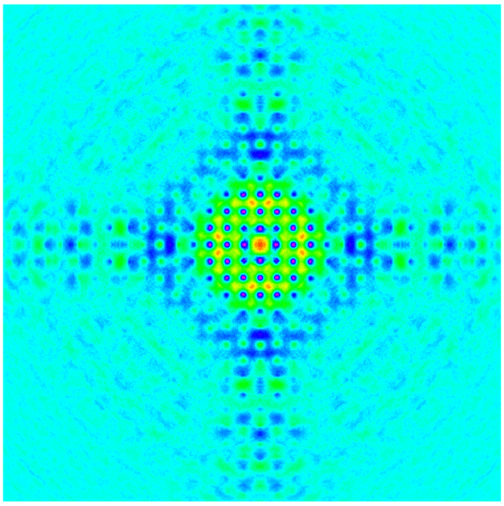
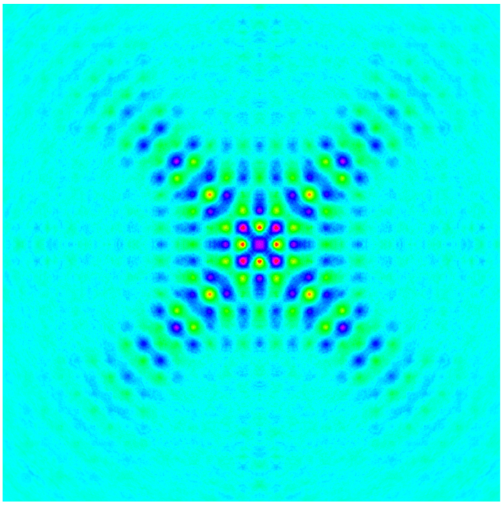
Study Plan
Master′s (M.Eng.) Program
Engineering Sciences

Studienplan incl. Modulhandbuch
Masterstudiengang
Ingenieurwissenschaften
SPO 20162





Numerical modeling of the electric field of self-guiding electromagnetic waves in a 2-D photonic crystal with a single point defect (MEEP FDTD, N.Seliger)

Prof. Dr.-Ing. Franz Perschl
Hochschule Rosenheim

June 26, 2022

Contents

1 Overview of Available Courses

1.1 Courses offered by the Faculty of Engineering Sciences

This section gives an overview of available courses offered by the faculty of engineering sciences of the Technical University of Applied Sciences Rosenheim.

- A minimum of 10 CPs must be earned from the MG group of courses.
- A minimum of 10 CPs must be earned from the MA group of courses.
- A minimum of 20 CPs must be earned from the MV group of courses.
- A minimum of 13 CPs must be earned from the MF group of elective courses

Please note that Technical University of Applied Sciences is under no obligation to offer an ENG Master′s program elective course (MF group) when enrollment is insufficient!

A minimum number of 10 participants is required for elective courses (MF group) to take place. The Faculty Council of the Faculty of Engineering decides on cancellation of modules due to insufficient number of participants.

For courses which are mainly based on lab class work, enrollment may be limited.

On request courses from the MV group can be taken to fulfill the MF credits requirement of 13 CPs. However this has to be explicitly approved by the ENG-Master′s Program Examination Commission.

Course MV06 comprises a lecture part MV06.1 and a lab class part MV06.2 which can only be taken in combination. The lab class part is graded separately and counts for the overall final mark.

1.1.1 Winter term 2022/23

Engineering Sciences Master's Program – Courses to be offered in winter term 2022/23 (SPO 20191)

No.	Modul / Course Title	EIT	MEC	MK	Lecturer	Type	Hours	CPs
MG02	Electrodynamics				Prof. Dr. Seliger	Lect./Exerc.	4	5
MG03	Solid State Electronics				Prof. Dr. Popp / Prof. Dr. Müller	Lect./Lab	4	5
MG04	Statistics				Prof. Dr. Schmiedt	Lect./Exerc.	4	5
MA02	Integrated Circuit Design and Test				Prof. Thurner, Prof. Versen	Lect./Exerc.	4	5
MA04	Selected topics in assembly technology				Prof. Dr. Meierlohr	Lect./Exerc.	4	5
MA06	Materials from Renewable Resources				Prof. Dr. Schroeter	Lect./Exerc.	4	5
		EIT	MEC	MK				
MV01	Advanced Control Systems	x	x		Prof. Dr. King	Lect./Lab	4	5
MV03	Servo Drive Systems	x	x		Prof. Dr. Hagl	Lect./Lab	4	5
MV04	Automation Systems	x	x		Prof. Dr. Meierlohr	Lect./Lab	4	5
MV05	Reliability of Mechatronic Systems		x	x	Prof. Dr. Versen	Lect./Lab	4	5
MV06	Wireless Communication Systems	x			Prof. Dr. Stahl	Lect./Lab	4	5
MV08	Digital Signal Processing and Machine Learning	x	x		Prof. Dr. Stichler	Lect./Lab	4	5
MV09	Advanced FEM		x	x	Prof. Dr. Schinagl	Lect./Exerc.	4	5
MV11	Image Processing for automated Production	x	x		Prof. Dr. Wagner	Lect./Lab	4	5
MV15	Selected topics of Polymer Chemistry and Materials Sciences			x	Prof. Dr. Muscat	Lect./Lab	4	5
MV16	Free-Form Surfaces			x	Prof. Dr. Lazar	Lect./Proj.	4	5
MF04	Applied Didactics				offered on demand	Tutorial	2	3
MF10	Electronics Packaging and Manufacturing				Prof. Dr. Winter	Lect./Lab	4	5
MF12	Satellite Navigation				LB Trautenberg	Lect.	4	5
MF20	RF and Microwave Systems				Prof. Dr. Leather	Lect./Exerc.	4	5
MF22	Kalman Filtering in Control Systems and Communications Applications				Prof. Dr. Stichler / Prof. Dr. Mysliwetz	Lect./Exerc.	4	5
MF23	Design of Materials				Prof. Dr. Strübbe	Lect./Exerc.	3	5
MF33	Heat Transfer				Prof. Dr. Stanzel	Lect.	2	3
MF38	Chemical H2 Conversion: Applications and industrial processes				Prof. Dr. Völkl	Lect./Lab	4	5
MF42	Homogeneous Catalysis				Prof. Dr. Pentlehner	Lect./Lab	4	5
*	ANG543 Technical and Business English				n.n.	Lect.	4	5
*	ANG516 Business English				n.n.	Lect.	4	5
**	ANG569 DaF Technisches Deutsch 1				n.n.	Lect.	2	3
**	ANG570 DaF Technisches Deutsch 2				n.n.	Lect.	2	3
**	ANGWF568 DaF German Language & Culture 2				n.n.	Lect.	4	5
RenewEnerg	Renewable Energies				Prof. Stier	Lect.	4	5
MP02	Master's Project						10	12
VHB	Scientific writing						2	3
VHB	Medical Image Processing for Diagnostic Applications						4	5
VHB	Integrated Production Systems						4	5
VHB	Leadership and Communication in Global Business						2	3

* for German students only: will be accepted as MF module (SPO2019 and SPO2016) restricted to a maximum of 5 Credit Points

** for non-German students only: will be accepted as MF module (SPO2019 and SPO2016) restricted to a maximum of 5 Credit Points

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1.1.2 Summer term 2023 (Preliminary)

Engineering Sciences Master's Program – Courses expected to be offered in summer term 2023 (SPO2019)

No.	Modul / Course Title				Lecturer	Type	Hours	CPs
MG01	Advanced Engineering Mathematics				Prof. Dr. Schulze	Lect./Exerc.	4	5
MG05	Fluid Mechanics				Prof. Dr. Buttinger / Prof. Dr. Schäfle	Lect./Exerc.	4	5
MG06	Applied numerical methods for mechanical engineering				Prof. Dr. Riß / Prof. Dr. King	Lect./Lab	4	5
MA01	Real-Time Systems				Prof. Dr. Mysliwetz	Lect./Lab	4	5
MA03	Mixed Signal Systems				Prof. Dr. Stubenrauch	Lect./Lab	4	5
MA05	Model based development				Prof. Dr. Perschl	Lect./Lab	4	5
MA06	Materials from Renewable Resources				Prof. Dr. Schroeter	Lect./Exerc.	4	5
		EIT	MEC	MK				
MV07	Advanced Digital Communications	x			Prof. Dr. Stichler	Lect./Lab	4	5
MV10	Electromagnetic Compatibility	x	x		Prof. Dr. Seliger	Lect./Lab	4	5
MV12***	Mechanical Design		x	x	Prof. Dr. Ragai	Lect./Proj.	4	5
MV13	Advanced light weight construction			x	Prof. Dr. Riß	Lect./Exerc.	4	5
MV14	Advanced Injection Molding			x	Prof. Würtele	Lect./Proj.	4	5
MV17	Mechanical Transmission			x	Prof. Dr. Doleschel	Lect./Proj.	4	5
MF01	Microelectronics				Prof. Dr. Popp	Lect./Lab	4	5
MF04	Applied Didactics				offered on demand	Tutorial	2	3
MF14	Power Electronics Circuit Design				Prof. Dr. Seliger	Lect./Lab	2	3
MF24	Ceramics and other Sintering materials				Prof. Dr. Müller	Lect./Lab	2	3
MF30	Experimental Modelling and Simulation				Prof. Dr. Zentgraf	Lect./Lab	2	3
MF31	Advanced additive manufacturing				Prof. Dr. Riß	Lect./Lab	4	5
MF32	Intellectual Property Protection				LB Wagner	Lect.	2	3
MF33	Heat Transfer				Prof. Dr. Stanzel	Lect.	2	3
MF36	Trajectory Planning for Robots and Automatic Machines				Prof. Dr. King	Lect./Lab	4	5
MF37	Chemistry of renewable resources				Prof. Dr. List / Prof. Dr. Pentlehner	Lect./Lab	4	5
MF39***	International Master Summer School				Fac. WI / Prof. Dr. Riß	Lect./Lab	4	5
MF41	Structural Optimization				Prof. Riß	Lect./Lab	4	5
*	ANG543 Technical and Business English				n.n.	Lect.	4	5
*	ANG516 Business English				n.n.	Lect.	4	5
**	ANG569 DaF Technisches Deutsch 1				n.n.	Lect.	2	3
**	ANG570 DaF Technisches Deutsch 2				n.n.	Lect.	2	3
**	ANGWF568 DaF German Language & Culture 2				n.n.	Lect.	4	5
MP02	Master's Project						10	12
VHB	Scientific writing						2	3
VHB	Medical Image Processing for Diagnostic Applications						4	5
VHB	Integrated Production Systems						4	5
VHB	Leadership and Communication in Global Business						2	3

* for German students only: will be accepted as MF module (SPO2019 and SPO2016) restricted to a maximum of 5 Credit Points
** for non-German students only: will be accepted as MF module (SPO2019 and SPO2016) restricted to a maximum of 5 Credit Points
*** block course

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1.2 Courses offered by other departments of the Technical University of applied Sciences

Instead of choosing MF group courses from the Faculty of Engineering Sciences, you can also choose courses which are listed in the following subsections.
Important notice: In any case you also have to submit the following registration form:

`https://www.th-rosenheim.de/fileadmin/user_upload/Dokumente_und_Merkblaette/Formulare_Pruefungsamt/Anmeldung_zu_WPF_aus_externem_Studiengang_DE_EN_sept2018.pdf`

1.2.1 Courses offered by the Faculty of Informatics: Masterstudium Informatik

The following courses are offered as joint modules for the Master Course Engineering Sciences and for the Masterstudium Informatik. Please note that these modules are taught in German only. Up to 10 Students could apply per email to franz.perschl@th-rosenheim.de for a course. In case of overload in applications, the general rules according § 7 Abs. 5 Satz 2 Immatrikulationssatzung apply.

Winter Term:

- Computer Vision
- Embedded Linux
- Systems Engineering

Summer Term:

- Autonome mobile Systeme
- Maschinelles Lernen
- Eingebettete Echtzeitsysteme

Detailed course descriptions are found at

`http://www.fh-rosenheim.de/die-hochschule/fakultaeten-institute/fakultaet-fuer-informatik/studienorganisation/regularien`

Application for course "Maschinelles Lernen" will not be accepted, if the applicant has taken the course "Grundlagen maschinellen Lernens" during his Bachelor study at TH Rosenheim.

1.2.2 Courses offered by Bavarian Virtual University (Virtuelle Hochschule Bayern)

The following courses may also be granted on request for the master course in engineering sciences. Before you register, please submit the registration form as depicted in the section before.

Winter Term and Summer Term:

- Integrated Production Systems
- Medical Image Processing for Diagnostic Applications
- Scientific writing
- Leadership and Communication in Global Business

You can get additional information on VHB courses by following this link:

`https://www.th-rosenheim.de/en/home/information-for/students/organise-your-studies/virtual-courses-vhb/`

1.2.3 Courses offered by the language center

The following courses offered by the language center of the Faculty of Applied Natural Sciences and Humanities can be granted as MF-modules. German speaking students can choose the English courses, non-German speaking students are recommended to choose the German language courses. Accreditation is limited to a maximum of 5 Credit Points.

Winter Term and Summer Term:

- DaF Technisches Deutsch 1
- DaF Technisches Deutsch 2
- DaF German Language & Culture 2
- Technical and Business English
- Business English

You will find additional information on courses offered by the language center by following this links:

German language courses: `https://www.th-rosenheim.de/en/studies/language-centre/daf-german-as-a-foreign-language/`

English language courses: `https://www.th-rosenheim.de/studium/sprachenzentrum/sprachen-a-z/englisch/`

1.2.4 Elective course offered by Faculty of Management and Engineering

The following course is offered by the Faculty of Management and Engineering. It can be granted as MF module.

Winter Term and Summer Term:

- Renewable Energies

Further information can be found by following this link:

`https://www.th-rosenheim.de/die-hochschule/fakultaeten-institute/fakultaet-fuer-angewandte-natur-und-geisteswissenschaften/wahlfaecher-wahlpflichtfaecher-awpm/wahlfachkatalog-gesamt/`

2 Recommendations for your individual study plan

The master project usually starts at the end of the first semester.

The master thesis usually starts at the end of the second semester.

The order of semesters may be changed if necessary as course contents in all three semesters are independent of each other. Please note that courses are typically held once per year, i.e. either in the spring/summer term or in the fall/winter term.

The following table may be used as a template for planning the three semesters of your master program:

Semester	Modules	CP	CP
1	1 MG module (mandatory)	5	
	1 MA module (mandatory)	5	
	3 MV modules (mandatory)	15	
	Other modules	5	30
2	Master project	12	
	1 MG module (mandatory)	5	
	1 MA module (mandatory)	5	
	1 MV module (mandatory)	5	
	Other modules	3	35
3	Master thesis	25	

Spring/Summer Term:
Lecture Period: March 15^{th} - approx. July 7^{th}.

Fall/Winter Term:
Lecture Period: October 1^{st} - approx. January 20^{th}.

The examination period in the winter semester is from about January 25^{th} until February 15^{th}, the examination period in the summer semester is typically from about July 5^{th} until July 25^{th}.

3 Detailed Course Descriptions

IMPORTANT NOTICE:

The module titles and module numbering are taken from the SPO 2019 rather than from the SPO 2016. We officially use these module titles and numbering in the curriculum as well from now on.

The following changes are noted:

- MA07 has changed to MA06 (but still applies as MA07)
- MA05 has changed to MV16 (but still applies as MA05)
- MV13 has changed to MA05 (but still applies as MV13)
- MV16 has changed to MV13 (but still applies as MV16)
- MV17 has changed to MV14 (but still applies as MV17)
- MV18 has changed to MV15 (but still applies as MV18)

MG Advanced mathematical/scientific basic modules

MG 01

Title	Advanced Engineering Mathematics
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr. Achim Schulze
Teacher	Prof. Dr. Achim Schulze
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Multivariable calculus, ordinary differential equations, integral transforms
Specific Goals	Knowledge of important PDE, their origin and fundamental knowledge of solution techniques . .
Learning Objectives	Acquire the basic theory of the most important PDE (heat-/diffusion, wave- and laplace equation), Gain an overview of and insight in solution techniques for PDE (separation of variables, integral transforms, numerical solutions) . .
Topics	Prerequisites and introduction to PDE - Surface integrals and integral theorems (Gauss and Stokes theorem) - Derivation of important PDE - Boundary conditions Classical solution methods - Solution and analysis of the heat-/diffusion equation in one and three variables - Solution of the wave equation and laplace equation Numerical methods - Finite differences: heat-/diffusion equation and the stability criterion, laplace equation and numerical solution of linear systems of equations - Finite elements - Case studies in Matlab/Octave or C
Material	Problem sheets and some lecture notes

Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Farlow, S.J.: Partial Differential Equations for scientists and engineers, Dover 1993 Strauss, W.A.: Partial Differential Equations. An Introduction, Wiley 1992 . . . .

MG 02

Title	**Electrodynamics**
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr. Norbert Seliger
Teacher	Prof. Dr. Norbert Seliger
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Mathematics (vector calculus and analysis), Electromagnetic field basics, Matlab/Octave
Specific Goals	The mathematical and physical principles of classical electrodynamics form the basis of all applications where the interaction of electromagnetic fields with technical systems is of importance, e.g. propagation of electromagnetic waves, antenna theory, electromagnetic compatibility (EMC) . .
Learning Objectives	Fundamental understanding of electromagnetic field theory (static, quasi-stationary and non-stationary fields) Computation and analysis of static and time-dependent electromagnetic fields and their application in modern electronic systems Introduction to numerical methods and FEM software for the solution of practical electrodynamics problems
Topics	Dipole fields, multipole fields, Potential theory, Coulomb and Lorenz gauge, Maxwell capacitance matrix, Partial and loop inductance, Electromagnetic radiation (retarded potentials), Wave scattering Computational Electrodynamics: Method of Moments, Finite Difference Time Domain, Finite Element Method Analytical Solution of Laplace equation, e.g. by Fourier series
Material	Lecture notes, worksheets available as download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Heino Henke. Elektromagnetische Felder: Theorie und Anwendung (Springer Lehrbuch, German Edition). Springer, 2003.

	John David Jackson. Classical Electrodynamics Third Edition. Wiley, 1998. Klaus W. Kark. Antennen und Strahlungsfelder: Elektromagnetische Wellen auf Leitungen, im Freiraum und ihre Abstrahlung (German Edition). Vieweg+Teubner Verlag, 2011. Mathew N.O. Sadiku. Numerical Techniques in Electromagnetics, Second Edition. CRC Press, 2000. Mathew N.O. Sadiku. Elements of Electromagnetics (Oxford Series in Electrical and Computer Engineering). Oxford University Press, USA, 2006. Prof. Dr. David J. Griffiths, Elektrodynamik, Eine Einführung 3., aktualisierte Auflage, Pearson 2011.

MG 03

Title	**Solid State Electronics**
Semester	ING M1-3 (winter term)
Coordinator	Prof. Dr. Popp (I), Prof. Dr. Müller (II)
Teacher	Prof. Dr. Popp (I), Prof. Dr. Müller (II)
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 75 % Exercises 0 % Lab Course 25 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 40 Exercise preparation/follow-up (hours) 30 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Working principles of electronic devices. Basic know-ledge of the atomic structure of matter and electronic properties of materials. Knowledge of the fundamental mechanisms of interaction.
Specific Goals	Enable students to understand the principles of quantum effect devices Give insight into fundamentals of nano technology .
Learning Objectives	. . .
Topics	Part I (Popp) Fundamental principles of quantum mechanics. Bandgap engineering. Heterostructure devices and quantum effect devices. Part II (Müller) Scanning probe microscopy: Working principle, interaction between sample and cantilever, modes of operation (contact, non-contact, tapping, MFM), structuring at a nanoscale. Scanning electron microscopy: Interaction electron beam with matter, EDX. Nano materials: Production methods, properties. Practical lab exercises. .
Material	Lecture notes, worksheets available as PDF download
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	R. E. Hummel: Electronic Properties of Materials, Springer, New York, 2001 S. M. Sze: High-Speed Semiconductor Devices, John Wiley, New York, 1990

	G. Timp: Nanotechnology, Springer, . . .

MG 04

Title	**Statistics**
Semester	ING M1-3 (winter term)
Coordinator	n.n.
Teacher	n.n.
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Knowledge of mathematical fundamentals
Specific Goals	Knowledge of the various statistical methods and a fundamental knowledge of probability calculus. . .
Learning Objectives	Identify stochastic / statistical aspects in every-day processes and issues, especially in technical and economic processes and issues; Gain a broad overview of basic descriptive and explorative methods of statistical data analysis and the possibilities resp. limits of its application. Acquire the foundations of probability theory and application of central inductive statistical methods. Be able to perform independently data analysis and to apply statistical methods using current statistics software (R). Knowledge and integration of the functionalities and features of popular statistics software packages; Gain the ability to independently acquire stochastic / statistical methods, to evaluate them critically and to implement them in practice using statistics software.
Topics	I. Applied Statistics , * introduction , * descriptive and explorative statistics , * univariate analysis , * multivariate analysis , * inductive statistics , * point estimation , * interval estimation , * testing of hypotheses , * linear model II. Principles of probability calculus III. Statistics software: Introduction to data analysis with R IV. Tutorial assignments , * theory and methods , * statistics software (R) . .

Material	Lecture notes, exercise problem descriptions, R sample programs, demonstration of program results
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Billingsley, P.: Probability and Measure. Anniversary Edition, Wiley Series in Probabilit (2012). Ross, S.M.: Introduction to Probability and Statistics for engineers and scientists. Fourth edition, Academic Press (2009). Tukey, J.: Exploratory Data Analysis, Addison-Wesley Reading Massachusetts (1977). Venables, W.N.: An Introduction to R, http://www.cran.r-project.org/doc/manuals/R-intro.pdf (2014) . .

MG 05

Title	**Fluid Mechanics**
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr.-Ing. Frank Buttinger
Teacher	Prof. Dr.-Ing. Frank Buttinger, Prof. Dr. Claudia Schäfle
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	none
Specific Goals	The course Fluid mechanics provides a basic introduction in fluid mechanics in theory and practice. Students gain competence in analytical problem understanding and enhance their problem solving capabilities in experiments and with numerical methods. In the computer exercises ?CFD-simulations? students improve their skills by using modern computational fluid dynamics (CFD) software programs and they will be able to analyze complex fluid dynamics problems . .
Learning Objectives	. . .
Topics	Fluid mechanics of real flows Fluid mechanics of compressible non-viscous fluids Fluid mechanics of viscous fluids Introduction to CFD simulation Simulation of compressible and incompressible fluids Laboratory experiments and validation of CFD results . .
Material	Exercise problem descriptions, sample programs, demonstration of program results
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Einführung in die technische Strömungslehre, G. Junge, Hanser Verlag

	Strömungsmechanik, H. Kuhlmann, Pearson Verlag CFD-Modellierung: Grundlagen und Anwendungen bei Strömungsprozessen, R. Schwarze, Springer Vieweg Verlag . . .

MV Advanced modules from the fields of Automation Technology, Communications Technology, Mechatronics, Mechanical Engineering, Plastics Engineering

MV 01

Title	**Advanced Control Systems**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr. F.A. King
Teacher	Prof. Dr. F.A. King
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 60 % Exercises 20 % Lab Course 20 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 50 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 30 Lab course (hours) 20 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Classical' control theory in frequency domain. Vector and matrix fundamentals.
Specific Goals	Enable students to design modern control systems Analyse state-space systems and design controllers/observers by use of numeric tools .
Learning Objectives	Apply state-space descriptions to control systems Analyse a system's stability, controllability and observability Design state space controllers and state observers by pole placement and optimal control
Topics	State Space Control: State space description, solutions for the state-space equations, analysis of state-space description (stability, controllability, observability). State-space controller design, controller structure, computation of the pre-filter, computation of the controller matrix using pole placement and optimal control. State observer structure and design.
Material	Lecture notes, worksheets and lab-class problem descriptions available as PDF download files

Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Dorf, R.C., Bishop, R.H.: Modern Control Systems, Prentice Hall Franklin, G.F., Powell, J.D., Emani-Naeini, A.: Feedback Control of Dynamic Systems, Prentice Hall Ogata, K.: Modern Control Engineering, Prentice Hall . . .

MV 02

Title	**Industrial Process Control**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr.-Ing. habil. Klaus Krämer
Teacher	Prof. Dr.-Ing. habil. Klaus Krämer, Dipl.-Ing. (FH) Peter Crämer
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Basics of sensor applications in automation technology. Knowledge of electrical / pneumatic drives and actuators. Experience in designing logic and sequential controllers. Basics of safety rules and safety devices in industrial automation.
Specific Goals	To enable students to design and implement solutions in industrial automation. Give insight into fundamentals and specific knowledge in CNC-machinery and CNC-programming as well as in designing logical and sequential control Give an overview about higher-level ind. process control component
Learning Objectives	Evaluate different devices and methods with focus on the different technical parts, Develop CNC-control programs as well as more complex PLC programs Analyse and structurize CNC and PLC systems, select the right system(s) for the planned surrounding Calculate the costs of installation and maintenance of automation plants
Topics	. Part II (Crämer): Structure and operation of a PLC system (SIMATIC S7). Application of the hardware configurator: Examples for parallel wired plants and fieldbus configurations. Characteristic parameters of CPU and signal modules. Overview of programming languages. Processing of analogue Signals. Programming sequential control functions. Overview of database and SQL language, Overview of visualization and control systems .

Material	Lecture notes, worksheets and lab course descriptions available as download files. Videos, PPT-presentations, PC-simulations.
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Dictionary of Electrical Engineering, Power Engineering and Automation, Siemens, A&D Translation Services (Eds.), 5th edition, 2003, ISBN 3-89578-192-4 FESTO didactic: Dictionary of Control Technology Automatisierungstechnik mit Informatik und Telekommunikation, Prof. Dr.-Ing. Dietmar Schmid, EUROPA Lehrmittel, 5. Auflage, 2002, ISBN 3-8085-5155-0 Automating with SIMATIC, Hans Berger, Siemens / MCD Verlag, Auflage, 2000, ISBN 3-89578-133-9 The AS-Interface for Automation, Prof. Dr. W. Kriesel/Dr. O.W. Madelung, Carl Hanser Verlag, 2. Auflage, 1999, ISBN 3-89578-133-9 Phoenix Contact: Industrial Communication, Chapt 1-7, PPT Presentation1. Isermann, R.: Mechatronische Systeme, Springer Verlag Marlin, Process Control: Designing processes and control systems for dynamic performance, Mac Graw Hill Daxl, Kurz, Schachinger: Grundlagen über numerisch gesteuerte Werkzeugmaschinen (CNC), Verlag Jugend & Volk, Wien Kief, Roschiwal: CNC-Handbuch 2009/2010, Hanser Verlag München Suk-Hwan Suh,Theory and Design of CNC Systems, Springer Verlag CNC Programming Handbook Peter Smid . . . . .

MV 03

Title	**Servo Drive Systems**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr.-Ing. Rainer Hagl
Teacher	Prof. Dr.-Ing. Rainer Hagl
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Basic knowledge in electrical drives, closed loop control, and MATLAB/ Simulink
Specific Goals	Enable students to design and commission motion control systems with electromechanical and direct driven servo drives. Optimization of motion profile, controller parameters regarding reference and disturbance behavior, and contouring behavior. . .
Learning Objectives	Knowledge of static and dynamical behavior of different drive components and their interaction. Functional principles of motion controllers, including feed forward and filters. Specific characteristics of digital motion controllers. Optimization of parameter setting of motion controller. Understanding of field oriented control for 3-phase AC-motors without and with field weakening. Influence of position measuring devices. Usage of simulation and engineering tools e.g. MATLAB and Simulink. . .
Topics	Static and dynamical requirements for servo drives. Control structures and motion profiles. Motion control of stiff drive systems, including influence of sampling time and processing dead time. Simulation and engineering tools. Motion control of elastic drive systems. Feed forward and filters. Practical courses for drive simulation. Dynamical models of DC and AC drives including field oriented control. Interaction of motor and mechanics. Influence of axis controllers on contouring behavior. Influence of position measuring devices. Practical exercises with servo drive systems.

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Material	Scipt for lecture and practical course
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	[1] Andreas Binder Elektrische Maschinen und Antriebe Springer Verlag, Berlin Heidelberg 2012 ISBN 978-3-540-71850-5 [2] Rolf Fischer Elektrische Maschinen Carl Hanser Verlag, München 2009 ISBN 978-3-446-41754-0 [3] Jean Pollefliet Electronic Power Control, Volume 2: Electronic Motor Control Academia Press, Gent 2011 ISBN 978-9038219110 [4] Dierk Schröder Elektrische Antriebe - Grundlagen Springer Verlag Berlin Heidelberg 2009 ISBN 978-3-642-02989-0 . .

MV 04

Title	**Automation Systems**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr.-Ing. Christian Meierlohr
Teacher	Prof. Dr.-Ing. Christian Meierlohr
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 50 % Exercises 30 % Lab Course 20 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 40 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 20 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Fundamental knowlegde on automation of manufacturing processes, basic knowledge on industrial robots
Specific Goals	To enable students to design and apply state-of-the-art automation systems for industrial manufacturing systems
Learning Objectives	Know details on the design and plannig procedure for automated manufacturing systems Simulating and programming an industrial robot Apply safety aspects and doing a risk-analysis according to legal standards
Topics	Flexible automation, planning procedures Safety regulations and equipment Interlinking, buffers, workpiece carriers
Material	Lecture notes and lab-class problem descriptions available as PDF download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published by Prüfungsamt (Examination Office)
Literature	Lecture Notes DIETRICH, Edgar: Abnahme von Fertigungseinrichtungen. 4. Auflage, München: Carl Hanser Verlag, 2019 FOCKE, Markus: Steigerung der Anlagenproduktivität durch OEE-Management ? Definitionen, Vorgehen und Methoden ? von manuell bis Industrie 4.0. Berlin Heidelberg New York : Springer-Verlag, 2018

	HESSE, Stefan: Grundlagen der Handhabungstechnik. 4. Auflage, München: Carl Hanser Verlag, 2016 PILZ: The Safety Compendium ? For the application of functional safety standards. Ostfildern : Pilz GmbH & Co. KG, 2017 REINHART, Gunther: Industrieroboter ? Planung, Integration, Trends : ein Leitfaden für die KMU. Würzburg : Vogel Communications Group, 2018

MV 05

Title	**Reliability of Mechatronic Systems**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr. M. Versen
Teacher	Prof. Dr. M. Versen
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Statistics
Specific Goals	To enable students to evaluate mechatronic systems under the aspects of reliabilty . .
Learning Objectives	Know different failure models Apply virtual qualification methods based on robustness validation concept Plan a test scenario for a give model, Setup/design reliable systems
Topics	Failure Modes, Defects &Testing of CMOS ICs, power devices, passive devices and electronic packaging, Fail Rate Models ESD, Reliability Analysis on case studies, e.g. ESD Test planning, Use of Redundancy and Monitors
Material	Lectures notes and hardcopies and/or PDF download files for seminar class preparation
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	A. Meyna, B. Pauli.: Zuverlässigkeitstechnik, 2nd ed., Hanser, 2010; ISBN 978-3-446-41966-7 J. Segura, C. F. Hawkins: CMOS Electronics, How it Works, How it Fails, IEEE Press, 2004, ISBN 0-471-47669-2. S. Voldman: ESD Physics and Devices, Wiley, 2004, ISBN 0-470-84753-0

	J. Lutz: Semiconductor Power Devices, Springer, Berlin, 2011, ISBN 978-3642111242. A. Birolini: Reliability Engineering Theory and Practice, Springer, Berlin, 2010, ISBN-13: 978-3642149511. J. McPherson: Reliability Physics and Engineering, Springer, New York, 2010, ISBN-13: 978-1441963475.

MV 06

Title	**Wireless Communication Systems**
Semester	ING-M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr. H. Stahl
Teacher	Prof. Dr. H. Stahl
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 67 % Exercises 0 % Lab Course 33 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 22 Exercise preparation/follow-up (hours) 24 Lab course (hours) 24 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Fundamentals of System Theory, Digital Modulation and Communication Protocols
Specific Goals	Understanding the structure and the underlying transmission techniques of selected current wireless communication systems and networks. Analysis and assessment of services, components, and protocols of wireless networks.
Learning Objectives	In this course, two or three different modern mobile communciation and wireless broadcast systems are explained in a holistic manner. Most current wireless standards use the transmistion principles OFDM (Orthogonal Frequency Division Multiplex) or OFDM-A, which will be explained thoughly during the class. After a very short (90 min) review of the prerequistite knowledge, the course treats some fundamentals of wireless and mobile communication. In the main part of this class, examples for communication and broadcast systems are treated. The matter is taught both theoretically, and practically in form of interactive class queries and acompanying lab exercises.
Topics	Lecture: Basics of wireless communication: Propagation and link budget; cellular systems; 4G mobile communication: LTE; Digital Video Broadcasting DVB-T2). Lab Class with Hands-on Exercises: Spectrum overview; DVB-T channel and signal analysis; LTE RF Measurements and Protocol Analysis

Material	Lecture notes, worksheets and lab-class instructions are available electronically
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	M. Sauter: Grundkurs Mobile Kommunikationssysteme UMTS, HSDPA und LTE, GSM, GPRS und Wireless LAN. Vieweg+Teubner, Wiesbaden, 2011 (available in German as eBook) S. Sesia, M. Baker, I. Toufik: LTE ? The UMTS Long Term Evolution: From Theory to Practice. John Wiley & Sons, Croydon, UK, 2011 C. Gessner: Long Term Evolution ? A concise introduction to LTE and its measurement requirements. Rohde&Schwarz, München, 2011 W. Fischer: Digitale Fernsehund Hörfunktechnik in Theorie und Praxis. Springer, Berlin, 2016 (available in German as eBook) W. Fischer: Digital Video and Audio Broadcasting Technology. Springer, Berlin, 2010 .

MV 07

Title	**Advanced Digital Communications**
Semester	ING M1-3 (summer term)
Coordinator/Responsibility	Prof. Dr. Markus Stichler
Teacher	Prof. Dr. Markus Stichler
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Basics of system theory and digital signal processing
Specific Goals	Understanding of the basics of digital communication systems; concepts of modern digital communication systems: OFDM and CDMA. . .
Learning Objectives	. . .
Topics	Lecture Basics of digital communication systems: Modulation, mobile communication channel, time variant multi-path propagation, demodulation, synchronization, channel estimation and equalization. Concepts of modern mobile communication systems: OFDM, basics, synchronization, equalization. CDMA, basics, synchronization, equalization. Lab Class Simulation of methods and algorithms used in digital communication systems with tools like e.g. MatLab .
Material	Lecture notes, worksheets and lab class handouts are available in hardcopy and PDF
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	B. Sklar: Digital Communications, Fundamentals and Applications, Prentice Hall, 2000; ISBN 0-13-084788-7

	John G. Proakis: Digital Communications, McGraw Hill, 2001; ISBN 0-07-232111-3 . . . .

MV 08

Title	**Digital Signal Processing and Machine Learning**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr. Markus Stichler
Teacher	Prof. Dr. Markus Stichler
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 0 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Fundamentals of system theory
Specific Goals	Advanced knowledge in applied digital signal processing with view on applications in the areas of information and communication technology as well as control technology . .
Learning Objectives	. . .
Topics	Lecture Deterministic and stochastic signals and systems, discrete Fourier- and Wavelet-Transformation, LTI systems, design and implementation of digital systems, sample rate conversion, multirate signal processing. Lab class Design, simulation (using MatLab and/or Simulink) and implementation of simple algorithms on digital signal processors (DSPs) and/or FPGAs. .
Material	Overhead, board, beamer
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Oppenheim, Schafer: Discrete-Time Processing, Prentice Hall, 1992 V. K. Ingle, J. G. Proakis: Digital Signal Processing using Matlab, Brooks/Cole, 2000; ISBN 0-534-37174-4

	J.H. Chow, D. K. Frederick, N. W. Chbat: Discrete-Time Control Problems using Matlab, Brooks/Cole, 2003; ISBN 0-534-38477-3 . . .

MV 09

Title	**Advanced FEM**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr.-Ing. S. Schinagl
Teacher	Prof. Dr.-Ing. S. Schinagl
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 40 % Exercises 20 % Lab Course 20 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 36 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 30 Lab course (hours) 24 Examination preparation (hours) 30 Total workload (hours) 150
Credits	5
Prerequisites	Engineering Mechanics (Statics, Strength of materials, Dynamics), FEM basics
Specific Goals	To enable students to evaluate structures and components with respect to their mechanical behavior and reliabilty . .
Learning Objectives	analyse nonlinear structural mechanic problems considering all kinds of nonlinearities (geometry, material, contact) work in the field of modal based linear structure dynamical analyses strength verification
Topics	Fundamentals of numerical modeling and analysis of nonlinear structural problems Modal based linear dynamics: Natural frequencies and mode shapes, frequency response analysis / harmonic analysis, response spectrum analysis Strength verification: Influence factors on static strength and fatigue strength, concepts of strength verification with local stresses .
Material	Lecture notes and hardcopies and/or PDF download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	C. Gebhardt: Praxisbuch FEM mit ANSYS Workbench: Einführung in die lineare und nichtlineare Mechanik. Carl Hanser Verlag GmbH & CO. KG, 2011

	Analytical Strength Assessment of Components, FKM Guideline. VDMA Verlag, 2013 J. A. Collins: Failure of Materials in Mechanical Design. 2nd ed. John Wiley & Sons, New York, 1993. J. A. Bannantine, J. J. Comer, J. J. Handrock: Fundamentals of Metal Fatigue. Prentice Hall, Upper Saddle River, NJ: 1990 . .

MV 010

Title	**Electromagnetic Compatibility**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr. Norbert Seliger
Teacher	Prof. Dr. Norbert Seliger
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Knowledge in electromagnetic fields, transmission lines, electrical signals and circuit components
Specific Goals	Within this lecture students will learn the basics of EMC engineering and its application in early system design. By discussing case studies and lab experiments we will bridge the gap between theory and practical implementation. . .
Learning Objectives	Understanding of basic aspects of EMC: theory of emission and reception of conducted and radiated electro-magnetic interference signals, coupling mechanisms and their models. Design methods and techniques for EMC compliance: PCB and circuit design, grounding, filter design, signal spectra, system design, shielding aspects. EMC measurement techniques and EMC standards .
Topics	Introduction to EMC and EMI phenomena, Basic concepts (conducted and radiated emission and susceptibility) Electrical signals and their spectra, Propagation and crosstalk, coupling, EMC modeling Interference control techniques (PCB and circuit design, shielding, grounding, filter design), EMC measurements and EMC Standards, Case studies and Lab experiments
Material	Lecture notes and problem sheets

Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Paul: Introduction to EMC, Wiley 2006 Ott: EMC Engineering, Wiley 2009 Franz: EMV, Vieweg+Teuber 2008 Christopoulos: Principles and Techniques of EMC, CRC Press Montrose, Nakauchi: Testing for EMC Compliance, Wiley 2004 Schwab: Elektromagnetische Verträglichkeit, Springer 2007, Dhia, Ramdani, Sicard: EMC of Integrated Circuits, Springer 2006

MV 011

Title	**Image Processing for Automated Production**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr. Michael Wagner
Teacher	Prof. Dr. Michael Wagner
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Familiarity with basic matrix calculations
Specific Goals	Goals: Students will be enabled to * select suitable hardware components for a given imaging problem , * calibrate the optical system, , * design, test and optimize the network of imaging operators by using a GUI imaging toolkit, , * create a graphical user interface, , * establish a complete industrial application by generating sequences for operator execution and data exchange. . .
Learning Objectives	During this course, students will gain knowledge in: * Types of cameras, data formats, optics, illuminations, , * two dimensional algorithms in image enhancement, extraction and localization of features, classification of features, , * 2d and 3d transformations, * 2d and 3d camera calibration, , * creation of industrial imaging applications by using a GUI (graphical user interface) imaging toolkit. . .
Topics	* Camera types, image- and data formats, optics, illuminations, optical filters. * Binary image morphology. * Image enhancement: Noise reduction filters, grey value scaling, thresolding. * Digital Fast Fourier Transform (DFFT). * Extraction of edges and ridges. * Pattern matching. * Shape analysis. * Hough Transform and Generalized Hough Transform (GHT) for object localization. * Classifiers, especially Neural Network Classifiers. * Texture analysis. * 2d transforming of images and masks. * 2d camera calibration, internal and external camera parameters. * 3d camera calibration. * 3d object localization. * 3d line section based surveying.

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Material	Lecture notes and problem sheets
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Sergios Theodoridis, Konstantinos Koutroumbas: Pattern Recognition. Academic Press, Elsevier: 2009. ISBN: 978-1-59749-272-0. E. R. Davies: Machine Vision - Theory, Algorithms, Practicalities. Morgan Kaufmann Publishers, Elsevier: 2005. ISBN: 0-12-206093-8. Steger, Ulrich, Wiedemann: Machine Vision Algorithms and Applications. Wiley-VCH Verlag GmbH & CO. KGaA. ISBN: 978-3-527-40734-7. . . .

MV 012

Title	**Mechancial Design**
Semester	ING M1-3 (summer term)
Coordinator/Responsibility	Prof. Dr. Michael Wagner, Prof. Dr. Martin Neumaier
Teacher	Prof. Dr. Ihab Ragai, Prof. Dr. Michael Wagner
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	A minimum of 15 credits in mechanical drawing, calculation of geometric tolerances, CAD
Specific Goals	The students will have a practical knowledge of and ability to develop, design and optimize technical, mainly mechanical products in a conflicted area of complex requirements. The students will have experience in project management. . .
Learning Objectives	Various complex design tasks are given to student teams. The teams have to plan and execute the development and design tasks independently under supervision of professors and engineers. Depending on the task, the teams use supporting tools and methods for mechanical design such as * advanced CAD (free form surface, sheet metal design, motion assembly) * DFMA (Design for Manufacturing and Assembly) method * FEM (Finite Element Method) * creative design methodologies * industrial design basics * arithmetic and statistical tolerance calculations * project management * prototyping and testing At the end, all product documents are to be submitted and a final pre-sentation is to be given in a concluding seminar meeting. . .
Topics	* Design methodologies * Optimizing for assembly and manufacturing * Design project management * Advanced design tools * Product documentation * Tolerance calculations . .

Material	Literature in the library and on the internet, standards, patents, software, tools and methods (DFMA, CAD, FEM, statistical tolerance calculation)
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Pahl et. al.: Engineering Design: A Systematic Approach. Springer: 2007 3rd edition. VDI-Guideline 2221 . . . .

MV 013

Title	**Advanced light weight construction**
Semester	ING-M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr. Riss
Teacher	Prof. Dr. Riss
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 60 % Exercises 20 % Lab Course 20 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 36 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 30 Lab course (hours) 24 Examination preparation (hours) 30 Total workload (hours) 150
Credits	5
Prerequisites	Engineering Mechanics (Statics, Strength of materials, Dynamics), FEM basics; Manufacturing basics, Material Science basics
Specific Goals	Within this lecture students will learn the basics of lightweight design topics (combination of structural lightweight design, manufacturing lightweight design and material lightweight design) and getting to know how to apply this. . .
Learning Objectives	Understanding the basic effect of lightweight design: lightweight design approaches, assessment and selection of lightweight designs, methods and rules for lightweight design parts, standard elements for lightweight design (shell, lattice, honeycomb, ?) Learning the basics of manufacturing for lightweight design: manufacturing technologies, limits Understanding the basics of lightweight materials: kind of material, selection of material, pros and cons .
Topics	Introduction in the topic of lightweight design, terminology, basic mechanical engineering topics for lightweight design, lightweight design approaches (for example: topology optimization), manufacturing technology dedicated to lightweight design, materials for lightweight design, analysis and calculation of lightweight design parts, bionic design, lightweight design standards, lessons learnt from practical application, case studies and lab exercises . .

Material	Lecture notes and hardcopies and/or PDF download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Degischer, H.-P.; Lüftl, S.: Leichtbau - Prinzipien, Werkstoffauswahl und Fer-tigungsvarianten. Weinheim: Wiley-VCH 2009. ISBN: 978-3527323722. Gibson, L. J.; Ashby, M. F.: Cellular solids. 2. Aufl. Cambridge, New York: Cambridge University Press 1997. ISBN: 978-0-521495608. Klein, B.: Leichtbau-Konstruktion - Berechnungsgrundlagen und Gestaltung. 8. Aufl. Wiesbaden: Vieweg + Teubner 2009. ISBN: 978-3834899651. Mattheck, C.: Design in der Natur. 4. Aufl. Freiburg im Breisgau: Rombach Druck- und Verlagshaus 2006. ISBN: 978-3-793094708. Mattheck, C.: Verborgene Gestaltgesetze der Natur. Karlsruhe: Karlsruher Institut für Technologie 2006. ISBN: 978-3923704538. Nachtigall, W.: Bau-Bionik - Natur, Analogien, Technik. Berlin, Heidelberg: Springer 2003. ISBN: 978-3540443360., Wiedemann, J.: Leichtbau. 3. Aufl. Berlin, Heidelberg: Springer 2007. ISBN: 9783-540336570.

MV 014

Title	**Advanced injection molding**
Semester	ING-M1-3
Coordinator/Responsibility	Prof. M. Würtele
Teacher	Prof. M. Würtele
Language	German
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 30 Total workload (hours) 150
Credits	5
Prerequisites	Bachelor course injection molding
Specific Goals	Learning off Machine and processing technology for standard injection molding and also for special processes and learning to project injection molding plants . .
Learning Objectives	Materials for injection molding, Injection molding Machines, Injection molding processing Calculations for projecting Special process technologies
Topics	. . .
Material	.
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	. . . . . .

MV 015

Title	**Selected topics of Polymer Chemistry and Materials Sciences**
Semester	ING-M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr. D. Muscat
Teacher	Prof. Dr. D. Muscat / Dr. Schmid
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	none
Specific Goals	Part I : Caoutchoucs, Plastics, Reaction-mechanisms Understanding 1) types and production of caoutchoucs, vulcanization and production of rubbers 2) novell networks based on pericyclic reactions (Diels Alder reactions) 3) analysis of Plastics Part II :: Peroxide modification of polymers 1) Radikal initators ? Use and reactions (Organic peroxides) 2) Safe handling of organic peroxides 3) Crosslinking of polyolefines and elastomers 4) Vis breaking of polymers (i. e. PP degradation) 5) Monomer grafting onto polymers6) Curing of unsaturated polyesters .
Learning Objectives	. . .
Topics	Part I The first part introduces the different types of caoutchoucs and their nomenclature. Typical examples are explained. The vulcanization of caoutchoucs and the production of tires as the major example in the rubber field are discussed. Besides classical rubbers new polymer networks based on pericyclic reactions are introduced. Therefore, first the Diels Alder reaction is explained and then the use of this reaction in polymeric networks is reagarded. For a better understanding of the analysis of plastics an overview of applied techniques is given and some examples are discussed in detail.

	Part II Understanding the reactions of organic Peroxides as radikcal sources. Including safe handling with organic peroxides. Application of organ. peroxides for the modification of polymers. Explanation of the radical reactions for crosslinking, grafting and curing, as well as for the PP-degradation. This from an application-technical point of view. .
Material	.
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Makromoleküle, Band 1 und 2, Hans Georg Elias, Verlag Hüttig und Wepf, Basel Click Chemistry, Joerg Lahann, Verlag Wiley, ISBN 978-0-470-69970-6 ; Saechtling Kunststoff Taschenbuch, Baur, Brinkmann, Osswald, Rudolph, and Schmachtenberg Auflage: 31. Ausgabe Jahr: 2013, Verlag: Carl Hanser Verlag GmbH & Co. KG Walter Hellerich, Guenther Harsch, Erwin Baur, Werkstoff-Führer Kunststoffe Eigenschaften - Prüfungen ? Kennwerte, 10. Auflage. 10/2010 . . . .

MV 016

Title	**Freeform-Surfaces**
Semester	ING M1-3 (winter term)
Coordinator/Responsibility	Prof. Dr.-Ing. Markus Lazar
Teacher	Prof. Dr.-Ing. Markus Lazar
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Knowledge of mathematical fundamentals 3D-CAD
Specific Goals	Goals Knowledge of principles in the development of products with freeform surfaces Learning Objectives * Mathematic background of curves and surfaces * Methods of designing freely shaped objects * Methods of manufacturing freely shaped objects * Inspection of freely shaped objects . .
Learning Objectives	Mathematic background of curves and surfaces Methods of designing freely shaped objects Methods of manufacturing freely shaped objects Inspection of freely shaped objects
Topics	Mathematical Background (Bezier Curves, B-Splines, NURBS) CAGD: Introduction to shape design with CATIA Scanning Technologies, Reverse Engineering, CAD-CAM and 5-axes Machining, Rapid Prototyping
Material	Lecture notes, Software: CATIA, CAMWorks, Colin3D
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	L. Piegl, W. Tiller: The NURBS Book, Springer Berlin (1997) G. Farin, J. Hoschek, M.-S. Kim; Handbook of Computer Aided Geometric Design, Elsevier Amsterdam (2002) . .

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MV 017

Title	**Gear Box Technology**
Semester	ING-M1-3 (summer term)
Coordinator/Responsibility	Prof. Dr. Doleschel
Teacher	Prof. Dr. Doleschel
Language	English
Position in Curriculum	Specialization subject in ENG-Master
Course Type	Lecture 80 % Exercises 20 % Lab Course %
Weekly Hours	4
Workload	Lecture/class presence (hours) 80 Lecture follow-up (hours) 20 Exercise preparation/follow-up (hours) 10 Lab course (hours) Examination preparation (hours) 40 Total workload (hours) 150
Credits	5
Prerequisites	basic course in mechanical design
Specific Goals	design capability on typical gear box types (spur gears, worm gears, bevel gears), on lubrication calculation methods .
Learning Objectives	. . .
Topics	Gear design Gear failure analysis Analysis of industrial and automotive systems
Material	Lecture notes
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Dudley's Handbook of Practical Gear Design and Manufacture, Third Edition, CRC press . . . . .

MA Application-based focus

MA 01

Title	Real-Time Systems
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr. B. Mysliwetz
Teacher	Prof. Dr. B. Mysliwetz
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Working principles of microprocessors (IO, interrupts, stack). Programming experience in a blockstructured high level language, preferably ANSI C or C++. Basic knowledge of structure and working principles of a ?general purpose? operating system. Fundamental knowledge of the functional units of a personal computer. Fundamentals of control theory.
Specific Goals	To enable students to design and implement software for real-time applications . .
Learning Objectives	Understand the mechanisms and problems associated with real- time applications Apply real-time software design rules Know the working principles and utilize the services of real-time operating systems, Realize the advantages of using real-time operating systems

Topics	Part I - Real-Time Software Design and Real-Time Operating Systems (Mysliwetz) Technical terms and definitions; examples of embedded real-time systems; real-time operating system concepts; processes, threads, tasks; scheduling principles; real-time software design; rate-monotonic scheduling approach; reentrant code; semaphores, mutual exclusion, shared re- sources; synchronization mechanisms; deadlocks; priority inversion; interprocess communication, overview of commercial real-time operating systems; practical laboratory exercises. Lab (Part I) Processes and Threads under Windows; Analysis of Fundamental Real- Time Properties of Windows on a PC; implementing a step motor control application with the real-time kernel uC/OS on an ARM Cortex-M based microcomputer; application of semaphores as a mutual exclusion mechanism while accessing shared resources, effect of priority inversion. Part II - PC-based Real-Time Control Systems (Schittenhelm) Real-time applications based on personal computers: requirements, hardware and software design, overview and comparison of commercial PC-based systems. Lab (Part II) PC-based real-time systems via OPC-servers; Windows-CE development environment; real-time programming under VxWorks. .
Material	Lecture notes, worksheets and lab-class problem descriptions available as PDF download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Labrosse, J. J.: MicroC/OS-II - The Real-Time Kernel, CMP Books, 1999; ISBN 0-87930-543-6 Tanenbaum, A. S.: Modern Operating Systems, Prentice Hall, 1992 Brause, R.: Betriebssysteme - Grundlagen und Konzepte, Springer, 2001; ISBN 3-540-67598-1 Iwanitz, F., Lange, J.: OPC Fundamentals, Implementation and Application; Hüthig-Verlag, 2006; ISBN 3-77-852904-8 Stallings, W.: Operating Systems: Internals and Design Principles, Prentice Hall, 2014; ISBN 1292061359 .

MA 02

Title	**Integrated Circuit System Design and Test**
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr. H. Thurner
Teacher	Prof. Dr. H. Thurner (I), Prof. Dr. M. Versen (II)
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Familiarity with digital logic and switching circuits; basic knowledge of a high level programming language.
Specific Goals	Part I *To enable students to design complex digital circuits (ASICS or FPGAs) and systems using architecture optimization at RTL level, different synthesis steps and system simulation Part II: To enable students to verify and test IC systems and to use test system .
Learning Objectives	Part I *Understanding the fundamentals of digital VLSI (or SoC) circuit design methodology. *Optimizing architecture design at RTL level using equivalent transforms for combinational and sequential computations *Design digital VLSI (or SoC) circuits using appropriate design tools to determine and optimize a RTL level architecture, to verify the model behavior by simulation and to synthesize the model into a FPGA. Part II: Understand the fundamental problems associated with fail observation and analysis. Use of test systems and design for test methods to ensure system debug and product engineering .
Topics	Part I - Design of Digital Integrated VLSI Circuits Design methodology: modelling behaviour and structure using different levels of abstraction. Design flow, synchronous design. Architecture design and optimization at RTL level: Data dependency graph, isomorphic architecture, equivalent transforms for combinational computations, equivalent transforms for non-recursive sequential computations, unfolding of recursive sequential loops for LTI and linear time variant systems.

	Part II - Test of Integrated Systems: Basic Function of Integrated Circuits, Failure and Defect Models, Observing and Detecting Failures, Fundamentals of Digital Test, Hardware Test Setups.
Material	Part I: Lecture notes, problem sheets and lab-class problem descriptions
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Hubert Kaeslin: Digital Integrated Circuit Design; Cambridge University Press, ISBN 978-0-521-88267-5 J. Segura, C. F. Hawkins: How it Works, How it Fails, IEEE Press, 2004. Training Tutorial of the Hilevel Griffin System, Hilevel Technology Inc., 2005.

MA 03

Title	**Mixed Signal Systems**
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr. F. Stubenrauch
Teacher	Prof. Dr. F. Stubenrauch
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Good knowledge of the representation of continuous and time discrete signals in the time and frequency domain; fundamentals of digital signal processing, analogue and digital circuit design.
Specific Goals	To enable students to design mixed signal systems in a professional manner with respect to the properties of real world data converters Assess the properties of data converters as given in the corresponding data sheets in order to select appropriate components for a mixed signal application Evaluate the properties of data converters and mixed signal systems by measurement and hardware characterization To enable students to design mixed signal systems in a professional manner with respect to the properties of real world data converters
Learning Objectives	Understand the fundamental problems associated with analogue to digital and digital to analogue conversion in real world mixed signal systems Assess the properties of data converters as given in the corresponding data sheets in order to select appropriate components for a mixed signal application Evaluate the properties of data converters and mixed signal systems by measurement and hardware characterization
Topics	Fundamentals of data conversion, discrete and fast Fourier transform including the use of windows, analogue and quantization noise, voltage references, static and dynamic properties of data converters, fast ADC and DAC architectures, mixed signal design guidelines . .

Material	Book like lecture notes and problem sheets including detailed solutions
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Demler, Michael J.: High Speed Analog to Digital Conversion, Academic Press 1991,ISBN-0-122-09048-9 Hoeschele, David F.: Analog to Digital and Digital to Analog Conversion Techniques, J. Wiley, 1994, ISBN-0-471-57147-4 Kester, Walt et al.: High Speed Design Techniques, Analog Devices Inc., 2010, http://www.analog.com/en/technical-documentation/resources/index.html, Kester, Walt et al.: Mixed Signal and DSP Design Techniques, Analog Devices Inc., 2009, http://www.analog.com/en/technical-documentation/resources/index.html Pease, Robert A.: Troubleshooting Analog Circuits, Newnes, 1991, ISBN 978-0-7506-9499-5 Zumbalen, Hank (Ed.): Linear Circuit Design Handbook, Analog Devices, 2008, ISBN 978-0-7506-8703-4 Training Tutorial of the Hilevel Griffin System, Hilevel Technology Inc., 2005.

MA 04

Title	**Selected Topics in Assembly Technology**
Semester	ING M1-3 (winter term)
Coordinator	Prof. Dr.-Ing. Christian Meierlohr
Teacher	Prof. Dr.-Ing. Christian Meierlohr
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 60 % Exercises 20 % Lab Course 20 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 70 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 10 Lab course (hours) 40 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Knowledge in assembly and manufacturing processes and assembly organization
Specific Goals	Have in-depth knowledge in selected joining processes, in using specialized equipment for material supply and in applying state-of-the-art methods for planning assembly systems
Learning Objectives	Have in-depth knowledge in selected joining techniques and procedures Have in-depth knowledge in selected technologies and equipment for assembly Be able to carry out the design of assembly systems with special attention to current strategies and planning methods, Have knowledge about and be able to optimize existing assembly systems
Topics	Bonding with adhesives: material-fit based assembly Design for assembly Handling processes and equipment for automated assembly
Material	Lecture notes and lab-class problem descriptions available as PDF download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published by Prüfungsamt (Examination Office)
Literature	Lecture notes HESSE, Stefan: Grundlagen der Handhabungstechnik. 4. Auflage, München: Carl Hanser Verlag, 2016

	JÜNTGEN, Tim: Klebtechnik ? klebgerechte Konstruktionen und Anwendungen in der Praxis. 1. Auflage, Würzburg : Vogel Communications Group, 2018 LOTTER, Bruno: Montage in der industriellen Produktion. 2. Auflage, Berlin Heidelberg New York: Springer-Verlag, 2012 SPUR, Günter: Handbuch Fügen, Handhaben und Montieren. München: Carl Hanser Verlag, 2013. WOLF, Andreas: Grippers in Motion ? The Fascination of Automated Handling Tasks. München: Carl Hanser Verlag, 2018

MA 05

Title	**Model-Based Development**
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr.-Ing. Franz Perschl
Teacher	Prof. Dr.-Ing. Franz Perschl
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 75 % Exercises 0 % Lab Course 25 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Basic knowledge of Matlab/Simulink/Stateflow; Basic knowledge of control theory
Specific Goals	In this lecture students will get profound knowledge about many aspects of model based development of embedded systems and state-of-the-art development methods in various industries like automotive, aerospace and consumer industries. Also, the students will learn to apply basic aspects of modelling and simulating dynamic systems with TheMathworks tool chain. Furthermore they will learn how to use the dSpace tool chain for rapid control prototyping and code generation for embedded systems.
Learning Objectives	. . .
Topics	Definition and basics of model based development Basics on modelling dynamic systems with Simulink dSPACE tool chain (RTI, ControlDesk, Hardware) Aspects of real-time programming / Multivariate control Modelling of discrete states with Stateflow Advanced modelling techniques
Material	Lecture notes
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Angermann, Beuschel, Rau, Wohlfarth: Matlab Simulink - Stateflow; Oldenbourg (in german).

	Lutz, Wendt: Taschenbuch der Regelungstechnik mit Matlab und Simulink; Europa Lehrmittel (in german). Matlab documentation; TheMathworks. dSpace HelpDesk; dSpace. . .

MA 06

Title	**Materials from Renewable Resources**
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr. Johannes Schroeter
Teacher	Prof. Dr. Johannes Schroleter
Language	English
Position in Curriculum	Semi-mandatory course in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Chemistry; Material Science
Specific Goals	Goals Provide knowledge about materials, whose biomass feedstocks are provided by nature annualy. . .
Learning Objectives	Learning Objectives Definitions History of mankind's use of materials from renewable resources (MFRR) Present impact Survey of materials . .
Topics	Statutes, standards, guidelines, certification History of mankind?s use of MFRR (wood, natural fibres, leather, rubber, colourants) Present impact for the environment and for sustainable feedstock supply Survey of materials available (plastics/ non-plastics/ additives) Life cycle analysis . .
Material	Lecture notes, worksheets available as download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt

Literature	Kaplan, D.: Biopolymers from renewable resources. Berlin: Springer 1998 Scheper, T. (ed.): Biopolyesters. Advances in biochemical engineering/ Biotechnology. Vol. 71. Berlin: Springer 2001 Endres, H., Siebert-Raths, A.: Technische Biopolymere. München: Hanser 2009 Fengel, D., Wegener, G.: Wood: Chemistry, Ultrastructure, Reactions. Berlin and New York. Walter de Gruyter 1984 Belgacem, M., Gandini, A.: Monomers, Polymers and Composites from Renewable Resources. Amsterdam: Elsevier 2008 . . . . .

MF Specialist required elective courses

MF 01

Title	**Microelectronics**
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr. Popp
Teacher	Prof. Dr. Popp
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 60 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 0 Lab course (hours) 60 Examination preparation (hours) 15 Total workload (hours) 150
Credits	5
Prerequisites	Working principles of semiconductor devices. DC- and AC-description of MOS- and bipolar-devices. Basic familiarity with SPICE-modelling.
Specific Goals	Enable students to understand the principles of full custom design and fabrication of integrated circuits . .
Learning Objectives	. . .
Topics	Lecture Semiconductor technology (layer growth, doping, masking, mounting). MOS- and BIP- Circuit integration, layout-rules, dimensioning with typical examples. Lab class On-wafer measurements of MOSand BIP-devices and circuits. Electrical characterisation, SPICE-parameter extraction. Mounting and bonding of a small IC. Layout exercises. SPICE-simulations. .
Material	.
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Weste, Eshragian: Principles of CMOS VLSI Design, Addison Wesley, 1994 S. M. Sze: VLSI Technology, John Wiley, New York, 1990

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MF 04

Title	**Applied Didactics**
Semester	ING M1-3
Coordinator	Prof. Dr.-Ing. Franz Perschl
Teacher	dependent on module
Language	German or English, in agreement with the responsible professor / teacher
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 100 % Exercises 0 % Lab Course 0 %
Weekly Hours	2
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 28 Exercise preparation/follow-up (hours) 2 Lab course (hours) 0 Examination preparation (hours) 0 Total workload (hours) 60
Credits	3
Prerequisites	Excellent professional skills of the subjects, the student has to teach. This course 'Applied Didactics' can be chosen only in agreement with the professor / teacher, who is responsible for this lab class or exercise.
Specific Goals	. .
Learning Objectives	A deeper understanding of selected basic engineering topics ('learning by teaching') and of didactic concepts in engineering education. . .
Topics	Depends on selected course for tutorial . .
Material	.
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Depends on selected course for tutorial . . . . .

MF 010

Title	**Electronic Packaging and Manufacturing**
Semester	ING M1-3 (winter term)
Coordinator	Prof. Dr. Matthias Winter
Teacher	Prof. Dr. Matthias Winter
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 80 % Exercises 10 % Lab Course 10 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 50 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 20 Lab course (hours) 10 Examination preparation (hours) 40 Total workload (hours) 150
Credits	5
Prerequisites	.
Specific Goals	Students shall get an overview and understanding about packagaging technologies used for electronic devices as ICs and sensors and the impact of each technology on the system performance and reliability. Furthermore the students should be enabled to integrate electronic devices on system level (second-level assembly). . .
Learning Objectives	Understand basics of material science involved in electronic packaging with focus on reliability Common technologies for mounting integrated circuits and sensor chips on carriers and for providing electrical interconnections. Technologies for substrate configuration, component assembly technology and encapsulation including relevant application examples from state-of-the-art development for consumer and automotive products like MEMS sensors (pressure sesors, gas sensors, microphones).

Topics	Challenges and definitions of microelectronics packaging, IC and MEMS sensors backend manufacturing processes, first-level packaging: Integrated circuit packaging, sensor packaging and interconnection * Lead frames, die bonding * Wire bonding * Flip Chip Technology (FC) * Chip Size Packages (CSP) * Wafer Bonding (WB) * Through Hole Technology (THT) * Area array packages * Ball Grid Arrays (BGA) * Substrates: Organic substrates, Single and multilayer printed circuit boards , Multilayer cofired ceramic technology (HTCC and LTCC) * Polymers * Encapsulation: Molding, Glob Top * Second-level packaging: board assembly processes * Surface Mount Technology (SMT) * Third level: Interconnects and switches * basics of involved material science * manufacturing processes . .
Material	Lecture notes, multimedia presentations
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	R. Tummala: Fundamentals of Microsystem Packaging, McGraw-Hill C. Harper:Electronic Packaging and Interconnection Handbook, Mc Graw Hill . . . .

MF 012

Title	**Satellite Navigation**
Semester	ING M1-3 (winter term)
Coordinator	Prof. Dr. Holger Stahl
Teacher	Dr. Hans L. Trautenberg
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 50 % Exercises 30 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 60 Exercise preparation/follow-up (hours) 30 Lab course (hours) 0 Examination preparation (hours) 30 Total workload (hours) 150
Credits	5
Prerequisites	Basic linear algebra, analysis and statistics. Basics of electrodynamics (wave propagation). Proficiency in a programming language to solve homework problems (mostly linear algebra problems)
Specific Goals	To enable students to assess the applicability of satellite navigation for a given problem . .
Learning Objectives	Understand the principles of satellite navigation Know the limitations of satellite navigation .
Topics	History of satellite navigation, positioning methods, description of orbits, range measurements with CDMA techniques, signal propagation in ionosphere and troposphere, multi path and interference problems, user equivalent range error budget and link budgets, system architecture of satellite navigation systems, GPS overview, Galileo overview, integrity of position solutions, integrity of navigation systems, implementation of navigation algorithms. . .
Material	Lecture notes
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Elliott D. Kaplan: Understanding GPS Principles and Applications, Artech House Publisher

	Bradford W. Parkinson, James J. Spliker: Global Positioning System: Theory and Applications, American Institute of Aeronautics and Astronautics Gilbert Strand, Kai Borre: Linear Algebra, Geodesy, and GPS, Willesly-Cambridge Press B. Hofmann-Wellenhof, H. Lichtenegger, J. Collins: GPS Theory and Practice, Springer . .

MF 014

Title	**Power Electronic Circuit Design**
Semester	ING M1-3 (summer term)
Coordinator	Prof. Dr. Norbert Seliger
Teacher	Prof. Dr. Norbert Seliger
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	2
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 15 Lab course (hours) 0 Examination preparation (hours) 30 Total workload (hours) 90
Credits	3
Prerequisites	Knowledge in power electronics, electrical circuits, semiconductor devices, Matlab/PSPICE basics
Specific Goals	. . .
Learning Objectives	Design of complex power electronic circuits based on specifications. Ability to select the proper topology and calculate and simulate (Matlab, PSPICE) voltage and current transients in power semiconductor elements and passive components. Layout rules for power electronic circuits. Cooling solutions, thermal management. Interfacing with digital signal processing. . .
Topics	Electrical Design: Topology Selection, Circuit Design, Losses in Power Semiconductors, Power Passives (Inductors, Transformers, Capacitors), Simulation (MatLab, PSPICE), Layout, Isolation Coordination Thermal Design: Thermal Impedance, Thermal Management, Reliability Issues, Case studies and Lab experiments .
Material	Lecture notes, worksheets available as PDF downloads
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Mohan: Power Electronic Circuits, Wiley 2003. Schlienz: Schaltnetzteile, Vieweg 2009.

	Shaffer: Fundamentals of Power Electronics with Matlab, Charles River Media, 2007. Yang: Circuit Systems with MatLab and PSPICE, Wiley 2008. Batarseh: Power Electronic Circuits, Wiley 2004. Erickson: Fundamentals of Power Electronics, 2001.

MF 020

Title	**RF and Microwave Systems**
Semester	ING M1-3 (winter term)
Coordinator	Prof. Dr. Paul S.H. Leather
Teacher	Prof. Dr. Paul S.H. Leather
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 50 % Exercises 50 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 65 Lab course (hours) 0 Examination preparation (hours) 25 Total workload (hours) 150
Credits	5
Prerequisites	.
Specific Goals	. . .
Learning Objectives	1. Develop an overall picture of radio and microwave systems, primarily for communications. 2. Understand performance requirements and how they relate to system specifications. 3. Learn about various transceiver architectures, their merits and costs. 4. Derive system specifications from wireless communication standards. 5. Calculate an end-to-end link budget, develop a level plan and create system-level behavioural models. . .
Topics	1. Modulation, Transmitters and Receivers Receiver, transmitter and transceiver architectures RF signals Analogue and digital modulation Interference and distortion Early receiver technology Modern transmitter architectures Modern receiver architectures 2. Antennas and the RF Link RF antennas Radiation from a current filament Resonant antennas Traveling-wave antennas Fundamental antenna parameters The RF link Radio link interference 3. RF Systems Broadcast, simplex, duplex, diplex and multiplex Cellular communications Multiple access schemes Spectrum efficiency Cellular phone systems Generations of radio 4G, fourth generation radio: beyond 3G and LTE family 5G, fifth generation radio: beyond 4G . .

Material	The course is based mainly on reference A, in particular chapters 2-4. Additional material may also be sourced from references B-G. Students should be able to derive their notes from course lectures.
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	A) Steer: Microwave and RF Design (2nd Ed.), Scitech, 2013, ISBN: 978-1-61353-021-4 B) De Los Santos: Radio Systems Engineering, Springer, 2015, ISBN: 978-3-319-07325-5 C) Egan: Practical RF System Design, Wiley-IEEE, 2003, ISBN: 978-0-471-20023-9 D) Bowick: RF Circuit Design, Newnes, 2007, ISBN: 978-0-750-68518-4 E) Hagen: Radio-Frequency Electronics, Cambridge, 1996, ISBN: 978-0-521-88974-2 F) Gharaibeh: Non-linear Distortion in Wireless Systems, Wiley-IEEE, 2012, ISBN: 978-0- 470-66104-8 G) Smaïni: RF Analog Impairments Modeling for Communication Systems Simulation, Wiley, 2012, ISBN: 978-1-119-99907-2 H) McCune: Practical Digital Wireless Signals, Cambridge, 2010, ISBN: 978-0-521-51630-3 . . . . .

MF 022

Title	**Kalman Filtering in Control Systems and Communications Applications**
Semester	ING M1-3 (winter term)
Coordinator	Prof. Dr. B. Mysliwetz, Prof. Dr. M. Stichler
Teacher	Prof. Dr. B. Mysliwetz, Prof. Dr. M. Stichler
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 25 % Exercises 0 % Lab Course 75 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 0 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 60 Lab course (hours) 30 Examination preparation (hours) 30 Total workload (hours) 150
Credits	5
Prerequisites	Familiarity with MATLAB and C (or C++) programming. Course MV01 Advanced Control Systems is strongly recommended. Passing of assessment test is required for admission.
Specific Goals	Enable students to understand the working principles and application areas of recursive estimation methods and to design and implement numerically efficient and stable algorithms for state and parameter estimation. Practial implemementation and analysis is done within a lab project . .
Learning Objectives	* Know application areas of state and parameter estimation approaches * Understand central working principles and algorithms of recursive estimation methods * Be aware of potential numerical problems and the computational load of different mathematical formulations of KF algorithms * Gain hands-on application experience in KF design, filter tuning and embedded implementation . .

Topics	* Introduction Background, Motivation and Application Fields of Kalman Filtering * Mathematical Fundamentals Matrix Algebra Basics, Linear Systems Theory, Discretization * Probability Theory Fundamentals Random Variables, Stochastic Processes, White Noise * State Space Model of a Dynamic System Continuous-Time vs. Discrete Time, State Observer, Observability * Least Squares Estimation * Propagation of States and Covariances * The Discrete-Time Kalman Filter * Alternate Filter Formulations Factorization, Square Root Filters, Nonlinear/Extended Kalman Filter * Special Topics Resolving Numerical/Stability Problems, Filter Tuning * Practical Lab Projects/Exercises e.g.: Positionand Motion-Estimation from Image Pro- cessing Data, Carrier Phase Recovery in a Receiver/Demodulator, Position- and Motion- Estimation for Inertial Navigation . .
Material	Lecture notes, worksheets and lab-class problem descriptions available as PDF download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Simon, Dan: Optimal State Estimation. Kalman, H Infinity, and Nonlinear Approaches. John Wiley & Sons 2006. ISBN-10 0-471-70858-5. Gibbs, Bruce P.: Advanced Kalman Filtering, Least-Squares and Modeling: A Practical Handbook. John Wiley & Sons 2011. ISBN 978-0-470-89004-2 . . . .

MF 023

Title	**Design of Materials**
Semester	ING-M1-3 (winter term)
Coordinator	Prof. Dr. Norbert Seliger
Teacher	Prof. Nicole Strübbe
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 66 % Exercises 0 % Lab Course 33 %
Weekly Hours	3
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 20 Exercise preparation/follow-up (hours) Lab course (hours) 60 Examination preparation (hours) 40 Total workload (hours) 150
Credits	5
Prerequisites	Basic course in polymer chemistry and extrusion
Specific Goals	Goals: The students should learn how to design/achieve specific needed material properties, e.g. corrosion protection, scratch resistance, low shrinkage in thermoplastics, elastomers as well as in paints and coatings. . .
Learning Objectives	Learning Objectives: To gain the knowledge and competence how to use fillers and additives in plastics or how to create material combinations (plastic - plastic, wood - plastic, metal - plastic, etc) to achieve enhanced material/composite properties. . .
Topics	*Definition of terms: additives, pigments, fillers *Additives in General*Polymer Compounds *Fillers: Classification of Fillers, Particle morphology of Fillers, Fillers and their function, Rules of Mixtures, Effect of Filler, Form of Filler, Dispersing and Grinding, Interaction between particles *Methods for particle incorporation *Extrusion *Dissolver *Triple roll mill *High Speed agitator ball mill*Application examples and recipes in thermoplastics, paints and coatings and elastomers *Methods for testing specific filler properties e.g. color, oil absorption; *Methods for testung specific application properties e.g. scratch resistance, corrosion protection; .

Material	Creation of own extruder screw configuration Lecture notes, worksheets and lab-class problem descriptions available as PDF download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	*Füllstoffe, Ceresana: Market Study 2016 *Additives In Polymers: Industrial Analysis And Applications, J. C. J. Bart, 2005 John Wiley & Sons, Ltd ISBN: 0-470-85062-0 *Füllstoffe, Detlef Gysau, 3., überarbeitete Auflage, Hannover: Vincentz Network, 2014, Farbe und Lack // Bibliothek ISBN 3-86630-840-X, ISBN 978-3-86630-840-4 *Polymer Engineering, Peter Eyerer, Thomas Hirth, Peter Elsner, Springer Verlag, Heidelberg, 2008 *Functional Fillers for Plastics, Marino Xanthos, 2. Edition, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2010 *Nanocomposites, Deutsche Forschungsgemeinschaft (DFG), D. Walter, Primary Particles ? Agglomerates ? Aggregates, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2013 *Dispergieren von Pigmenten und Füllstoffen, J. Winkler, Hannover: Vincentz Network, 2010; *Hoffmann Mineral GmbH, www.hoffmann-mineral.com . . . . .

MF 024

Title	**Ceramics and other Sintering materials**
Semester	ING-M1-3 (summer term)
Coordinator	Prof. Dr. Müller
Teacher	Prof. Dr. Müller
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	2
Workload	Lecture/class presence (hours) 15 Lecture follow-up (hours) 15 Exercise preparation/follow-up (hours) 15 Lab course (hours) 15 Examination preparation (hours) 30 Total workload (hours) 90
Credits	3
Prerequisites	.
Specific Goals	Enable students to understand the specific properties and production methods of ceramic materials and the resulting different appications . .
Learning Objectives	. . .
Topics	*powders: properties and production methods * feedstock composition * forming technologies * sintering *mechanical properties: KIc, Weibull-Statistics, life-time prediction *oxide-ceramics * non-oxide-ceramics * functional ceramics * lab-course: manufacturing of ceramics according different methods, determination of properties . .
Material	.
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	. . . . . .

MF 030

Title	**Experimental modeling and simulation**
Semester	ING-M1-3 (summer term)
Coordinator	Prof. Dr. Zentgraf
Teacher	Prof. Dr. Zentgraf
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 100 % Exercises 0 % Lab Course 0 %
Weekly Hours	2
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 0 Exercise preparation/follow-up (hours) 15 Lab course (hours) 30 Examination preparation (hours) 15 Total workload (hours) 90
Credits	3
Prerequisites	no formal Prerequisites, but recommendations are from mathematics linear differential equations, Laplace transformation, vector algebra and MATLAB/Simulink
Specific Goals	methods to describe physical systems mathematically, coding the methods into MATLAB/Simulink, checking of program inputs and outputs . .
Learning Objectives	modelling of physical systems applied to real simple and complcated systems, self-coding of the methods from bottom up and evaluating of results (no click-and-look usage of existing programs) . .
Topics	Principals of physical modelling, experimental meodelling methods, coding of the methods, checking of the methods, application of the methods on real, non-trivial systems . .
Material	Lecture notes
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Kahlert, Jörg, Simulation technischer Systeme, Vieweg, 2004 . . .

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MF 031

Title	**Advanced additive manufacturing**
Semester	ING-M1-3 (summer term)
Coordinator	Prof. Dr. Riß
Teacher	Prof. Dr. Riß
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 100 % Exercises 0 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 0 Exercise preparation/follow-up (hours) 15 Lab course (hours) 30 Examination preparation (hours) 15 Total workload (hours) 90
Credits	5
Prerequisites	CAD FEM Lightweight design
Specific Goals	Designing parts dedicated to additive manufacturing, . .
Learning Objectives	Getting the ability to take the full potemtial of AM parts based on applying the right way of desinging additive manufacturing parts . .
Topics	introdution in additive manufacturing Product development for Additive Manufacturing design rules
Material	Lecture notes
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	. . . . . .

MF 032

Title	**Intellectual Property Protection**
Semester	ING-M1-3 (summer term)
Coordinator	LB Hermann Wagner
Teacher	LB Hermann Wagner
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 100 % Exercises 0 % Lab Course 0 %
Weekly Hours	2
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 0 Exercise preparation/follow-up (hours) 15 Lab course (hours) 30 Examination preparation (hours) 15 Total workload (hours) 90
Credits	3
Prerequisites	none
Specific Goals	The students get an introduction to the use of ideas for their technical product developments they learn the basics fort he successful registration and defense of their industrial property right they can research and evaluate property rights in databases and assess their importance for their own applications; they can prepare patent applications for their inventions
Learning Objectives	. . .
Topics	Overview of the industrial property rights patent, utility model, design and trademark; - search methods for industrial property rights - formulation and registration of industrial property rights; - effect and scope of protection of industrial property rights; - appeal for industrial property rights - measures against infringements of property rights; - economic significance and utilization of property rights (innovations management); - inventor rights for employees; - copyright in the field of science and technology
Material	lecture notes available as download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	lecture notes

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MF 033

Title	**Heat Transfer**
Semester	ING-M1-3 (summer term)
Coordinator	Prof. Dr. S. Stanzel
Teacher	Prof. Dr. S. Stanzel
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 70 % Exercises 30 % Lab Course 0 %
Weekly Hours	2
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 15 Lab course (hours) Examination preparation (hours) 15 Total workload (hours) 90
Credits	3
Prerequisites	basic principles of heat transfer mechanisms and basics of fluid mechanics, partial differential equations
Specific Goals	Knowledge and application of heat transfer mechanisms with regard to technical applications . .
Learning Objectives	Know heat transfer mechanisms and assign them to technical applications, solve heat transfer problems, analyze applications with regard to heat transfer . .
Topics	heat conduction: steady state and transient, one dimensional and selected multidimensional, with different boundary conditions heat transfer by convection and radiation applications: fin design, heat exchanger design
Material	see literature
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Lienhard, J.H., A Heat Transfer Textbook, Phlogiston Press 2019 . . . . .

MF 034

Title	**Applied numerical methods for mechanical engineering**
Semester	ING-M1-3 (summer term)
Coordinator	Prof. Dr. F. Riss
Teacher	Prof. Dr. F. Riss, Prof. Dr. F. King
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 100 % Exercises 0 % Lab Course 0 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 30 Lab course (hours) 30 Examination preparation (hours) 30 Total workload (hours) 150
Credits	5
Prerequisites	Engineering mechanics (statics, strength of materials, dynamics), basic knowledge in machine dynamics, mathematic basics (matrix/vector calculus, differential equations),
Specific Goals	Mechanical engineering and CAE tools have a close link to applications, but do not provide any further information about the methods necessary in the background to solve the related engineering problems (every tool is a sort of ?black box?). On the other hand, classical engineering mathematics is marked with proofs, abstract thinking and no link to any engineering application. . Within this lecture students will learn to apply methods of numerical mathematics to solve mechanical problems from the field of gearing mechanism, robots, dynamic of machines, kinematics,? by use of widespread numerical tools like MATLAB.
Learning Objectives	Acquire the ability to apply methods of numerical mathematics to solve mechanical problems i.a. form the field of machine dynamics and get a basic understanding of the underlying numerical methods. . .
Topics	Coordinate transformations, numeric matrix calculus and eigenvalue / eigenvector problems, solution of higher-dimensional linear and non-linear systems of equations (i.a. from the field of mechanic frame structures), numerical solution of problems from machine dynamics or multibody systems (i.a. ordinary differential equations, oscillations of rigid body systems). . .

Material	Lecture notes, hardcopies and/or PDF download files. MATLAB m-files for lab course.
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	· MATLAB und SIMULINK - Beispielorientierte Einführung in die Simulation dynamischer Systeme", J. Hoffmann, Addison-Wesley 1999 · H. Kerkele, R. Pittschellis, "Einführung in die Getriebelehre", Teubner Verlag 1998 · "Maschinendynamik", H. Ulbrich, Teubner Studienbücher (Mechanik) 1996 . . .

MF 036

Title	**Trajectory Planning for Robots and Automatic Machines**
Semester	ING-M1-3 (summer term)
Coordinator	Prof. Dr. King
Teacher	Prof. Dr. King
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 60 % Exercises 20 % Lab Course 20 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 50 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 30 Lab course (hours) 20 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Fundamentals of linear algebra (vectors, matrices, coordinate systems). Fundaments of control engineering and Fourier analysis.
Specific Goals	Enable students to generate desired paths and trajectories for robots and multi-axes mechatronic systems. Analyze the resulting trajectory with regard to its basic properties and the tendency to generate oscillations.
Learning Objectives	Describe robots and other mechatronic systems with one or more axes with regard to the kinematic structure using multiple coordinate systems. Generate different types 1D desired trajectories for the movement of 1D systems. Generate path and trajectory for Cartesian and point-to-point movement of robots and multi-axes systems as an input to the servo control system. Simulate, visualize and analyze the generated trajectories and paths using Matlab.
Topics	Necessary fundamentals of robotic theory: introduction to robotics, kinematics (translational, rotational). Introduction to trajectory and path planning. 1D trajectory planning: basic motion profiles, composition of motion profiles, multi-point trajectories, dynamic analysis of trajectories. Multi-dimensional trajectories and path planning: point-to-point movement based on motion profiles, Cartesian movement in 2D and 3D space including orientation interpolation.
Material	Lecture notes, worksheets and lab course problem descriptions available as PDF for download; Matlab files to demonstate examples.

Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	R.N. Jazar: "Theory of Applied Robotics", Springer, 2010. L. Biagiotti, C. Melchiorri: "Trajectory Planning for Automatic Machines and Robots", Springer, 2008.

MF 037

Title	**Chemistry of renewable resources**
Semester	ING-M1-3 (summer term)
Coordinator	Prof. Dr. List / Prof. Dr. Pentlehner
Teacher	Prof. Dr. List / Prof. Dr. Pentlehner
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 75 % Exercises 0 % Lab Course 25 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 45 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 15 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	basic knowledge in chemistry
Specific Goals	overview and knowledge about the chemistry of renewable resources. Different types of resources, pathways, applications.
Learning Objectives	definitions, advantage and disadvantages compared to fossil raw materials, pathways for renewable resources, applications
Topics	· Biorefinary: from renewable resources to chemicals and pharmaceeuticals · Chemical modifications of chemicals from renewable resources, e.g. Celluloseacetate, ? · Bulk chemicals from renewable resources · Biopolymers · Fats and oils · Carbohydrates · Lignin · Amino acids and proteins Others, e.g. terpenoids, vitamins
Material	lecture notes available as download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	specific literature for each chapter

MF 038

Title	**Chemical H2 Conversion: Applications and industrial processes**
Semester	ING-M1-3 (winter term)
Coordinator	Prof. Dr. Völkl
Teacher	Prof. Dr. Völkl
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 50 % Exercises 25 % Lab Course 25 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 30 Lab course (hours) 30 Examination preparation (hours) 30 Total workload (hours) 150
Credits	5
Prerequisites	basic knowledge in chemistry, thermodynamics and (process) modelling
Specific Goals	Students should get in-depth knowledge of Hydrogen conversion processes
Learning Objectives	Understand the different routes for Hydrogen conversion based on desired products and origin of hydrogen Understand the material cycle of the chemical industry and bring this in context to new developments Compare different routes based on economical and sustainability quality parameters Analyze the different proceses to get all reactants for the conversion processes beside Hydrogen Deepen the understanding of Hydrogen conversion processes by working on an individual case study of a selected example of a Hydrogen conversion process
Topics	· overview of Hydrogen conversion processes · overview of the material cycle of the chemical industry · overview of different sources for all important components of the material cycle · Introduction of economical and sustainability performance indicators · Comparision of different routes of hydrogen conversion processes · Individual case study on a selected example of a hydrogen conversion process
Material	lecture notes available as download files

Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	Specific literature for each chapter, current papers.

MF 039

Title	**International Master Summer School**
Semester	ING-M1-3 (summer term)
Coordinator	Prof. Dr.-Ing. Franz Perschl
Teacher	Prof. Dr.-Ing. Fabian Riß
Language	English
Position in Curriculum	Technical elective course in ING-Master
Course Type	Lecture 50 % Exercises 25 % Lab Course 25 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 40 Lecture follow-up (hours) 50 Exercise preparation/follow-up (hours) 20 Lab course (hours) 20 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	Basic knowledge in 3D-CAD
Specific Goals	Basic concept of this course is to transmit short overviews and insights into today´s tools and methods transitioning fast to practical examples in personal exercises and workshops. The examples origin from actual situations or compressed typical situations in industrial use. Students gain basic knowledge on Additive Manufacturing Technologies. Based on practical design and manufacturing lessons in the workshop, all participants get in direct contact with the total process chain.
Learning Objectives	- understand and experience data analysis methods and practical use of artificial intelligence - transfer the ideas of Lean Management to different corporate sectors of producing units - classify and evaluate occurring industrial situations into change and future proof concepts - obtain insights into the concept of emission trading and its challenges - develop an understanding of what does it take to be a successful leader in international setting. - Understand the basic terminology and processes of Additive Manufacturing - utilize methods in design for layer-wise technology - recognize the complete end-to-end process - understand the challenges of designing parts and operating machines.
Topics	- Digital Technologies - Artificial Intelligence Basics - Lean Managment - EU Emissions Trading - Gear Design - Additive Production Technology - Construction of parts - Manufacturing - Quality Management - Post-Processing - Assembly and Testing

Material	
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	- Balsliemke/Behrens (2019): Lean Administration - Bertagnolli F. (2018): Lean Management - Burgess, Andrew (2020): The Executive Guide to Artificial Intelligence - Kollmann, Tobias (2019): E-Business - Radzevich S. (2016): Dudley's Handbook of practical gear design and manufacture, CRC Press - Whetten/Cameron (2015): Developing Management Skills - Gibson, Ian (2015): Additive manufacturing technologies - 3D printing, rapid prototyping, and direct digital manufacturing. New York, NY [u.a.], Springer. ISBN: 978-1-4939-2113-3,978-1-4939-2112-6. - Diegel, Olaf, Nordin, Axel, Motte, Damien (2020): A Practical Guide to Design for Additive Manufacturing. Singapore, Springer Singapore. ISBN: 978-981-3294-33-2. - Gebhardt, A. (2011): Understanding additive manufacturing - rapid prototyping, rapid tooling, rapid manufacturing. Munich, Hanser. ISBN: 978-3-446-43162-1,978-3-446-42552-1.

MF 042

Title	**Homogeneous Catalysis**
Semester	ING-M1-3 (winter term)
Coordinator	Prof. Dr. Pentlehner
Teacher	Prof. Dr. Pentlehner
Language	English
Position in Curriculum	Technical elective course in ENG-Master
Course Type	Lecture 50 % Exercises 0 % Lab Course 50 %
Weekly Hours	4
Workload	Lecture/class presence (hours) 30 Lecture follow-up (hours) 30 Exercise preparation/follow-up (hours) 40 Lab course (hours) 30 Examination preparation (hours) 20 Total workload (hours) 150
Credits	5
Prerequisites	profound knowledge in chemistry
Specific Goals	overview and knowledge about the catalytic methodes in chemistry, e.g. hetergenous, homogeneous, transition metal catalysis or organocatalysis. Understanding of the working principle (reaction mechanism) of homogeneus catalysist. Ability to run experiments under inert atmosphere. . .
Learning Objectives	definitions, advantage and disadvantages compared to other cataylic methods. Reaction mechanisms and experimental setups for homogenoeus catalysis. . .
Topics	· overview catalytic methods · organometal-chemistry and transition metal catalysis · organocatalysis · stereoselective reactions · Photocatalysis
Material	lecture notes available as download files
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	specific literature for each chapter overview: Breitmaier, E., Jung, G.: Organic Chemistry; Thieme . .

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MP Master's project, Master's thesis

MP 01

Title	Master's project
Semester	ING-M1-3 (winter and summer term)
Coordinator	Prof. Dr.-Ing. Franz Perschl
Teacher	Professor as advisor
Language	English
Position in Curriculum	Mandatory subject in ENG-Master
Course Type	Lecture 0 % Exercises 0 % Lab Course 100 %
Weekly Hours	18
Workload	Lecture/class presence (hours) 0 Lecture follow-up (hours) 0 Exercise preparation/follow-up (hours) 0 Lab course (hours) 360 Examination preparation (hours) 0 Total workload (hours) 360
Credits	12
Prerequisites	none, but some projects require competences from specialization modules
Specific Goals	To learn to apply project management methods and to train team working skills; in a close-to-real-life situation students shall experience what it means to systematically analyze and plan a project, to organize themselves and to cooperate in a team and to deliver results within the planned deadline. . .
Learning Objectives	. . .
Topics	Case study project that typically deals with a real-world problem assigned by industry or proposed by professors; project is carried out by a team of 4-6 students and coached by one or two professors. The project has to be carried out in the laboratories of the university .
Material	project related
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	project related . .

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MP 02

Title	**Master Thesis**
Semester	ENG M2 at the earliest (winter or summer term)
Coordinator	Prof. Dr.-Ing. Franz Perschl
Teacher	2 professors as advisors
Language	English / German
Position in Curriculum	Mandatory subject in ENG-Master
Course Type	Lecture 0 % Exercises 0 % Lab Course 100 %
Weekly Hours	24
Workload	Lecture/class presence (hours) 0 Lecture follow-up (hours) 0 Exercise preparation/follow-up (hours) 0 Lab course (hours) 720 Examination preparation (hours) 30 Total workload (hours) 750
Credits	24+1
Prerequisites	none
Specific Goals	Final project at an engineer?s qualification level; carried out by an individual student on his/her own with two professors as advisors either at Rosenheim University of Applied Sciences or at an industrial company . .
Learning Objectives	. . .
Topics	Depending on student?s selection and availability . .
Material	project related
Examination	Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published from Prüfungsamt
Literature	project related . . . . .

A Declaration of Originality/Eigenständigkeitserklärung

A.1 Declaration

Note that some written documentation (master's project report, coursework) would need a declaration of originality placed immediately after the title page.

Hiermit bestätige ich, dass ich die vorliegende Arbeit selbständig verfasst und keine anderen als die angegebenen Hilfsmittel benutzt habe. Die Stellen der Arbeit, die dem Wortlaut oder dem Sinn nach anderen Werken (dazu zählen auch Internetquellen) entnommen sind, wurden unter Angabe der Quelle kenntlich gemacht.

I declare that I have authored this thesis independently, that I have not used other than the declared sources / resources, and that I have explicitly marked all material which has been quoted either literally or by content from the used sources.

Place, Date: ________________________________ *Signature:* ________________________________

A.2 Electronic Workflow

The complete process of registration and submission of your thesis is supported by an electronic workflow. Details can be found by following this link:

`https://www.th-rosenheim.de/en/home/information-for/students/organise-your-studies/theses/`

B Guidelines for the preparation of final theses at the Faculty of Engineering

Before writing your final thesis, consider the "Guidelines", which can be found at the following link:
`https://www.th-rosenheim.de/die-hochschule/fakultaeten-institute/fakultaet-fuer-ingenieurwissenschaften/regularien/`