kit.edu/

Course: VLSI Technology [23660]

Coordinators: M. Siegel
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
23655 (Electronic Devices and Circuits)

Learning Outcomes
To understand basic silicon technology: wafer preparation; mask generation techniques; lithography; diffusion process; ion implantation; oxidation; etching techniques - wet etching and plasma etching; thin film deposition - epitaxial growth, chemical vapor deposition techniques, metallization; To understand nMOS and CMOS technology steps and advanced process integration for CMOS, To understand and apply scaling techniques of CMOS devices and short channel effects, To understand future trends in VLSI technology, technology limitations and possible new devices for the future.

Content

-
- ITRS - Roadmap
- CMOS process
- Silicon – the material of VLSI technology
- Basics of manufacturing integatred circuits
- Thermal oxidation of silicon, ion implantation, diffusion processes
- Thin film CVD and silicon epitaxy
- Lithography, chemical and physical patterning
- N-well CMOS process
- Characteristics of short channel MOSFETs
- Latch-up, twin well process
- Ultra-Large Scale Integration (ULSI)
- Scaling rules for MOS devices
- Local oxidation of silicon (LOCOS)
- Short channel effects
- Power consumption
- Overview of worldwide research activities for future devices
- Nano-MOSFET

Literature

-
- Lecture presentation

- Hilleringmann, Ulrich, Silizium-Halbleitertechnologie, B.G. Teubner Verlag
- Giebel, Thomas, Grundlagen der CMOS-Technologie , B.G. Teubner Verlag

Remarks
Current information can be found on the IMS (www.ims.kit.edu) webpage.

Course: Heatpumps [2166534]

Coordinators: H. Wirbser, U. Maas
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
The attendance of this course enables students to:

-
- describe the setup and the working principle of heat pumps.
- specify the various types of heat pumps.
- analyse the energetic requirements.
- asses the advantages and drawbacks of heat pumps as heating system.

Content
The aim of this lecture is to promote heat pumps as heating systems for small an medium scale facilities and to discuss their advantages as well as their drawbacks. After considering the actual energy situation and the political requirements the different aspects of heat pumps are elucidated. The requirements concerning heat sources, the different components and the various types of heat pumps are discussed. In addition ecological and economical aspects are taken into consideration. The coupling of heat pumps with heat accumulators in heating systems will also be part of the lecture.

Literature
Vorlesungsunterlagen
Bach, K.: Wärmepumpen, Bd. 26 Kontakt und Studium, Lexika Verlag, 1979
Kirn, H., Hadenfeldt, H.: Wärmepumpen, Bd. 1: Einführung und Grundlagen, Verlag C. F. Müller, 1987
von Cube, H.L.: Lehrbuch der Kältetechnik, Verlag C.F. Müller, Karlsruhe, 1975.
von Cube, H.L., Steimle,F.: Wärmepumpen, Grunglagen und Praxis VDI-Verlag, Düsseldorf, 1978.

Course: Heat Transfer in Nuclear Reactors [2189907]

Coordinators: X. Cheng
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral examination; duration: 20 minutes

Conditions
None.

Learning Outcomes
This lecture is focused on students of mechanical engineering and chemical engineering in bachelor or master degree courses. The students learn important processes and methods of heat transfer nuclear reactors. Exercises with numerical simulationa programs will enhance the understanding.

Content

1. Overview of nuclear systems
2. Design tasks and design criteria of nuclear thermal-hydraulics
3. Heat release and distribution in nuclear reactors
4. Heat transfer process in nuclear reactors
5. Temperature distribution in coolant and structural materials
6. Pressure drops in nuclear systems
7. Flow stability of nuclear systems
8. Critical flow under accident conditions
9. Natural circulation and passive safety systems
10. Methodologies of thermal-hydraulic design

Literature

1. W. Oldekop, Einführung in die Kernreaktor und Kernkraftwerkstechnik, Verlag Karl Thiemig, München, 1975
2. L.S. Tong, J. Weisman, Thermal-hydraulics of pressurized water reactors, American Nuclear Society, La Grande Park, Illinois, USA
3. R.T. Lahey, F.J. Moody, The Thermal-Hydraulics of a Boiling Water Nuclear Reactor, 2nd edition, ANS, La Grande Park, Illinois, USA, 1993

Course: Probability Theory [23505 + 23507]

Coordinators: F. Jondral
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT], Kommunikationstechnik (ETIT) (p. 23)[BSc-MIT - B-PE3]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	de

Learning Control / Examinations
Written exam

Conditions
Mathematics I and II, Fourier Transform

Learning Outcomes
The goal is to relay theoretical fundamentals.
Fundamental lecture on probability theory. This lectures gives an introduction to the fields of probability and stochastic processes. It makes basic knowledge available that is needed to understand continuative lectures.
In addition to the lectures, exercises have to be solved. Problems as well as methods to find their solutions are discussed biweekly in the lecture hall.

Content
The daily work of a modern engineer, especially in the field of communications, calls for a sound fundamental knowledge of stochastics. This lecture on probability theory introduces the students of electrical engineering and information technology to this domain. The lecture is organized as follows: First the notions probability space, conditional probability as well as random variable are thoroughly defined. After highlighting the parameters of random variables, the most important probability distributions are discussed. The chapter on multidimensional random variables particularly covers correlation coefficients and functions of multidimensional random variables. One chapter is devoted to the laws of large numbers and to the central limit theorem. The chapters on basics of stochastic processes and on special stochastic processes make the lecture's content perfect.

Literature
Friedrich K. Jondral, Anne Wiesler: Wahrscheinlichkeitsrechnung und stochastische Prozesse - Grundlagen für Ingenieure und Naturwissenschaftler. 2. Auflage, Stuttgart, Leipzig, Wiesbaden 2002: B.G. Teubner, ISBN 3-519-16263-6

Remarks
The lecturer reserves the right to alter the contents of the course without prior notification.

Course: Wave Propagation and Radio Channels for Mobile Communications [23411 + 23413]

Coordinators: T. Fügen
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	de

Learning Control / Examinations
Written Exam

Conditions
Fundamentals on Mathematics, Electrodynamics, High Frequency Techniques, and Communications Engineering

Learning Outcomes
To convey the theoretical background of wave propagation and radio channels for analogue and digital mobile radio communication systems and networks.
Focus of the lecture is the procurement of fundamental knowledge for the description and calculation of the propagation of electromagnetic waves in mobile radio communications systems. Essential subject areas are the description of the propagation effects free space propagation, reflexion, scattering and diffraction, the characterisation of the system-theoretical properties of the radio propagation channel, wave propagation models, procedures for network planning, and fundamentals of multiple antenna systems (MIMO).

Content
The design and the planning of modern analog and digital mobile radio communications systems requires sophisticated tools for a prediction of the system performance before ever building the system. Course and tutorial teach the fundamentals needed for the development and/or usage of these design tools. They provide a detailed understanding of the physical wave propagation channel between the transmitting and the receiving antenna ports, including the description of all relevant wave propagation effects (e.g., free space propagation, influence of the antennas, reflection, transmission, scattering, diffraction, multipath propagation, spatial interference pattern etc.).
Following an overview over common empirical and deterministic wave propagation models (e.g., Okumura- and COST-Hata model, ray-optical models) as well as physical and analytical channel models are given.
The most important functions and parameters for a characterization of the time variant and frequency selective propagation channel are introduced (e.g., Rice and Rayleigh fading, log-normal fading, power delay profile and delay spread, Doppler spectrum and Doppler spread etc.).
In addition course and tutorial also give a brief introduction into frequency planning and interference reduction techniques and trunking.
In addition the fundamentals of smart antenna systems (MIMO: multiple input multiple output) are taught.

Literature
Material to the lecture can be found online at www.ihe.kit.edu.

Remarks
Current information is available on the webpage of the IHE (www.ihe.kit.edu).

Course: Wave Propagation [2161219]

Coordinators: W. Seemann
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral

30 minutes (optional subject), 20 minutes (major subject)

no means

Conditions
Vibration theory

Learning Outcomes
The course gives an introduction into wave propagation phenomena. This contains both one-dimensional continua (beams, rods, strings) as well as two- and three-dimensional continua. Initial condition problems are treated. Fundamental effects like phase velocity, group velocity or dispersion are explained. Wave propagation is used to show the limits of structural models like beams. In addition surface waves and acoustic waves are covered.

Content
Wave propagation in strings and rods, d'Alembert's solution, initial value problem, boundary conditions, excitation at the boundary, energy transport, wave propagation in beams, Bernoulli-Euler beams, group velocity, beams with changing cross-section, reflexion and transmission, Timoshenko beam theory, wave propagation in membranes and plates, acoustic waves, reflexion and refraction, spherical waves, s- and p-waves in elastic media, reflexion and transmission at bounding surfaces, surface waves

Literature
P. Hagedorn and A. Dasgupta: Vibration and waves in continuous mechanical systems. Wiley, 2007.

Course: Material Analysis [2174586]

Coordinators: J. Gibmeier
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination
duration: 20 - 30 minutes
no auxillray resources

Conditions
obligation: Material Science I/II

Learning Outcomes
The students have basic knowledge about methods of material analysis. They have a basic understanding to transfer this nasic knowledge on problems in engineering science. Furthermore, the students have the ability to describe technical material by its microscopic and submicroscopic structure

Content
The following methods will be introduced within this module:

microscopic methods: optical microscopy, electron microscopy (SEM/TEM), atomic force microscopy

material and microstructure analyses by means of X-ray, neutron and electron beams

spectroscopic methods

Literature
lecture notes (will be provided at the beginning of the lecture)

literature will be quoted at the beginning of the lecture

Course: Materials for Lightweight Construction [2174574]

Coordinators: K. Weidenmann
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 20 - 30 Min
none

Conditions
Werkstoffkunde I/II (recommended)

Learning Outcomes
The students are capable to name different lightweight materials and can describe their composition, properties and fields of application. They can describe the hardening mechanisms of lightweight materials and can transfer this knowledge to applied problems.
The students can apply basic mechanical models of composites and can depict differences in the mechanical properties depending on composition and structure. The students can describe the basic principle of hybrid material concepts and can judge their advantages in comparison to bulk materials. The students can name special materials for lightweight design and depict differences to conventional materials. The students have the ability to present applications for different lightweight materials and can balance reasons for their use.

Content
Introduction

Constructive, production-orientied and material aspects of lightweight construction

Aluminium-based alloys
Aluminium wrought alloys
Aluminium cast alloys

Magnesium-based alloys
Magnesium wrought alloys
Magnesium cast alloys

Titanium-based alloys
Titanium wrought alloys
Titanium cast alloys

High-strength steels
High-strength structural steels
Heat-treatable and hardenable steels

Composites - mainly PMC
Matrices
Reinforcements

Literature
Presentation slides and additional lecture notes are handed out during the lecture, additional literature recommendations given

Course: Materials Science and Engineering for ciw, vt, MIT [2181555]

Coordinators: J. Schneider
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH], Werkstoffe des Maschinenbaus (MACH) (p. 24)[BSc-MIT - B-PM1]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Winter term	de

Learning Control / Examinations
Combined with Materials Science and Engineering II; oral; 30 to 40 minutes
No tools and reference tools are allowed!

Conditions
None

Recommendations
None

Learning Outcomes
The students are able to describe the relationship between atomic structure, microscopical observations, and properties of solid materials.

The students can describe the typical property profiles and can name applications for the most important engineering materials.

The students are able to describe standard materials characterization methods and can explain the evaluation of these methods. They can judge materials on base of the data obtained by these methods.

Content
Atomic structure and atomic bonds

Structures of crystalline and amorphous solids

Defects in crystalline solids

Alloys

Transport and transformation phenomena in the solid state
Corrosion

Wear

Mechanical properties
Testing of materials

Literature
Lecture Notes
Problem Sheets

J.F. Shackelford: Introduction to Materials Science for Engineers. Prentice Hall, 2008 (eBook)
W. D. Callister: Materials Science and Engineering. John Wiley & Sons, 2013 (eBook)
M. Ashby: Materials. Elsevier, 2007 (eBook)

Course: Materials Science and Engineering II for ciw, vt, MIT [2182562]

Coordinators: J. Schneider
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH], Werkstoffe des Maschinenbaus (MACH) (p. 24)[BSc-MIT - B-PM1]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Summer term	de

Learning Control / Examinations
Combined with Materials Science and Engineering I; oral; 30to 40 minutes
The successful partcipation in the lab course is obligatory for the admission to the examination.
No tools and reference tools are allowed!

Conditions
Materials Science and Engineering I

Learning Outcomes
The students are able to describe the relationship between atomic structure, microscopical observations, and properties of solid materials.

The students can name representative materials for different material classes and can describe the differences.
The students are able to describe the basic mechanisms of hardening for ferrous and non-ferrous materials and reflect these mechanisms using phase and TTT diagrams.
The students can interpret given phase, TTT or other diagrams relevant for materials science, gather information from them and can correlate them regarding the microstructure evolution.
The students can describe the phenomena correlated with materials science in polymers, metals and ceramics and depict differences.
The students know about standard materials characterization methods and are able to asses materials on base of the data obtained by these methods.

Content
Ferrous materials

Non-ferrous metals and alloys

Polymers

Engineering ceramics
Composites

Literature
Lecture Notes
Problem Sheets;

J.F. Shackelford: Introduction to Materials Science for Engineers. Prentice Hall, 2008 (eBook)
W. D. Callister: Materials Science and Engineering. John Wiley & Sons, 2013 (eBook)
M. Ashby: Materials. Elsevier, 2007 (eBook)

Course: Materials Science and Engineering III [2173553]

Coordinators: M. Heilmaier
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	5	Winter term	de

Learning Control / Examinations
oral; 30-40 minutes

Conditions
Basic knowledge in materials science and engineering (Werkstoffkunde I/II)

Learning Outcomes
The students are familiar with the thermodynamic foundations of phase transformations, the kinetics of phase transformations in the solid states (nucleation and growth phenomena), the mechanisms of microstructure formation and microstructure-property relationships and can apply them to metallic materials. They can assess the effects of heat treatmens and of alloying on the microstructure and the properties of iron-based materials (steels in particular). The can select steels for structural applications in mechanical engineering and subject them to appropriate heat treatmens.

Content
Properties of pure iron; thermodynamic foundations of single-component and of binary systems; nucleation and growth; diffusion processes in crystalline iron; the phase diagram Fe-Fe3C; effects of alloying on Fe-C-alloys; nonequilibrium microstructures; multicomponent iron-based alloys; heat treatment technology; hardenability and hardenability tests.

Literature
Lecture Notes; Problem Sheets; Bhadeshia, H.K.D.H. & Honeycombe, R.W.K.
Steels – Microstructure and Properties
CIMA Publishing, 3. Auflage, 2006

Course: Materials modelling: dislocation based plasticy [2182740]

Coordinators: D. Weygand
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
None.

Recommendations
preliminary knowlegde in mathematics, physics and materials science

Learning Outcomes
The student

- has the basic understanding of the physical basics to describe dislocations and their interaction with point, line and area defects.
- can apply modelling approaches for dislocation based plasticity.
- can explain discrete methods for modelling of microstructural evolution processes.

Content
1. Introduction
2. elastic fields of dislocations
3. slip, crystallography
4. equations of motion of dislocations
a) fcc
b) bcc
5. interaction between dislocations
6. discrete dislocation dynamics in two dimensions
7. discrete dislocation dynamics in three dimensions
8. continuum description of dislocations
9. microstructure evolution: grain growth
a) physical basis: small/large angle boundaries
b) interaction between dislocations and GBs
10) Monte Carlo methods in micro structure evolution

Literature

1. D. Hull and D.J. Bacon, Introduction to Dislocations, Oxford Pergamon 1994
2. J.P. Hirth and J. Lothe: Theory of dislocations, New York Wiley 1982. (oder 1968)
3. J. Friedel, Dislocations, Pergamon Oxford 1964.
4. V. Bulatov, W. Cai, Computer Simulations of Dislocations, Oxford University Press 2006
5. A.S. Argon, Strengthening mechanisms in crystal plasticity, Oxford materials.

Course: Machine Tools and Industrial Handling [2149902]

Coordinators: J. Fleischer
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
8	6	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are capable to explain the use and application of machine tools and handling devices as well as differentiate their characteristics and structure.
- are able to name and describe the essential components (frame, main spindles, feed axis, peripheral equipment, control) of machine tools.
- Are capable to distinguish and select and describe the essential components regarding structure, characteristics advantages and disadvantages.
- are enabled to dimension the main components of machine tools.
- are able to name and describe the control principles of machine tools.
- are capable to name examples of machine tools and industrial handling as well as to deduce compare the essential components. Additionally they can allocate manufacturing processes.
- are enabled to identify drawbacks as well as derive and asses measures for improvements.
- are qualified to apply methods for selection and evaluation of machine tools.
- are experienced to deduce the particular failure characteristics of a ball screw.

Content
The lecture provides an overview of machine tool and handling devices structures, use and application areas. Within the lecture based and industrially oriented knowledge for selection, dimensioning and evaluation is conveyed. First the components of machine tools are explained systematically. Here the distinctive features of dimensioning machine tools are deduced followed by the integral dimensioning of machine tools. Subsequently the use of machine tools is shown in exemplary application areas e.g. turning, milling, grinding, metal forming, sheet metal forming and gear cutting.
The lecture provides an inside view of industrial application and is illustrated with current examples.
The topics are as follows:

- Frame and frame components
- Main drives and main spindles
- Requirements for feed axes
- Electro-mechanical feed axis
- Fluidic feed axes
- Control technologies

- Peripheral components
- Metrological assessment
- Machine maintenance
- Process-diagnosis
- Machinery Directiv
- Machine tool examples

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Scientific computing for Engineers [2181738]

Coordinators: D. Weygand, P. Gumbsch
Part of the modules: Elective Subjects MACH (p. 35)[BSc-MIT - B-W-MACH]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
compulsory preconditions: none

Learning Outcomes
The student can

- apply the programming language C^{++} for scientific computing in the field of materials science
- adapt programs for use on parallel platforms
- choose suitable numerical methods for the solution of differential equations.

Content
1. Introduction: why scientific computing
2. computer architectures
3. Introduction to Unix/Linux
4. Foundations of C++
* progamm organization
* data types, operator, control structures
* dynamic memory allocation
* functions
* class
* OpenMP parallelization
5. numeric /algorithms
* finite differences
* MD simulations: 2nd order differential equations
* algorithms for particle simulations
* solver for linear systems of eqns.

Literature

1. C++: Einführung und professionelle Programmierung; U. Breymann, Hanser Verlag München
2. C++ and object-oriented numeric computing for Scientists and Engineers, Daoqui Yang, Springer Verlag.
3. The C++ Programming Language, Bjarne Stroustrup, Addison-Wesley
4. Die C++ Standardbibliothek, S. Kuhlins und M. Schader, Springer Verlag

Numerik:

1. Numerical recipes in C++ / C / Fortran (90), Cambridge University Press
2. Numerische Mathematik, H.R. Schwarz, Teubner Stuttgart
3. Numerische Simulation in der Moleküldynamik, Griebel, Knapek, Zumbusch, Caglar, Springer Verlag

Course: Electronics Workshop I [23901]

Coordinators: T. Zwick
Part of the modules: Key Competences (p. 47)[BSc-MIT - B-SQ]

ECTS Credits	Hours per week	Term	Instruction language
1.5	1	Winter term	de

Learning Control / Examinations
The experiments are accomplished in groups with the µController-Boards and the results presented in a written report. Students will receive help and support in the form of Tutors, forums and consultations with academic staff. The forums will also allow mutual help between the students. The written report (only one per group) is to be uploaded to ILIAS at the end of the course.

Conditions
None.

Learning Outcomes
The team project is conducted at the beginning of the studies to relate the basic/fundamental courses with practical project work, in order to give a better understanding of the lecture contents. The basic practical tools which are required in the studies of electrical engineering are introduced. This includes signal theory, data acquisition and data evaluation, basic electronics or basic knowledge of µController programming

Content
Teamlab:
In all the tasks of the Team Project a micro-controller board with a signal generation and recording function is used. The experiments can thus be accomplished independently according to the task. The participating institutions are also available for support. In addition to that, at the beginning of the studies the software tool Matlab, which is very important for the electrical engineering study will be introduced.
1. Measurement recording and regenerative (1st semester) energy
Short description:
In this experiment, students learn about the current issue of regenerative energy sources. For this purpose a solar cell is used in different practical applications in order to investigate the characteristics of photovoltaic and the benefits of energy storage. In the task, the optimal utilization of regenerative energy sources or the negative effects on solar panels such as shading are to be investigated. Additionally, through a lengthy experiment, the students will be exposed to basic Matlab functions and possibilities of data logging will be highlighted.
2. Circuit analysis with operational amplifiers (2nd semester)
Short description:
Different basic operational amplifier circuits, as for example inverting, non-inverting and differential amplifiers, impedance converter or RC- and RL-networks are investigated and amplitude, frequency or phase responses are measured. In addition active filter (high-pass, low-pass, RCL-networks) are characterized.
3. Sensors (2nd Semester)

Short description:
In this course, different sensors are analyzed. The general operation and theory of temperature, light or pressure sensors are introduced and in addition suitable circuits are examined to convert the physical values into proportional electrical signals as voltage or current. The content is adapted to the semester. Therefore only simple sensor principles are treated. For temperature measurement, temperature-dependent resistors or pn-junctions are studied. Applications for brightness measurements can be realized with LEDs, photodiodes and phototransistors. The experiment is divided into the following steps: understanding the sensor principle, design of evaluation circuits for sensor signals, simulation of circuits in LTSpice, comparative analysis of circuits and evaluation using the microcontroller board.
4. Programming and Signal Processing (2nd Semester)

Short description:
Another important part of the studies in the field of electrical engineering and information technology is programming. The goal of this course is to introduce to the students at the beginning of their studies the basics of system programming and signal theory. This includes microcontroller hardware basics such as embedded programming, controlling of peripheral units (IO ports, UART, ADC) and data acquisition and processing. In the field of signal

processing, important aspects of signal theory such as the Fourier series, sampling theorem and quantization will be linked with the practice. In addition, the handling with Matlab will be extended.

Literature
Lecture materials can be found online in ILIAS at https://ilias.studium.kit.edu/goto_produktiv_cat_146475.html

Course: Electronics Workshop II [23902]

Coordinators: T. Zwick
Part of the modules: Key Competences (p. 47)[BSc-MIT - B-SQ]

ECTS Credits	Hours per week	Term	Instruction language
1.5	1	Summer term	de

Learning Control / Examinations
The experiments are accomplished in groups with the µController-Boards and the results presented in a written report. Students will receive help and support in the form of Tutors, forums and consultations with academic staff. The forums will also allow mutual help between the students. The written report (only one per group) is to be uploaded to ILIAS at the end of the course.

Conditions
None.

Learning Outcomes
The team project is conducted at the beginning of the studies to relate the basic/fundamental courses with practical project work, in order to give a better understanding of the lecture contents. The basic practical tools which are required in the studies of electrical engineering are introduced. This includes signal theory, data acquisition and data evaluation, basic electronics or basic knowledge of µController programming

Content
Teamlab:
In all the tasks of the Team Project a micro-controller board with a signal generation and recording function is used. The experiments can thus be accomplished independently according to the task. The participating institutions are also available for support. In addition to that, at the beginning of the studies the software tool Matlab, which is very important for the electrical engineering study will be introduced.
1. Measurement recording and regenerative (1st semester) energy
Short description:
In this experiment, students learn about the current issue of regenerative energy sources. For this purpose a solar cell is used in different practical applications in order to investigate the characteristics of photovoltaic and the benefits of energy storage. In the task, the optimal utilization of regenerative energy sources or the negative effects on solar panels such as shading are to be investigated. Additionally, through a lengthy experiment, the students will be exposed to basic Matlab functions and possibilities of data logging will be highlighted.
2. Circuit analysis with operational amplifiers (2nd semester)
Short description:
Different basic operational amplifier circuits, as for example inverting, non-inverting and differential amplifiers, impedance converter or RC- and RL-networks are investigated and amplitude, frequency or phase responses are measured. In addition active filter (high-pass, low-pass, RCL-networks) are characterized.
3. Sensors (2nd Semester)

Short description:
In this course, different sensors are analyzed. The general operation and theory of temperature, light or pressure sensors are introduced and in addition suitable circuits are examined to convert the physical values into proportional electrical signals as voltage or current. The content is adapted to the semester. Therefore only simple sensor principles are treated. For temperature measurement, temperature-dependent resistors or pn-junctions are studied. Applications for brightness measurements can be realized with LEDs, photodiodes and phototransistors. The experiment is divided into the following steps: understanding the sensor principle, design of evaluation circuits for sensor signals, simulation of circuits in LTSpice, comparative analysis of circuits and evaluation using the microcontroller board.
4. Programming and Signal Processing (2nd Semester)

Short description:
Another important part of the studies in the field of electrical engineering and information technology is programming. The goal of this course is to introduce to the students at the beginning of their studies the basics of system programming and signal theory. This includes microcontroller hardware basics such as embedded programming, controlling of peripheral units (IO ports, UART, ADC) and data acquisition and processing. In the field of signal

processing, important aspects of signal theory such as the Fourier series, sampling theorem and quantization will be linked with the practice. In addition, the handling with Matlab will be extended.

Literature
Lecture materials can be found online in ILIAS at https://ilias.studium.kit.edu/goto_produktiv_cat_146475.html

Course: Workshop Mechanical Design II (ciw/VT/MIT) [2146197]

Coordinators: S. Matthiesen
Part of the modules: Key Competences (p. 47)[BSc-MIT - B-SQ]

ECTS Credits	Hours per week	Term	Instruction language
1	1	Summer term	de

Learning Control / Examinations
Concomitant to the lecture a workshop with 3 workshop sessions take place over the semester. During the workshop the students were divided into groups and their knowledge will be tested during a colloquium at the beginning of every single workshop session. The attendance is mandatory and will be controlled. The pass of the colloquia and the process of the workshop task are required for the successful participation.
Further information's will be announced at Ilias and at the beginning of the lecture mechanical design.

Conditions
Successful participation in mechanical design I.

Learning Outcomes
The students are able to develop technical solutions in a team, to implement their ideas in technical solutions and to illustrate their own working- and decision process by using protocols and diagrams.

Content
Interrogation of the purchased knowledge in mechanical design I and II by means of the workshop task.

Literature
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8
CAD:
3D-Konstruktion mit Pro/Engineer - Wildfire, Paul Wyndorps, Europa Lehrmittel, ISBN: 978-3-8085-8948-9
Pro/Engineer Tipps und Techniken, Wolfgang Berg, Hanser Verlag, ISBN: 3-446-22711-3 (für Fortgeschrittene)

Remarks
Bonus
The student can achieve an extra bonus for the mechanical design exam.
The bonus amounts to 0,3 exam points and it can only be achieved in case of passed MD-exam (lowest passing grade 4,0).
More details will announce in the lecture mechanical design II.

Course: Workshop Mechatronical Systems and Products [2145162]

Coordinators: S. Matthiesen, S. Hohmann
Part of the modules: Mechatronics and Products (p. 20)[BSc-MIT - B8]

ECTS Credits	Hours per week	Term	Instruction language
2.5	2	Winter term	de

Learning Control / Examinations
Written examination
No auxiliary material
Joint examination for lecture and project.

Conditions
Participation on the course mechatronic systems and products requires participation on the courses workshop mechatronic systems and products and cooperation in interdisciplinary teams at the same time.

Recommendations
None
Knowledge in CAD is advantageous but not necessary.

Learning Outcomes
The lecture provides the theoretic basics, which will be applied and enhanced in development project during the semester. The project will take part in small groups, where the students have to organize and distribute the tasks on their own. The educational objectives are as follows:
The students

- are able to describe the difficulties of interdisciplinary projects.
- are able to coordinate processes, structures, responsibilities and interfaces within a project.
- know different solutions for mechanic/electric problems.
- know the elements of the treated product development processes, are able to describe different views onto them and execute them.
- know the model based systems engineering approaches and the basics of modelling with SysML.
- know the basic principles of virtual design and are able to apply the methods of virtual system design.
- are able to identify the differences between virtuality and reality.
- are able to recognize the advantages of early validation.
- are able to work in teams.

Content

- Introduction
- Product development processes
- MBSE and SysML
- Mechatronic selection of solutions
- Methods of early validation
- Architectural design
- Virtual functional design
- Validation and verification
- Reflection and presentation of the team results

Literature

Alt, Oliver (2012): Modell-basierte Systementwicklung mit SysML. In der Praxis. In: Modellbasierte Systementwicklung mit SysML.
Janschek, Klaus (2010): Systementwurf mechatronischer Systeme. Methoden - Modelle - Konzepte. Berlin, Heidelberg: Springer.
Weilkiens, Tim (2008): Systems engineering mit SysML/UML. Modellierung, Analyse, Design. 2., aktualisierte u. erw. Aufl. Heidelberg: Dpunkt-Verl.

Remarks

All lecture notes and excercises are provided via the elearning platform ILIAS.

Course: 2D Signals and Systems [23543]

Coordinators: M. Tacke, M. Tacke, K. Lütjen
Part of the modules: Elective Subjects ETIT (p. 31)[BSc-MIT - B-W-ETIT]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Winter term	de

Learning Control / Examinations
Oral exam

Conditions
Elementary signal processing

Learning Outcomes

Content
The first lecture gives an overwiew of the whole subject and the covered material.
The first topics are digitisation and Fourier-Transformation of two-dimensional distributions. These are essential basics of the following scientific and technical contents.
The next chapter deals with point and neighbourhood operations. Both are used frequently for image processing and are the first step of image analysis.
Segmentation is the foundation of automatic image understanding. Segmentation separates data points of objects under consideration and other objects (the background). Different techniques are introduced.
The character of segmented data is automatically described by features extracted from them. Their use for classification is described, and techniques for classification are explained.
Technical image formation is treated both for optical sensors and for techniques that make use of two-dimensional transformations of sensor material for image formation: tomography and radar with synthetic aperture (SAR).
One chapter is devoted to detection and tracking of motion in image sequences, and one to techniques for gaining three-dimensional information of 3D – scenes from image pairs and image sequences.

Literature
Written material is distributed during the lectures. The contents are covered by introductory textbooks on image processing and signal analysis.

Studienplan für den
Bachelorstudiengang Mechatronik und Informationstechnik

Dieser Studienplan tritt zum 01.04.2014 in Kraft.

Werden in den folgenden Tabellen keine Angaben über Prüfungsart oder -dauer angegeben, so werden sie nach § 6 Absatz 2 der Prüfungsordnung für den Bachelorstudiengang fristgerecht bekannt gegeben. Prüfungsart und/oder -dauer können nach § 6 Absatz 2 und 3 geändert werden. Sofern angegeben, dient die Semesterangabe „WS" oder „SS" zur Information. Die tatsächliche Durchführung der Veranstaltungen ist dem jeweils aktuellen Vorlesungsverzeichnis zu entnehmen.

Studienplan Bachelor:

Sem.	Modul	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungsart	Prüfungsdauer
1	B-1	0131000 0131100	Höhere Mathematik I	4+2+0	7	schriftlich	2 h
	B-2	2161245 2161246	Technische Mechanik I	3+2+0	6	schriftlich	1,5 h
	B-3	23256 23258	Lineare elektrische Netze	4+1+0	7,5	schriftlich	2 h
	B-4	23615 23617	Digitaltechnik	3+1+0	6	schriftlich	2 h
	B-6	2145179 2145195	Maschinenkonstruktionslehre I für CIW, VT, BIW und MIT	2+1+0	3	Prüfung mit MKL II	
	B-SQ	23901	Workshop Elektrotechnik und Informationstechnik I	0+0+1	1,5	Schein	
2	B-1	0180800 0180900	Höhere Mathematik II	4+2+0	7	schriftlich	2 h
	B-2	2162250 2162251	Technische Mechanik II	2+2+0	5	schriftlich	1,5 h
	B-3	23655 23657	Elektronische Schaltungen	3+1+0	6	schriftlich	2 h
	B-4	23622 23624	Informationstechnik	2+1+0	4,5	schriftlich	2 h
	B-6	2146195 2146196	Maschinenkonstruktionslehre II für CIW, VT, BIW und MIT	2+2+0	4	schriftlich	3,5 h
	B-SQ	2146197	Workshop Maschinenkonstruktionslehre II	0+0+1	1	Schein	
	B-SQ	23902	Workshop Elektrotechnik und Informationstechnik II	0+0+1	1,5	Schein	
3	B-1	0131400 0131500	Höhere Mathematik III	4+2+0	7	schriftlich	2 h
	B-2	2161203 2161204	Technische Mechanik III	2+2+0	5	schriftlich	1,5 h
	B-4	23626	Informationstechnisches Praktikum	0+0+2	3	schriftlich	1 h
	B-5	23055 23057	Felder und Wellen	4+2+0	9	schriftlich	2 h
	B-7	23109 23111	Signale und Systeme	2+1+0	4,5	schriftlich	3 h
4	B-5	23307 23309	Elektrische Maschinen und Stromrichter	2+2+0	6	schriftlich	2 h
	B-7	23155 23157	Systemdynamik und Regelungstechnik	2+1+0	4,5	schriftlich	2 h

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Sem.	**Modul**	**Vorl.Nr.**	**Lehrveranstaltung**	**SWS** V+Ü+P	**LP**	**Prüfungsart**	**Prüfungsdauer**
	B-8	2110085 2110086	Betriebliche Produktionswirtschaft	3+1+0	5	schriftlich	3 h
	B-P		Wahlpflichtbereich		15		
5	B-8		Mechatronische Systeme und Produkte	3+0+0	3,5	schriftlich	2 h
	B-8		Workshop Mechatronische Systeme und Produkte	0+0+2	2,5	Schein	
	B-SQ		Kooperation in interdisziplinären Teams		2	Schein	
	B-P		Wahlpflichtbereich		16,5 (11,5 – 21,5)		
	B-W		Wahlbereich		5,5 (0,5 – 10,5)		
6	B-P		Wahlpflichtbereich		6		
	B-W		Wahlbereich		13		
			Bachelorarbeit		12		

Master-Studiengang

Als konsekutive Masterstudiengänge zum vorliegenden Bachelorstudiengang „Mechatronik und Informationstechnik“ sind die beiden folgenden KIT-Masterstudiengänge vorgesehen:

- Masterstudiengang Elektrotechnik und Informationstechnik
- Masterstudiengang Maschinenbau

Es ist geplant, rechtzeitig einen Masterstudiengang im Fach „Mechatronik und Informationstechnik“ einzurichten.

Zulassung zur Prüfung

Gemäß §5, Absatz (3) der Prüfungsordnung wird zur Zulassung von Prüfungen abgelehnt, wer in einem mit der Mechatronik und Informationstechnik vergleichbaren oder einem verwandten Studiengang bereits eine Diplomvorprüfung, Diplomprüfung, Bachelor- oder Masterprüfung nicht bestanden hat, sich in einem Prüfungsverfahren befindet oder den Prüfungsanspruch in einem solchen Studiengang verloren hat.

Als vergleichbare oder verwandte Studiengänge sind insbesondere die Studiengänge Elektrotechnik und Informationstechnik (ETIT), Maschinenbau (MACH), Chemieingenieurwesen (CIW) und Materialwissenschaften und Werkstofftechnik (MWT) anzusehen.

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Zusammensetzung der Module im Pflichtbereich

Modul B-1 Höhere Mathematik (21 Leistungspunkte)
- Höhere Mathematik I
- Höhere Mathematik II
- Höhere Mathematik III

Modul B-2 Technische Mechanik (16 Leistungspunkte)
- Technische Mechanik I
- Technische Mechanik II
- Technische Mechanik III

Modul B-3 Elektrotechnische Grundlagen I (13,5 Leistungspunkte)
- Lineare elektrische Netze
- Elektronische Schaltungen

Modul B-4 Informationstechnische Grundlagen (13,5 Leistungspunkte)
- Digitaltechnik
- Informationstechnik
- Informationstechnisches Praktikum

Modul B-5 Elektrotechnische Grundlagen II (15 Leistungspunkte)
- Felder und Wellen
- Elektrische Maschinen und Stromrichter

Modul B-6 Maschinenkonstruktionslehre (7 Leistungspunkte)
- Maschinenkonstruktionslehre I
- Maschinenkonstruktionslehre II

Modul B-7 Automatisierungstechnik (9 Leistungspunkte)
- Signale und Systeme
- Systemdynamik und Regelungstechnik

Modul B-8 Mechatronik und Produkte (11 Leistungspunkte)
- Betriebliche Produktionswirtschaft
- Mechatronische Systeme und Produkte
- Workshop Mechatronische Systeme und Produkte

Modul B-SQ Schlüsselqualifikationen (6 Leistungspunkte)
- Workshop Elektrotechnik und Informationstechnik I
- Workshop Elektrotechnik und Informationstechnik II
- Kooperation in interdisziplinären Teams
- Workshop Maschinenkonstruktionslehre II

Zusammensetzung der Leistungspunkte

Module im Pflichtbereich: 106
Module im Wahlpflichtbereich: 32,5 – 42,5 (im Mittel 37,5)
Module im Wahlbereich: 13,5 – 23,5 (im Mittel 18,5)
Modul Schlüsselqualifikation: 6
Bachelorarbeit: 12
In Summe: 180 LP

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Wahlpflichtbereich Bachelor

Aus der Liste der folgenden Module müssen zwei (2) Hauptfachmodule und ein (1) Nebenfachmodul ausgewählt werden. Dabei muss eines (1) der beiden Hauptfachmodule aus dem Bereich der Elektrotechnik und Informationstechnik (ETIT) und eines (1) aus dem Bereich des Maschinenbaus (MACH) kommen.

Hauptfach-Module Wahlpflichtbereich

Modul B-PE1 Energie- und Elektrische Antriebstechnik (Bereich ETIT)
(13,5 Leistungspunkte)

Sem.	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungs-art	Prüfungs-dauer
4/6	23391 23393	Elektroenergiesysteme	2+1+0	4,5	schriftlich	2 h
5	23324 23325	Entwurf Elektrischer Maschinen	2+1+0	4,5	schriftlich	2 h
4/6	23311 23313	Praxis elektrischer Antriebe	2+1+0	4,5	mündlich	0,5 h

Modul B-PE2 Bauelemente der Elektrotechnik (Bereich ETIT)
(13,5 Leistungspunkte)

Sem.	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungs-art	Prüfungs-dauer
4	23704 23706	Festkörperelektronik	2+1+0	4,5	schriftlich	2 h
5	23206 23208	Passive Bauelemente	2+1+0	4,5	schriftlich	3 h
5	23456 23457	Halbleiter-Bauelemente	2+1+0	4,5	schriftlich	3 h

Modul B-PE3 Kommunikationstechnik (Bereich ETIT)
(15 Leistungspunkte)

Sem.	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungs-art	Prüfungs-dauer
5	23505 23507	Wahrscheinlichkeitstheorie	2+1+0	4,5	schriftlich	2 h
5	23406 23408	Grundlagen der Hochfrequenz-technik	2+1+0	4,5	schriftlich	2 h
6	23506 23508	Nachrichtentechnik I	3+1+0	6	schriftlich	3 h

Modul B-PM1 Werkstoffe des Maschinenbaus (Bereich MACH)
(9 Leistungspunkte)

Sem.	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungs-art	Prüfungs-dauer
5	2181555 2181556	Werkstoffkunde I	2+1+0	3	mündlich	0,5 h
6	2182562 2182564	Werkstoffkunde II	2+1+0	3		
6	2174565	Experimentelles Praktikum in Werkstoffkunde	0+0+3	3	Schein	

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Modul B-PM2 Thermodynamik (Bereich MACH)
(13,5 Leistungspunkte)

Sem.	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungs-art	Prüfungs-dauer
5	2165501	Technische Thermodynamik und Wärmeübertragung I	3+2+0	6,5	schriftlich	2 h
5	2153412 2153413	Strömungslehre	3+1+0	7	schriftlich	3 h

Modul B-PM3 Entwicklung und Konstruktion (Bereich MACH)
(14 Leistungspunkte)

Sem.	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungs-art	Prüfungs-dauer
5	2145151 2145153	Maschinenkonstruktionslehre III inkl. Workshop	2+1+1	5	Prüfung mit MKL IV	
6	2146177 2146184	Maschinenkonstruktionslehre IV inkl. Workshop	2+1+1	5	schriftlich	5 h *
4/6	2146190	Konstruktiver Leichtbau	2+0+0	4	mündlich	20 min

* Die Prüfung in MKL IV besteht aus 120 min Theorie, 180 min Konstruktion

<u>Nebenfach-Module Wahlpflichtbereich</u>

Als Nebenfach-Modul kann eines der verbleibenden Hauptfach-Module oder eines der folgenden Module gewählt werden:

Modul B-PI1 Informatik (Bereich Technische Informatik)
(12 Leistungspunkte)

Sem.	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungs-art	Prüfungs-dauer
4/6	24502	Rechnerorganisation	3+1+2	6	schriftlich	1 h
4/6	24576	Echtzeitsysteme	3+1+0	6	schriftlich	1 h

Modul B-PI2 Informatik (Bereich Softwareentwicklung)
(12 Leistungspunkte)

Sem.	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungs-art	Prüfungs-dauer
4/6	24518	Softwaretechnik I	3+1+2	6	schriftlich	1 h
5	24004	Programmieren	2+0+2	6	schriftlich	1 h

Modul B-PI3 Informatik (Bereich Robotik)
(10 Leistungspunkte)

Sem.	Vorl.Nr.	Lehrveranstaltung	SWS V+Ü+P	LP	Prüfungs-art	Prüfungs-dauer
5	24152	Einführung in die Robotik	2+0+0	3	schriftlich	45-60 min
5	24151	Steuerungstechnik für Roboter	2+0+0	3	mündlich	30 min
5	2400077	Mechano-Informatik in der Robotik	4+0+0	4	Noch offen	

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Modul B-PW1 Betriebswirtschaft (Bereich Wirtschaftswissenschaften)
(13 Leistungspunkte)

Sem.	**Vorl.Nr.**	**Lehrveranstaltung**	**SWS** V+Ü+P	**LP**	**Prüfungs-art**	**Prüfungs-dauer**
5	2610026	Betriebswirtschaftslehre: Finanzwirtschaft und Rechnungswesen	2+0+2	4	schriftlich	90 min
4	2550040	Einführung in das Operations Research I	2+2+0	4,5	Prüfung mit EOR II	
5	2530043	Einführung in das Operations Research II	2+2+0	4,5	schriftlich	2 h

Die Noten im Wahlpflichtbereich werden mit den jeweiligen Leistungspunkten gewichtet.

Wahlbereich Bachelor

Die Zusammenstellung der Wahlmodule ist in einem vom Prüfungsausschuss zu genehmigenden, individuellen Studienplan festzuhalten. Der genehmigte Studienplan ist spätestens vor Zulassung zur Bachelorarbeit beim Bachelorprüfungsamt der Fakultät für Elektrotechnik und Informationstechnik abzugeben.

Wahlpflichtbereich und Wahlbereich müssen zusammen mindestens 56 Leistungspunkte ergeben. Je nach Wahl der Wahlpflichtmodule müssen im Wahlbereich Veranstaltungen mit mindestens 13,5 bis 23,5 Leistungspunkte (LP) aus der Liste der in den Studiengängen der Fakultäten für Elektrotechnik und Informationstechnik, für Maschinenbau und für Informatik angebotenen Fächern gewählt werden (wählbare Veranstaltungen siehe Modulhandbuch). Unter schriftlicher Zustimmung des Studienberaters kann auch ein entsprechendes anderes Fach oder Seminar einer anderen Fakultät gewählt werden, davon maximal ein (1) Praktikum.

Folgende Fächer aus der Fakultät für Elektrotechnik und Informationstechnik sind für den Wahlbereich im Bachelor ausgeschlossen:

- Numerische Methoden (0180300, 0180400)
- Communication Systems and Protocols (23616, 23618)
- System and Software Engineering (23605, 23607)
- Technische Optik (23720, 23722)
- Mikrowellentechnik (23407, 23409) (oder Microwave Engineering 23434, 23436)
- Integrierte Signalverarbeitungssysteme (23125, 23127) (oder Integrated Systems of Signal Processing 23129)
- Optimierung dynamischer Systeme (23180, 23182) (oder Optimization of Dynamic Systems 23183, 23185)
- Batterien und Brennstoffzellen (23207, 23213)
- Energieübertragung und Netzregelung (23372, 23374)
- Leistungselektronik (23320, 23222)

Folgende Fächer aus der Fakultät für Maschinenbau sind für den Wahlbereich im Bachelor ausgeschlossen:

- Modellbildung und Simulation (Vorl.-Nr.: 2185227)
- Produktentstehung – Fertigungs- und Werkstofftechnik (Vorl.-Nr.: 2150510)
- Produktentstehung – Entwicklungsmethodik (Vorl.-Nr.: 2146176)

Folgende Fächer aus der Fakultät für Informatik sind für den Wahlbereich im Bachelor ausgeschlossen:

- Alle Fächer, außer denen, die im Modulhandbuch Informatik für den Bachelor-Studiengang enthalten sind.

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Schlüsselqualifikationen

Das Modul für die Schlüsselqualifikationen B-SQ ist mit 6 Leistungspunkten gemäß Modul B-SQ vorgegeben.
Schlüsselqualifikationen gehen in das Bachelor-Zeugnis ohne Note ein.

Weitere Schlüsselqualifikationen können als Zusatzleistung erworben werden.

Zusätzliche Leistungen

Es können nach SPO § 7 Absatz 11 und § 12 Absatz 1-3 auch Leistungen mit bis zu 40 Leistungspunkten mehr erworben werden als für das Bestehen der Bachelorprüfung erforderlich sind. In diesem Fall werden bei der Festlegung der Gesamtnote für die Bachelorprüfung nur diejenigen Noten der wählbaren Module berücksichtigt, die unter Abdeckung der erforderlichen Leistungspunkte die beste Gesamtnote ergeben, es sei denn, der Studierende beantragt eine andere Auswahl der erbrachten Prüfungsleistungen. Für die Fächer, die bei der Festsetzung der Note nicht einbezogen werden, gilt SPO § 12.

Bonusregelung

Bei mündlichen und schriftlichen Prüfungen kann vom Prüfer ein Bonus für vorlesungsbegleitende Übungen oder Projektarbeiten des Pflichtbereichs vergeben werden. Die Note wird in diesem Falle um den gewährten Bonus verbessert. Entspricht das so entstandene Ergebnis keiner der in SPO § 7 Abs. 2, Satz 2 definierten Notenstufen, so ist auf die nächstliegende Notenstufe zu runden.

Wiederholungen von Erfolgskontrollen anderer Art

Eine Erfolgskontrolle anderer Art kann beliebig oft wiederholt werden.

Bemerkung zur Notenberechnung im Wahlbereich

Die Note des Wahlbereichs wird mit einer Fächerkombination berechnet, die sich zusammensetzt aus mindestens den benötigten Leistungspunkten (56 abzüglich der Leistungspunkte des Wahlpflichtbereichs). Bei Überschreitung der geforderten minimalen Anzahl der Leistungspunkte kann der Studierende wählen, welche wählbaren Modellfächer angerechnet werden. Dabei dürfen nur so viele Fächer ausgewählt werden, dass durch Streichung eines Faches die Mindestanzahl der oben genannten Leistungspunkte nicht unterschritten wird. In die Gesamtnote geht der Wahlbereich mit der im Studienplan genannten Mindestanzahl der Leistungspunkte ein (56 abzüglich der Leistungspunkte des Wahlpflichtbereichs). Fächer, die nicht berücksichtigt wurden, können nach den Regeln der Prüfungsordnung als Zusatzleistung aufgenommen werden.

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