UNIVERSITÄT
DUISBURG
ESSEN

Syllabus Book

Bachelor of Science
Material Technology

Version: 01.10.2005

				V	Ü	P	S	Cr
Bachelor of Science in Material Technology				**75**	**37**	**17**	**0**	**174**

1.	**General Chemistry**	Mayer	*e*	2	1	0	0	4
	Introduction to CAx	Hunger Köhler	*e*	0	0	2	0	3
	Fundamentals of Computer Engineering 1	Hunger	*e*	2	1	0	0	4
	Fundamentals of Electrical Engineering 1	Pertz	*e*	2	1	0	0	4
	Interdisciplinary Labs	NN	*e*	0	0	2	0	2
	Mathematics 1	Gottschling	*e*	4	2	0	0	7
	Mechanics 1	Braun Kecskemethy	*e*	2	1	0	0	4
	Non-Technical Subject 1	NN		2	0	0	0	2
			Summe:	**14**	**6**	**4**	**0**	**30**

2.	**Computer Based Problem Solving**	Gottschling Weyh	*e*	0	0	2	0	2
	Fundamentals of Computer Engineering 2	Heisel	*e*	2	1	0	0	4
	Fundamentals of Electrical Engineering 2	Pertz	*e*	2	1	0	0	4
	Design Theory 1	Mauk	*e*	1	1	0	0	3
	Mathematics 2	Gottschling		3	2	0	0	6
	Mechanics 2	Braun Kecskemethy	*e*	2	1	0	0	4
	Non-Technical Subject 2	NN		2	0	0	0	2
	Physics	Franke	*e*	2	1	1	0	5
			Summe:	**14**	**7**	**3**	**0**	**30**

3.	**Anorganic Chemistry**	Geismar		2	0	1	0	3
	Metal Physics 1	Weiß	*d*	2	0	0	0	2
	Design Theory 2	Mauk	*e*	2	2	0	0	5
	Mathematics C2 (Numerical Mathematics)	Schreiber	*e*	2	2	0	0	6
	Statistics for Engineers	Gottschling	*d*	1	1	0	0	3
	Thermodynamics 1	Atakan	*e*	2	1	0	0	4
	Materials Science 1	Fischer	*d*	4	0	1	0	5
			Summe:	**15**	**6**	**2**	**0**	**28**

4.	**Computer Based Engineering Mathematics**	Gottschling		1	1	1	0	4
	Metal Physics 2	Weiß	*d*	2	0	1	0	4
	Fundamentals of Metallurgie	Deike	*d*	1	1	1	0	4
	Design Theory 3	Mauk	*e*	2	2	0	0	5
	Non-Technical Subject 3	NN		2	0	0	0	2
	Non-Technical Subject 4	NN		2	0	0	0	2
	Non-Technical Subject 5	NN		2	0	0	0	2
	Physical Chemistry	Mayer	*d*	2	0	1	0	3
	Materials Science 2	Nowack	*d*	2	0	1	0	4
			Summe:	**16**	**4**	**5**	**0**	**30**

5.	**Iron Making**	Deike	*d*	2	1	0	0	4
	Non-Technical Subject 6	NN		2	0	0	0	2
	Theory of Plasticity	Mauk	*d*	2	1	0	0	4
	Project or 2 Electives			0	6	0	0	6
	Steelmaking 1	Deike	*d*	2	1	0	0	4
	Metal Forming 1	Mauk	*d*	2	1	1	0	5
	Heat Transfer	Bauer	*d*	2	0	0	0	2
			Summe:	**12**	**10**	**1**	**0**	**27**

6.	**Bachelor Thesis**	NN		0	0	0	0	15
	Fundamentals of High Temperature Technology	Bauer	*d*	1	1	0	0	3
	Non Ferrous Metallurgy	Dette	*d*	1	1	0	0	3
	Steelmaking 2	Deike	*d*	1	1	1	0	4
	Metal Forming 2	Mauk	*d*	1	1	1	0	4
			Summe:	**4**	**4**	**2**	**0**	**29**

Description of the degree course

name of the degree course			shorthand expression of degree course
Bachelor of Science in Material Technology			
type	**period of study**	**SWS**	**ECTS-Credits**
Bachelor	6	129	174

description

The Bachelor degree course in Material Technology provides general engineering training in the areas of applied material technology of metallic and inorganic-non-metallic materials as well as an in depth knowledge in application areas. The students have the ability to solve interdisciplinary, engineer proportionate problems by way of subject and system comprehensive lectures.

The broad basic training enables on the one hand the ability to take up occupations as an engineer in several different fields of technical applications which were normally carried out by engineers from the fields of process engineering or mechanical engineering or inorganic chemistry. On the other hand the education satisfies the particularly high demands and requirements of industrial practice, especially in the following fields:

- Development of materials and processes for production in companies;
- Engineering (conception, planning, project development) of material specific concept formulations in all application areas (e.g. process engineering, production engineering, automotive, primary industry) in user- or service provider-companies;
- Maintenance tasks in production.

Modul- und lecture catalogue

modul name	shorthand expression of module
Applied Engineering Science	
course coordinator	**faculty**
Prof. Dr.-Ing. Paul Josef Mauk	-
used in degree course	
• Bachelor of Science in Material Technology	

nr	courses	semester	sws	workload	ECTS-credits
1	Fundamentals of High Temperature Technology	6	2	90	3
2	Heat Transfer	5	2	60	2
3	Materials Science 1	3	5	150	5
4	Materials Science 2	4	3	120	4
total			**12**	**420**	**14**

description:
The module applied engineering sciences comprises advanced lectures in material science, heat transfer and fundamentals of high temperature technology. It contains the basics of materials, their mechanical properties and the technologies for influencing the properties of materials. The lectures about heat transfer and high temperature technology contains the use of this technology in metallurgy and heat treatment of metallic and inorganic non-metallic materials with special respect to industrial furnace technology.

modul name	shorthand expression of module
Applied Engineering Science	
lecture name	**shorthand expression of lecture**
Fundamentals of High Temperature Technology	
lecturer	**department**
Prof. Dr.-Ing. Wolfgang Bauer	

semester	cycle	language	requirements
6		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	60	90	3

description
Introduction; Heating, reheating, and heat-treatment facilities; Reactions of furnace gases with metals; thermo chemical heat-treatment; Protection and reaction gases; Fuels, combustion, burner; Pollutants with high temperature processes; Electrical heating procedures; Energy balance and process efficiencies; Heat losses in high temperature plants; Modes of operation of industrial furnaces; Examples of reheating furnaces; Examples of heat-treating furnaces;
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
• Brunklaus; Stepanek: Industrieöfen, Bau und Betrieb 5. Auflage; Vulkan-Verlag, Essen 1986 • Trinks; Mawhenney: Industrial Furnaces (2 Bände) 4. Auflage; Wiley Verlag, New Qork 1967 • Hinweise auf russische Literatur auf Anfrage
remark

modul name	shorthand expression of module
Applied Engineering Science	
lecture name	**shorthand expression of lecture**
Heat Transfer	
lecturer	**department**
Prof. Dr.-Ing. Wolfgang Bauer	

semester	cycle	language	requirements
5		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description

Introduction Thermal conduction: stationary/intermittent; Heat guidance factor, temperature conductivity; Thermal conduction of different materials; Computation models stationary/intermittent; Thermal conduction in high temperature plants; Similitude theory, similarity indices; Convection: laminar/turbulent current, natural convection, heat transmission coefficient, convection in high temperature plants; Radiation: Laws, grey/spectral radiation, radiation characteristics, computation models, radiation in high temperature plants, greenhouse effect as example of spectral radiation heat transfer in pouring heat-transfer agents: Recuperator/regenerators total heat transfer

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

• Gröber; Erk; Grigull: Die Grundgesetze der Wärmeübertragung
3. Auflage, Verlag Springer, Berlin 1988
• Baehr; Stephan: Wärme- und Stoffübertragung
3. Auflage, Verlag Springer, Berlin 1998
• Schack: Der industrielle Wärmeübergang
7. Auflage, Verlag Stahleisen, Düsseldorf 1969
• Schlünder; Martin: Einführung in die Wärmeübertragung
8. neubearb. Auflage, Verlag Vieweg, Braunschweig 1995
• Chawla; Wiskot: Wärmeübertragung
Verlag VDI, Düsseldorf 1992
• Merker; Eiglmeier: Fluid- und Wärmetransport, Wärmeübertragung
Verlag Teubner, Stuttgart 1999

remark

modul name	shorthand expression of module
Applied Engineering Science	
lecture name	**shorthand expression of lecture**
Materials Science 1	
lecturer	**department**
Prof. Dr.-Ing. Alfons Fischer	

semester	cycle	language	requirements
3		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
5	75	75	150	5

description
Based on materials properties the context of quality and manufacturing in discussed. The Fe-C-System is presented in detail.
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
·1 Bargel/Schulze; Werkstoffkunde, Springer-Verlag ·2 Bergmann; Werkstofftechnik, Carl Hanser Verlag ·3 Hornbogen; Werkstoffe, Springer Verlag ·4 Schatt, Worch; Werkstoffwissenschaft, Germaner Verlag für Grundstoffindustrie
remark

modul name	shorthand expression of module
Applied Engineering Science	
lecture name	**shorthand expression of lecture**
Materials Science 2	
lecturer	**department**
Prof. Dr.-Ing. Horst Nowack	

semester	cycle	language	requirements
4		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
Based on the lecture Werkstoffe I by Prof. Fischer, the practical application of materials in various fields of mechanical engineering will be considered. The basic materials characteristics as well as the demands of engineering application will be outlined. High strength metallic materials (steel, Al-, Mg-, Ti- alloys), composite materials and ceramics will be presented.
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
·1 E. Hornbogen: Werkstoffe ·2 E. Haibach: Betriebsfestigkeit ·3 K. Schwalbe: Bruchmechanik ·4 Leitfaden der Betriebsfestigkeit VdeH ·5 FKM-Richtlinie ·6 Bergmann
remark

modul name	shorthand expression of module
Computer Engineering	
course coordinator	**faculty**
Prof. Dr.-Ing. Axel Hunger	-

used in degree course

- Bachelor of Science in Computer Engineering
- Bachelor of Science in Computer Science and Communications Engineering
- Bachelor of Science in Control and Information Systems
- Bachelor of Science in Electrical and Electronic Engineering
- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Material Technology

nr	courses	semester	sws	workload	ECTS-credits
1	Fundamentals of Computer Engineering 1	1	3	120	4
2	Fundamentals of Computer Engineering 2	2	3	120	4
total			**6**	**240**	**8**

description:

This module covers the fundamentals of computer science necessary for the design and the analysis of hardware. The design and the analysis on the sides of software- as well as on the sides of hardware-implementation are herewith considered.

modul name	shorthand expression of module
Computer Engineering	
lecture name	**shorthand expression of lecture**
Fundamentals of Computer Engineering 1	
lecturer	**department**
Prof. Dr.-Ing. Axel Hunger	

semester	cycle	language	requirements
1		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description

This course covers the fundamentals of computer science necessary for design and analysis of hardware. The topics include Boolean algebra, basic minimization methods, coding of information, arithmetic and logic functions with binary codes, design of digital circuits (combinational and sequential) as well as basics of automata and microprogramming. Based on Boolean algebra and information coding, the functions of gates and similar components of digital circuits are explained. These components are used to design more complex functions up to the modules required for the set up of a basic microcomputer.

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

·1 Roth, Charles: Fundamentals of Logic Design, PWS Publ., 2001 Boston, 45YGQ4426
·2 Green, Derek C: Digital Electronics,Longman, 2002 Harlow, 45YGQ4434
·3 Milos Ercegovac, Tomas Lang, Jaime H. Moreno: Introduction to Digital Systems, John Wiley & Sons Inc, 1999 New York, 45YGQ1436
·4 Ronald J. Tocci: Digital Systems: Principles and Applications, Prentice Hall, 1977 New Jersey, 43YGQ1436
·5 John Crisp: Introduction to Digital Systems, Newnes, 2000 Oxford, 45YGQ4141
·6 Judith L. Gersting: Mathematical Structures for Computer Science, W.H. Freeman and Company, 1982, New York, San Francisco, 01TVA1033 , 07TVA1033 , 45TVA1033
·7 Frederick J. Hill, Gerald R. Peterson: Introduction to Switching Theory and Logical Design, John Wiley & Sons Inc., 1974 Canada, 43YGQ175

remark

modul name	shorthand expression of module
Computer Engineering	
lecture name	**shorthand expression of lecture**
Fundamentals of Computer Engineering 2	
lecturer	**department**
Prof. Dr. rer. nat. Maritta Heisel	

semester	cycle	language	requirements
2		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
- Notion of algorithm - Functional vs. imperative paradigm - Notation for algorithms - Specification notation for algorithms - Method for developing correct algorithms - Transforming algorithms into programs - Analyzing the complexity of algorithms - Notion of abstract data type (ADT) - Examples of simple ADTs
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
David Gries: The Science of Programming, Springer-Verlag, 1981. Bertrand Meyer: Object-Oriented Software Construction, Prentice Hall, 1997.
remark

modul name	shorthand expression of module
Electrical Engineering	
course coordinator	**faculty**
Prof. Dr.-Ing. Klaus Solbach	-

used in degree course

- Bachelor of Science in Computer Engineering
- Bachelor of Science in Computer Science and Communications Engineering
- Bachelor of Science in Control and Information Systems
- Bachelor of Science in Electrical and Electronic Engineering
- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Material Technology

nr	courses	semester	sws	workload	ECTS-credits
1	Fundamentals of Electrical Engineering 1	1	3	120	4
2	Fundamentals of Electrical Engineering 2	2	3	120	4
total			**6**	**240**	**8**

description:

The module introduces fundamental methods of network analysis and first considerations of field theoretical methods, which is important for later modules. Secondly, application oriented questions concerning solid state circuits and electric machines and energy transport are discussed with a view to ready application to practical problems of mechanical engineers and material technologists.

modul name	shorthand expression of module
Electrical Engineering	
lecture name	**shorthand expression of lecture**
Fundamentals of Electrical Engineering 1	
lecturer	**department**
Dr.-Ing. Oliver Pertz	

semester	cycle	language	requirements
1		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
The first semester of this two semester course deals with three main topics. First, simple dc circuit elements are introduced (Sources, resistors) and methods for circuit analysis are taught (e.g. node and loop method). After that, amplifiers are introduced and various important circuits for operational amplifiers are discussed. At the end of the semester, ac circuit analysis and ac circuit elements like inductances and capacitors are introduced. Complex analysis is used for solving ac problems with sinusoidal voltages.
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
S.E. Schwarz, W. G. Oldham: Electrical Engineering: An Introduction ISBN 0195105850 List price: USD 102
remark

modul name	shorthand expression of module
Electrical Engineering	
lecture name	**shorthand expression of lecture**
Fundamentals of Electrical Engineering 2	
lecturer	**department**
Dr.-Ing. Oliver Pertz	

semester	cycle	language	requirements
2		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
"Fundamentals of Electrical Engineering" is a two semester course in the field of Electrical Engineering for the students of the first and second semester. The second semester continues with the ac circuit analysis already started with in the first semester. After that basic transistor and diode circuits are introduced and explained. At the end of the semester a brief introduction into electric machines and transformers finishes the second semester.
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
S.E. Schwarz, W. G. Oldham: Electrical Engineering: An Introduction ISBN 0195105850 List price: USD 102
remark

modul name	shorthand expression of module
Fundamental Labs	
course coordinator	**faculty**
Prof. Dr.-Ing. Axel Hunger	-

used in degree course

- Bachelor of Science in Computer Engineering
- Bachelor of Science in Computer Science and Communications Engineering
- Bachelor of Science in Control and Information Systems
- Bachelor of Science in Electrical and Electronic Engineering
- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Material Technology

nr	courses	semester	sws	workload	ECTS-credits
1	Computer Based Problem Solving	2	2	60	2
2	Interdisciplinary Labs	1	2	60	2
3	Introduction to CAx	1	2	90	3
total			**6**	**210**	**7**

description:

The labs contained in this module should impart the basic knowledge of and abilities in general dealing with computers, in computer-aided development and the deportment-comprehensive subjects beyond that.

modul name	shorthand expression of module
Fundamental Labs	
lecture name	**shorthand expression of lecture**
Computer Based Problem Solving	
lecturer	**department**
Prof. Dr. rer. nat. Johannes Gottschling Dr.-Ing. Bernhardt Weyh	

semester	cycle	language	requirements
2		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
·1 Pratap, R.: Getting Started with MATLAB 6. A Quick Introduction for Sci-entists and Engineers. Oxford University Press, New York-Oxford 2002 ·2 Überhuber, C., Katzenbeisser, S.: MATLAB 6, eine Einführung. Springer Verlag, Wien New York 2000
remark

modul name	shorthand expression of module
Fundamental Labs	
lecture name	**shorthand expression of lecture**
Interdisciplinary Labs	
lecturer	**department**
NN	

semester	cycle	language	requirements
1		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description
During the Interdisciplinary Lab the students get a general idea in the research fields of each department of the faculty of engineering disciplines. The students can choose 5 experiments out of the offer, where at least one experiment from each department should be chosen. By this the students have the chance to set up their priorities and get at the same time an overview over the research fields.
kind of examination
literature
Script
remark

modul name	shorthand expression of module
Fundamental Labs	
lecture name	**shorthand expression of lecture**
Introduction to CAx	
lecturer	**department**
Prof. Dr.-Ing. Axel Hunger Prof. Dr.-Ing. Peter Köhler	

semester	cycle	language	requirements
1		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	60	90	3

description

The Lab Exercise will give an introduction into the possibilities of computer aided development in general. It consists of two parts. The first part is an introduction to the computer aided Design (CAD), in particular the creating of technical drawings with the CAD-system MegaCAD. The second half covers computer aided development of digital circuits. The software Workview will be used to draw and simulate logical circuits such as code converters, adders and counters.

kind of examination

literature

·1 Krulikowski, A.: Fundamentals of Geometric Dimensioning and Tolerancing.Delmar Learning,2 edition (1997).
·2 Hoischen: Technisches Zeichnen. Cornelson-Verlag.
·3 Köhler, P.: Moderne Konstruktionsmethoden im Maschinenbau. Vogel Buchverlag. Würzburg 2002
·4 http://www.megacad.de/download/index.htm

remark

modul name	shorthand expression of module
Engineering Fundamentals	
course coordinator	**faculty**
Prof. Dr.-Ing. Paul Josef Mauk	-
used in degree course	
• Bachelor of Science in Material Technology	

nr	courses	semester	sws	workload	ECTS-credits
1	Design Theory 2	3	4	150	5
2	Design Theory 3	4	4	150	5
3	Thermodynamics 1	3	3	150	5
total			**11**	**450**	**15**

modul name	shorthand expression of module
Engineering Fundamentals	
lecture name	**shorthand expression of lecture**
Design Theory 2	
lecturer	**department**
Prof. Dr.-Ing. Paul Josef Mauk	

semester	cycle	language	requirements
3		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
4	60	90	150	5

description

Contents of this lecture are the breakable shaft-hub connections in mechanical design, like the shape and frictional fits. This is followed by the not breakable shaft hub connections with special emphasis of the shrink and press fits as well as the welded joints and the welding procedures for most diverse metallic materials. The further topics of the lecture are the fundamentals for axles, shafts and hubs as well as the methods for the computation of the shaft geometry and the shaft deformations under combined load as well as the strength for a given load condition also under kinematics conditions. Friction and lubrication with a systematic treatment of the lubricants and the lubrication theory leads the principles for the different bearing designs further on to roller and sliding bearings with its different characteristics, its construction, their computation of load-carrying capacity and endurance as well as. Rotary and stationary sealing are the last topic of the lecture.

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

Literaturempfehlung (German):
·1 G. Niemann, H. Winter, B.-R. Höhn,Maschinenelemente Band 2,3, Springer-Verlag, Berlin, 2001, ISBN 3-540-65816-5
Literaturempfehlung (English):
·2 J. E. Shigley, C.R. Mischke, Standard Handbook of Machine Design, McGraw Hill, New York, 1996, ISBN 0-07-056958-4

remark

modul name	shorthand expression of module
Engineering Fundamentals	
lecture name	**shorthand expression of lecture**
Design Theory 3	
lecturer	**department**
Prof. Dr.-Ing. Paul Josef Mauk	

semester	cycle	language	requirements
4		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
4	60	90	150	5

description

Contents of this lecture are the technical springs, cooperating and vibration response of technical springs and the design of such spring systems for technical applications. Form a further point gear wheel and gears with the teeth laws and tooth types as well as the kinematic and static-dynamic conditions of the load of transmission teeth. The relevant interpretation standards as well as the technically important gearbox failure follow. Clutch and brakes than represent a further topic stare and adjustable systems for braking and connecting rotating motion. The oil transmissions than form a further topic -, chain, flat and v-belt drives as well as synchronous belt drives for technical applications. Pipes, piping and hydraulic accumulators with their mechanical loads under internal pressure and load by transported media form a further part of the meeting. The application of different interpretation principles is represented by the example of the crank gears with the kinetics and dynamics of the crank gear of the relevant load of the elements by the example of applications of presses and shears. Special designs of the crank gear in form of crank gear systems put on such as knee levers and drive shaft crank gears form the conclusion of the lecture.

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

Literaturempfehlung (German):
·1 G. Niemann, H. Winter, B.-R. Höhn: Maschinenelemente Band 2,3: Springer-Verlag, Berlin, 2001, ISBN 3-540-65816-5

Literaturempfehlung (English):
·2 J. E. Shigley, C.R. Mischke: Standard Handbook of Machine Design, McGraw Hill, New York, 1996, ISBN 0-07-056958-4

remark

modul name	shorthand expression of module
Engineering Fundamentals	
lecture name	**shorthand expression of lecture**
Thermodynamics 1	
lecturer	**department**
Prof. Dr. rer. nat. Burak Atakan	

semester	cycle	language	requirements
3		English	helpful: Mathematics (1+2), Physics, Chemistry

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	60	90	150	5

description
The fundamentals of engineering thermodynamics will be introduced and applied to problems of energy conversion, chemical engineering and materials science. (Power cycles, refrigeration, and combustion will be covered in the second part of the lecture: "Thermodynamics 2" Contents: Introduction/Motivation, Concepts/Definitions, Properties of a pure substance , Work and Heat, The first Law of Thermodynamics (Cycles, closed systems, open Systems, internal energy and enthalpy) The second law of Thermodynamics(Carnot-Cycle, closed systems) Entropy and related properties (Gibbs and Helmholtz function, the chemical potential) The properties of simple mixtures Phase diagrams Chemical Equilibrium
kind of examination
According to ï¿½ 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
ï¿½1 Fundamentals of Thermodynamics, Richard E. Sonntag, Claus Borgnakke, Gordon J. Van Wylen, 5.Aufl., John Wiley & Sons . ï¿½2 Fundamentals of Engineering Thermodynamics von Michael J. Moran, Howard N. Shapiro, 3. Aufl., John Wiley & Sons . ï¿½3 Chemical and Engineering Thermodynamics, Sandler, Stanley I., John Wiley & Sons ï¿½4 Physical Chemistry, P.W. Atkins, Oxford University Press
remark

modul name	shorthand expression of module
Mechanical Engineering	
course coordinator	**faculty**
Prof. Dr. rer. nat. Jan-Dirk Herbell	-

used in degree course

- Bachelor of Science in Computer Engineering
- Bachelor of Science in Computer Science and Communications Engineering
- Bachelor of Science in Control and Information Systems
- Bachelor of Science in Electrical and Electronic Engineering
- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Material Technology

nr	courses	semester	sws	workload	ECTS-credits
1	Design Theory 1	2	2	90	3
2	Mechanics 1	1	3	120	4
3	Mechanics 2	2	3	120	4
total			**8**	**330**	**11**

description:

This module provides basic statics and dynamics to solve scientific and technical problems. Design Theory I deals with rules and approaches for the construction of tools with respect of function, production and economy. Material sciences presented in Mechanics 1 + 2 are elementary.

modul name	shorthand expression of module
Mechanical Engineering	
lecture name	**shorthand expression of lecture**
Design Theory 1	
lecturer	**department**
Prof. Dr.-Ing. Paul Josef Mauk	

semester	cycle	language	requirements
2		English	keine

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	60	90	3

description

At the beginning the product design process as problem solving procedure for technical problems is explaint, with problem definition and customer demands for the product. Following the basic forces are discussed which machines and their parts under operating conditions are subdued. Further on are discussed the boundary forces of construction basic materials at static and dynamic forces, with the definition of the shape stability of real parts. At least are the location- and mold tolerances, the fitting systems and allowance discussed. To practice the basic principles, it will be clarified at the example of an bolt connection.

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

·1 Robert L. Norton, Machine Design – An Integrated Approach, Prentice Hall, Inc. 2001, Upper Saddle River, ISBN 0-13-017706-7
·2 George E. Dieter, Engineering Design – A Materials and Processing Approach, McGraw Hill Publ., Boston, 2001, ISBN 0-07-366136-8
·3 Bernard J. Hamrock, Bo Jacobson, Steven R. Schmid, Fundamentals of Machine Elements, McGraw Hill Publ. Boston, 1999, ISBN 0-256-19069-0
·4 U. Claussen, Methodisches Auslegen – Rechnergestütztes Konstruieren,Carl Hanser Verlag, München, 1993
·5 Robert C. Juvinal, Kurt M. Marshek, Fundamentals of Machine Component Design, John Wiley & Sons Inc., New York, 2003, ISBN 0-471-44844-3
·6 U. Claussen, Methodisches Auslegen – Rechnergestütztes Konstruieren, Carl Hanser Verlag, München, 1993
·7 K. Lingaiah, Machine Design Data Book,McGraw Hill Publ., New York, 2001
·8 J. E. Shigley, C.R. Mischke, Standard Handbook of Machine Design, McGraw Hill, New York, 1996, ISBN 0-07-056958-4

remark

modul name	shorthand expression of module
Mechanical Engineering	
lecture name	**shorthand expression of lecture**
Mechanics 1	
lecturer	**department**
Prof. Dr. rer. nat. Manfred Braun Prof. Dr.-Ing. Andres Kecskemethy	

semester	cycle	language	requirements
1		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description

Introduction; Vector Notation Kinematics of point masses ”Geometry of Motion” Dynamics of point masses (”Interaction between forces and motion”) Kinematics and dynamics of multi-particle systems(center of mass, constraint forces, degrees of freedom, etc.)Rotational Motion (planar)Energy Methods

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

·1 Segel: Mathematics applied to Continuum Mechanics, Dover
·2 Goldstein: Classical mechanics, Addison-Wesley
·3 Lanczos: The Variational Principle of Mechanics, Dover
·4 kleppner, Kolenkow: An Introduction to Mechanics, McGraw-Hill

remark

modul name	shorthand expression of module
Mechanical Engineering	
lecture name	**shorthand expression of lecture**
Mechanics 2	
lecturer	**department**
Prof. Dr. rer. nat. Manfred Braun Prof. Dr.-Ing. Andres Kecskemethy	

semester	cycle	language	requirements
2		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
Continuation of Mechanics 1: Dynamics of planar rigid bodies, some special kinematics properties of planar motion Statics: special solutions of systems at rest, friction, beam theory
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
·1 Segel: Mathematics applied to Continuum Mechanics, Dover ·2 Goldstein: Classical mechanics, Addison-Wesley ·3 Lanczos: The Variational Principle of Mechanics, Dover ·4 Kleppner, Kolenkow: An Introduction to Mechanics, McGraw-Hill
remark

modul name	shorthand expression of module
Metals and Metal Forming	
course coordinator	**faculty**
Prof. Dr.-Ing. Paul Josef Mauk	-
used in degree course	
• Bachelor of Science in Material Technology	

nr	courses	semester	sws	workload	ECTS-credits
1	Metal Forming 1	5	4	150	5
2	Metal Forming 2	6	3	120	4
3	Metal Physics 1	3	2	60	2
4	Metal Physics 2	4	3	90	3
5	Theory of Plasticity	5	3	120	4
total			**15**	**540**	**18**

description:

The module metals and metal forming contains the fundamentals of physical metallurgy about alloys, lattice structure of metals as well as reactions in solid state of metals like precipitations, diffusion and dislocations. The lecture about theory of plasticity make use of this foundations in plasticity of metals for metal forming processes. The plastic flow of metals based on the physical yield theory leads to the technology of metals forming processes.

modul name	shorthand expression of module
Metals and Metal Forming	
lecture name	**shorthand expression of lecture**
Metal Forming 1	
lecturer	**department**
Prof. Dr.-Ing. Paul Josef Mauk	

semester	cycle	language	requirements
5		German	keine

SWS	presence hours	self-study hours	workload	ECTS-Credits
4	60	90	150	5

description

In this lecture will be discussed the metal forming process and also the machine- and system engineering of this production technology. First of all it starts with the rolling methods to produce plates and strips, the finishing due through cold rolling and surface treatment. The next block is the production of long products, like bars, sections and wire rod, beams, rails sections, special sections and construction sections.

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

Literaturempfehlung (German):
·1 K. Lange, Handbuch der Umformtechnik, Band 1 bis 4, Springer-Verlag, Berlin, 2001

Literaturempfehlung (English):
·2 B. Avitzur, Handbook of Metal Forming Processes, Wiley Interscience Publication, New York, 1993

remark

modul name	shorthand expression of module
Metals and Metal Forming	
lecture name	**shorthand expression of lecture**
Metal Forming 2	
lecturer	**department**
Prof. Dr.-Ing. Paul Josef Mauk	

semester	cycle	language	requirements
6		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description

The subjects of this lecture are the methods of solid forming. It starts with the free forging and die forging combined with the special machinary and equipment to produce such products. Further on the methods of extrusion and drawing, the slide and roll drawing with tensions for solid cross sections as well as for pipes and hollow sections are part of this lecture. At least their will be given an overview of different sheet forming methods like: deep drawing, sheet metal stretch forming, collar drawing with the special machinery of those production methods.

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

Literaturempfehlung (German):
·1 K. Lange: Handbuch der Umformtechnik, Band I-IV, Springer-Verlag, Berlin 2001.
Literaturempfehlung (English):
·2 B. Avitzur: Handbook of metalforming, Wiley Interscience Publication, 1993.

remark

modul name	shorthand expression of module
Metals and Metal Forming	
lecture name	**shorthand expression of lecture**
Metal Physics 1	
lecturer	**department**
Dr.-Ing. Sabine Weiß	

semester	cycle	language	requirements
3		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description
Starting with the atomistic structure of solids the crystallographic microstructure of metals is discussed. Experimental methods for the determination of crystallographic structures and their orientations are presented. Further an overview of defects in crystallographic structures (i.e. vacancies, dislocations) is given. These themes are followed by an introduction to binary systems and the basics of thermodynamic methods with the aim to train the practical use of phase diagrams.
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
Literaturempfehlung (German): ·1 G. Gottstein: Physikalische Grundlagen der Materialkunde, Springer Verlag Berlin, 2001, ISBN 3540419616 Literaturempfehlung (English): ·2 R. Cahn, P. Haasen: Physical Metallurgy, North Holland Verlag, 1983, ISBN 0444866280
remark

modul name	shorthand expression of module
Metals and Metal Forming	
lecture name	**shorthand expression of lecture**
Metal Physics 2	
lecturer	**department**
Dr.-Ing. Sabine Weiß	

semester	cycle	language	requirements
4		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	45	90	3

description

Based on the fundamentals of the lecture of metal physics I physical metallurgical mechanisms like diffusion, deformation and recrystallisation were discussed atomistically. The evolution of microstructure during solidification of metallic melts as well as the transformation processes taking place in solid solutions is presented. The lecture is closed by an explanation of the physical properties of metals (i.e. magnetism, thermal and electrical conductivity) based on an atomistic point of view.

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

Literaturempfehlung (German):
·1 G. Gottstein
Physikalische Grundlagen der Materialkunde
Springer Verlag Berlin, 2001, ISBN 3540419616
Literaturempfehlung (English):
·2 R. Cahn, P. Haasen
Physical Metallurgy,
North Holland Verlag, 1983, ISBN 0444866280

remark

modul name	shorthand expression of module
Metals and Metal Forming	
lecture name	**shorthand expression of lecture**
Theory of Plasticity	
lecturer	**department**
Prof. Dr.-Ing. Paul Josef Mauk	

semester	cycle	language	requirements
5		German	keine

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description

First of all are being discussed the physical metallurgy of plasticity of metals. Next are the different effects of the hot- and cold forming processes of metals, with its processes of strain hardening and recovery and recrystalliation and their consequences to the microstructure and mechanical properties of technical metals and alloys. The determination of the yield stress due to the forming process and the mathematical description are the following part of this lecture. The next part are the description of the stress state and plastic strain conditions, the flow rule for the plastic flow of metals at three dimensional stresses. The slab model of the theory of plasticity is the following part for calculation of the force; work and power for the technical forming process are another part of this lecture.

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

Literaturempfehlung (German):
·1 R. Kopp, H. Wiegels, Einführung in die Umformtechnik, Verlag der Augustinus Buchhandlung, Aachen, 1998

Literaturempfehlung (English):
·2 R.A.C. Slater, Engineering Plasticity: Theory and Application to metal forming problems, The McMillan Press, London, 1977

remark

modul name	shorthand expression of module
Metallurgy	
course coordinator	**faculty**
Prof. Dr.-Ing. Paul Josef Mauk	-
used in degree course	
• Bachelor of Science in Material Technology	

nr	courses	semester	sws	workload	ECTS-credits
1	Fundamentals of Metallurgie	4	3	120	4
2	Iron Making	5	3	120	4
3	Non Ferrous Metallurgy	6	2	90	3
4	Steelmaking 1	5	3	120	4
5	Steelmaking 2	6	3	120	4
total			**14**	**570**	**19**

description:
This module deals with the fundamentals of metallurgy for metals and the reaction kinetics of these processes as well as the technology of iron and steel making and non ferrous metallurgy. Beside the theoretical basics the process technology of metal making are the essentials of the module.

modul name	shorthand expression of module
Metallurgy	
lecture name	**shorthand expression of lecture**
Fundamentals of Metallurgie	
lecturer	**department**
Dr.-Ing. Rüdiger Deike	

semester	cycle	language	requirements
4		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
phase, phase boundary, solution, enthalpy of formation, Gibbs enthalpy, thermodynamic equilibrium, reaction equilibrium, distribution equilibrium, mass transfer, mass transport, thermodynamic activity, phase diagrams, metallurgical slags, slag properties, slag formation, theory of nucleation, metallurgical operations
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
·1 Atkins,P.W. "Physikalische Chemie",2. Auflage VCH Weinheim ·2 "Physikalische Chemie der Eisen- und Stahlerzeugung" ,Verlag Stahleisen,1964
remark

modul name	shorthand expression of module
Metallurgy	
lecture name	**shorthand expression of lecture**
Iron Making	
lecturer	**department**
Dr.-Ing. Rüdiger Deike	

semester	cycle	language	requirements
5		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
iron ores, dressing, ore sintering, pelletsing, coke, additions, fluxes, ferrous burden, hot metal production in the blast furnace, blast furnace plants and components, blast furnace automatisation and control, metallurgy of blast furnace, direct reduction process, production of direct reduced iron (DRI),smelting reduction
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
·1 Taube,K. "Stahlerzeugung kompakt", Vieweg Technik, 1998
remark

modul name	shorthand expression of module
Metallurgy	
lecture name	**shorthand expression of lecture**
Non Ferrous Metallurgy	
lecturer	**department**
Prof. Dr.-Ing. Manfred Dette	

semester	cycle	language	requirements
6		German	keine

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	60	90	3

description

Lecture structure: I. Introduction: 1. Definitions / Literature / History / Examples of use 2. Deposits/Frequency/Raw material 3. Commerce/Trade and industry for ore and nonferrous metals II. Basis of nonferrous metallurgy 1. Heat capacity and affinity 2. Methods of reduction and refining 3. Basic technologies for nonferrous metallurgy III. Specific nonferrous metallurgy 1. Aluminium i. Raw materials ii. Bayer-process iii. Molten metal flow electrolysis iv. Refining electrolysis v. Recycling methods vi. Manufacture and processing 2. Magnesium 3. Copper 4. Lead 5. Zinc Practical Exercises: Melt processing for aluminium alloys Melt processing for pure copper Melting for brass Surface treatment with aluminium alloys

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

Standardwerke:
·1 Pawlek, Franz: Metallhüttenkunde. Berlin; New York: de Gruyter, 1983
·2 Gocht, Werner: Handbuch der Metallmärkte. Springer-Verlag, Heidelberg. 1985
·3 Duisburger Recycling Tage. Sonderdrucke

Zeitschriften:
·4 Erzmetall, Aluminium, Metall

Practice:
·1 Melt processing for aluminium alloys
·2 Melt processing for pure copper
·3 Melting for brass
·4 Surface treatment with aluminium alloys

remark

modul name	shorthand expression of module
Metallurgy	
lecture name	**shorthand expression of lecture**
Steelmaking 1	
lecturer	**department**
Dr.-Ing. Rüdiger Deike	

semester	cycle	language	requirements
5		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
refining process, decarburization, silicon and manganese oxidation,dephosphorization,desoxidation,desulphurazition,alloying,materials for steelmaking, pig iron, sponge iron, scrap, ferroalloys, burnt lime, electro steelmaking, design of electric arc furnace, three phase arc (AC) furnace, direct current(DC)arc furnace, metallurgy of electric steelmaking, data collection, process control, oxygen converter steelmaking, top blowing, bottom blowing, combined blowing, converter steel plant, metallurgy of converter steelmaking, process models
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
·1 Oeters,F.: "Metallurgie der Stahlherstellung", Verlag Stahleisen Springer Verlag,1989 ·2 Heinen,H.:"Elektrostahlerzeugung", Verlag Stahleisen,1997
remark

modul name	shorthand expression of module
Metallurgy	
lecture name	**shorthand expression of lecture**
Steelmaking 2	
lecturer	**department**
Dr.-Ing. Rüdiger Deike	

semester	cycle	language	requirements
6		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
secondary metallurgy, Stirring treatment, ladle furnace, injection blowing, non metallic inclusions, steel ingot casting, casting temperature, structure of ingots, shrink hole, segregation, forging ingots, continuous casting, billet caster, bloom caster, slab caster, attribute of continuously cast products, near net shape casting, steel remelting process
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
·1 Stolte,G.:"Secondary Metallurgy", Verlag Stahleisen, 2002 ·2 Schwerdtfeger,K.:"Metallurgie des Stranggießens",Verlag Stahleisen,1992
remark

modul name	shorthand expression of module
Natural Science	
course coordinator	**faculty**
Prof. Dr.-Ing. Axel Hunger Prof. Dr.-Ing. Uwe Maier Prof. Dr.-Ing. Paul Josef Mauk Prof. Dr.-Ing. Klaus Solbach Prof. Dr. rer. nat. Jan-Dirk Herbell	-

used in degree course

- Bachelor of Science in Computer Engineering
- Bachelor of Science in Computer Science and Communications Engineering
- Bachelor of Science in Control and Information Systems
- Bachelor of Science in Electrical and Electronic Engineering
- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Material Technology

nr	courses	semester	sws	workload	ECTS-credits
1	General Chemistry	1	3	120	4
2	Mathematics 1	1	6	210	7
3	Mathematics 2	2	5	180	6
4	Physics	2	4	150	5
total			**18**	**660**	**22**

description:

Mathematics is taught in order to allow students to understand and follow courses in engineering theory and develop their ability to describe and solve engineering problems. Physics and Chemistry are taught in order to allow students to understand the fundamentals of many engineering disciplines and applications. The two courses in Mathematics cover the general fundamentals, while further mathematical fundamentals are added in later semesters depending on the requirements of the particular engineering discipline chosen by the individual student. The course in Chemistry covers introductory material for the understanding of basic principles used in engineering and lays the fundamentals for those students who continue with more specialized introductions to Chemistry in mechanical engineering and material technology. The course in Physics concentrates on those areas which are not covered by courses in mechanical engineering and electrical engineering of the first year in order to allow students a broader view of physical fundamentals and principles which are encountered in engineering sciences.

modul name	shorthand expression of module
Natural Science	
lecture name	**shorthand expression of lecture**
General Chemistry	
lecturer	**department**
Prof. Dr. rer. nat. Christian Mayer	

semester	cycle	language	requirements
1		English	keine

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description

The lecture deals with the fundamentals of general chemistry (atomic models, periodic table, chemical bonds, chemical thermodynamics and kinetics) as well as with some aspects of the field of chemistry which are of special relevance for engineering applications (structural and functional materials).

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

1) General Chemistry (English) first choice!
by Peter W. Atkins (New York 1989)
accessible in the library under code: 32UNP2386
2) Chemie – einfach alles (German)
by Peter W. Atkins and J.A. Beran (Weinheim 1996)
accessible in the library under code: 32UNP2653
3) General Chemistry (English)
by Wendell H. Slabaugh and Theran D. Parsons (New York 1976)
accessible in the library under code: 31UNP1453
4) Prinzipien der Chemie (German)
by Dickerson, Gray and Haight (Berlin 1978)
accessible in the library under code: 31UNP1762
5) Basic Principles of Chemistry (English)
by Harry B. Gray and Gilbert P. Haight (New York 1967)
accessible in the library under code: 33UNP1259

remark

modul name	shorthand expression of module
Natural Science	
lecture name	**shorthand expression of lecture**
Mathematics 1	
lecturer	**department**
Prof. Dr. rer. nat. Johannes Gottschling	

semester	cycle	language	requirements
1		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
6	90	120	210	7

description

Propositional calculus, Predicate calculus, Real numbers, Mathematical Induction, Complex numbers, Sequences of real numbers, Series of real numbers, Complex exponential function, Logarithm and general exponential functions, Limits and continuity of functions, Trigonometric functions, Hyperbolic functions, Techniques of differentiation, Tangent lines and rates of change, Rules for finding derivatives, Higher order derivatives, Antiderivatives, Rules for finding antiderivatives, Definite integrals, Properties of definite Integrals, Techniques of indefinite integration, The first derivative test, The second derivative test, Convexity and Concavity, Applications of extrema, L'Hôpital's Rule, Solids of revolution, Centroids of plane regions, Taylor series

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

·1 Forster, Otto: Analysis 1, Differential- und Integralrechnung, 4. Auflage, Vieweg & Sohn, Braunschweig 1983, ISBN 3-528-37224-9
·2 Haußmann, Werner; Jetter, Kurt; Mohn, Karl-Heinz: Mathematik für Ingenieure, Teil I, Duisburg 1998
·3 Cronin-Scanlon, Jane: Advanced Calculus, A Start in Analysis, D. C. Heath and Company, Lexington, Massachusetts 1969
·4 Swokowski, Earl. W: Calculus with Analytic Geometry, Second Edition, Prindle, Weber & Schmidt, Boston, Massachusetts 1979, ISBN 0-87150-268-2
·5 Ash, Carol; Ash, Robert B.: The Calculus Tutoring Book, IEEE Press, University of Illinois at Urbana-Champaign, ISBN 0-87942-183-5
·6 Livesley, R. K.: Mathematical Methods for Engineers, Ellis Horwood Limited, Chichester, West Sussex, England 1989, ISBN 0-7458-0714-3
·7 Jordan, D. W.; Smith, P.: Mathematical Techniques, Second Edition, Oxford University Press, New York 1997, ISBN 0 19 856461 9
·8 Apostol, T.M.: Calculus I, II, Xerox College Publishing: Lexton-Mass., Toronto 1967

modul name	shorthand expression of module
Natural Science	
lecture name	**shorthand expression of lecture**
Mathematics 2	
lecturer	**department**
Prof. Dr. rer. nat. Johannes Gottschling	

semester	cycle	language	requirements
2			

SWS	presence hours	self-study hours	workload	ECTS-Credits
5	75	105	180	6

description

Vector space, Matrices, Determinats and their properties, System of linear equations, Eigenvalues, Eigenvectors, Vector-valued functions, Functions of several variables, Limits and Continuity, Partial Derivatives, Local extrema, Vectorfields, Line Integrals, Introduction to ODE, Laplace transforms, Fourier series and transform, Introduction to PDE

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

·1 Forster, Otto: Analysis 2, Differentialrechnung im IR(n), Gewöhnliche Differentialgleichungen, Vieweg & Sohn, ISBN 3-499-27031-5
·2 Swokowski, Earl. W: Calculus with Analytic Geometry, Second Edition, Prindle, Weber & Schmidt, Boston, Massachusetts 1979, ISBN 0-87150-268-2
·3 Ash, Carol; Ash, Robert B.: The Calculus Tutoring Book, IEEE Press, University of Illinois at Urbana-Champaign, ISBN 0-87942-183-5
·4 Livesley, R. K.: Mathematical Methods for Engineers, Ellis Horwood Limited, Chichester, West Sussex, England 1989, ISBN 0-7458-0714-3
·5 Jordan, D. W.; Smith, P.: Mathematical Techniques, Second Edition, Oxford University Press, New York 1997, ISBN 0 19 856461 9
·6 Papula, Lothar: Mathematik für Ingenieure und Naturwissenschaftler, Band 1 und Band 2, 10. Auflage, Vieweg & Sohn, Braunschweig/Wiesbaden 2001, ISBN 3-528-94237-1
·7 Apostol, T.M.: Calculus I, II, Xerox College Publishing: Lexton-Mass., Toronto 1967

remark

modul name	shorthand expression of module
Natural Science	
lecture name	**shorthand expression of lecture**
Physics	
lecturer	**department**
Prof. Dr. rer. nat. Hilmar Franke	

semester	cycle	language	requirements
2		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
4	60	90	150	5

description

1)Introduction: vectors, units, equation of linear and circular motion, energy, elastic- and inelastic collision; 2)oscillations and waves: free-,damped-,enforced oscillations, waves, acoustic waves, what is sound?, intensity of sound, dB scale 3)optics: geometrical optics: prism, lenses, mirror, Snell´s law, light guiding, imaging with simple instruments 4)atomic physics: Bohr´s model, quantum numbers and their meaning, Franck-Hertz-experiment, X-rays, application of X-rays 5)nuclear physics: electrons, protons, neutrons, radiation, radioactive decay, radioactive clocks, nuclear energy from fusion and fission.

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

·1 U.Leute: Physik, Hanser Verlag, 1995
·2 Lindner: Physik für Ingenieure, Hanser Verlag, 2001
·3 H.J.Paus: Physik in Experimenten und Beispielen, Hanser Verlag, 2001
·4 Orear: Physik", Hanser Verlag, 2001
·5 Bohrmann, Pitka, Stöcker, Terlitzki: Physik für Ingenieure, Harri German,1993
·6 Übungsbuch: z.B.:Müller/Heinemann/Krämer/Zimmer: Übungsbuch Physik, Hanser Verlag, 2001

remark

modul name	shorthand expression of module
Mathematical and Natural Science Fundamentals	
course coordinator	**faculty**
Prof. Dr.-Ing. Paul Josef Mauk	-
used in degree course	
• Bachelor of Science in Material Technology	

nr	courses	semester	sws	workload	ECTS-credits
1	Anorganic Chemistry	3	3	0	3
2	Computer Based Engineering Mathematics	4	3	120	4
3	Mathematics C2 (Numerical Mathematics)	3	4	180	6
4	Physical Chemistry	4	3	0	3
5	Statistics for Engineers	3	2	90	3
total			**15**	**390**	**19**

description:

The module foundations of natural and mathematical sciences contains the methods of numerical mathematics, statistics and lectures about inorganic and physical chemistry as a basis for coming lectures about metallurgical technology and metal forming. The numerical mathematics contains lectures about the numerical solutions of differential an integral equations. Lecture about statistics comprises the statistical methods for quality control in material science.

modul name	shorthand expression of module
Mathematical and Natural Science Fundamentals	
lecture name	**shorthand expression of lecture**
Anorganic Chemistry	
lecturer	**department**
Prof. Dr. rer. nat. Günter Geismar	

semester	cycle	language	requirements
3			

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	0	0	0	3

description
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
Charles E. Mortimer, Chemie – Basiswissen der Chemie, Georg Thieme Verlag, Stuttgart, 2001, ISBN 3-13-484307-2
remark

modul name	shorthand expression of module
Mathematical and Natural Science Fundamentals	
lecture name	**shorthand expression of lecture**
Computer Based Engineering Mathematics	
lecturer	**department**
Prof. Dr. rer. nat. Johannes Gottschling	

semester	cycle	language	requirements
4			

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	45	75	120	4

description
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
.1 Script der Vorlesung .2 Gramlich, G; Werner, W.: Numerische Mathematik mit MATLAB, dpunkt.verlag, Heidelberg, ISBN 3-932588-55-X
remark

modul name	shorthand expression of module
Mathematical and Natural Science Fundamentals	
lecture name	**shorthand expression of lecture**
Mathematics C2 (Numerical Mathematics)	
lecturer	**department**
Prof. Dr. rer. nat. Wolfgang Schreiber	

semester	cycle	language	requirements
3		English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
4	60	120	180	6

description

1 Error Analysis Representation of numbers, Floating-point-numbers, Rounding errors, Error Propagation, Error propagation in arithmetic operations, Condition numbers 2 Nonlinear equations The method of Bisection, The secant method, Newton‘s method, Fixed point iteration, Polynomial equations, Systems of nonlinear equations, Newton‘s method for systems 3 Systems of Linear Equations The LR and Cholesky Decomposition, The LR-Decomposition, The Cholesky Decomposition, Gauss Elimination and Back-Substitution, Pivoting strategies, The QR Decomposition, Data fitting; Least square problems, lterative solutions, Jacobi Iteration (total-step-method), Gauss-Seidel-Iteration (single-step-method), Convergence properties 4 Finding Eigenvalues The Power method, Localizing eigenvalues , The QR-method, Hessenberg matrices 5 Ordinary Differential Equations Basic analytic methods, Separation of variables, Linear differential equations, One-step-methods, Euler‘s Method, Midpoint Euler, Two-stage-models, Runge-Kutta-methods 6 Polynoniial Interpolation Lagrange form of Interpolation Polynomial, Interpolation Error, Divided Differences, Spline Interpolation

kind of examination

According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature

·1 Gautschi, W. Numerical Analysis, Birkhäuser.
·2 Hammerlin und Hoffmann. Numerische Mathematik, Springer.
·3 Householder. A.S. Principles of Numerical Analysis, Dover Publications.
·4 Kincaid,D. and Cheney, W. Numerical Analysis, Brooks/Cole Publishing.
·5 Locher. Numerische Mathematik für Informatiker.
·6 Philipps,C. and Cornelius, B. Computional Numerical Methods, Ellis Hoorwood.
·7 Stoer, J. and Burlisch, R. Introduction to numerical Analysis.

remark

modul name	shorthand expression of module
Mathematical and Natural Science Fundamentals	
lecture name	**shorthand expression of lecture**
Physical Chemistry	
lecturer	**department**
Prof. Dr. rer. nat. Christian Mayer	

semester	cycle	language	requirements
4		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
3	0	0	0	3

description
1. Physical description of different phase states 1.1 The gas phase (the gas laws, the ideal gas, the kinetic gas model, real gas laws, the van-der-Waals-equation) 1.2 Properties of the liquid phase (mechanical properties, viscosity, Newtonic and non-Newtonic fluids) 1.3 Properties of solids (crystalline and amorphous structures, mechanical properties) 2. Chemical thermodynamics 2.1 The first law of thermodynamics (work, heat and energy, the perpetuum mobile, enthalpie, temperature dependencies of energy and enthalpy) 2.2 The second law of thermodynamics (the entropy, Carnot‘s circle, efficiency of a heat engine) 2.3 Driving force of spontaneous processes: free energy and free enthalpy (fundamental equations, dependence on temperature and pressure free enthalpy, the chemical potential, activity and activity coefficients) 3. Reaction kinetics 3.1 Defininition of the reaction rate 3.2 Reaction rate equations (reaction order: zero, first, second and third order reactions) 3.3 Temperature dependence of reaction rates (a simple rule of thumb, the activation energy, the Arrhenius law) 4. Thermodynamics and kinetics of phase transitions 4.1 Thermodynamics of phase transitions (phase transition enthalpies, free phase transition enthalpies, phase equilibria, phase diagrams) 4.2 Kinetiks of phase transitions (metastable conditions, catalysis of phase transitions) 4.3 Properties of mixed phases (partial molar parameters, solutions, colligative phenomena diffusion, osmosis, distribution equilibria) 5. Thermodynamics and kinetics of chemical reactions 5.1 Thermochemistry (reaction enthalpy, Nernst rule) 5.2 Driving force of chemical reactions, the chemical equilibrium (free reaction enthalpy, Gibbs-Helmhotz equation, the chemical equilibrium, the equilibrium constant, Le Chatelier‘s principle, catalysis, reaction molecularity)
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.

literature
· General Chemistry (English) first choice!by Peter W. Atkins (New York 1989)accessible in the library under code: 32UNP2386 · Chemie – einfach alles (German)by Peter W. Atkins and J.A. Beran (Weinheim 1996)accessible in the library under code: 32UNP2653 · General Chemistry (English)by Wendell H. Slabaugh and Theran D. Parsons (New York 1976)accessible in the library under code: 31UNP1453 · Prinzipien der Chemie (German)by Dickerson, Gray and Haight (Berlin 1978)accessible in the library under code: 31UNP1762 · Basic Principles of Chemistry (English)by Harry B. Gray and Gilbert P. Haight (New York 1967)accessible in the library under code: 33UNP1259
remark

modul name	shorthand expression of module
Mathematical and Natural Science Fundamentals	
lecture name	**shorthand expression of lecture**
Statistics for Engineers	
lecturer	**department**
Prof. Dr. rer. nat. Johannes Gottschling	

semester	cycle	language	requirements
3		German	

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	60	90	3

description
Introduction to theory of Probability, Laplace-Probability, Permutation and combination, Conditional probability, Independent events, Random variables, Distribution of a random variable, Mean and variance of probability distributions, Binomial distribution, Poisson & Hypergeometric distributions, Normal distribution, Confidence intervals, Testing of hypothesis, Quality control, Control chart, Chi-Quadrat test, Kolmogoroff-Smirnow test, Regression analysis and curve fitting, Analysis of variance
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
·1 Kreyszig, Erwin: Statistische Methoden und ihre Anwendungen Vandenhoeck & Ruprecht, Göttingen 1991, ISBN 3-525-40717-3 ·2 Gottschling, Johannes: Statistik für Ingenieure, Skript zur Veranstaltung
remark

modul name	shorthand expression of module
Non-Technical Subjects 1	
course coordinator	**faculty**
Prof. Dr.-Ing. Axel Hunger Prof. Dr.-Ing. Uwe Maier Prof. Dr.-Ing. Paul Josef Mauk Prof. Dr.-Ing. Klaus Solbach Prof. Dr. rer. nat. Jan-Dirk Herbell	-

used in degree course

- Bachelor of Science in Computer Engineering
- Bachelor of Science in Computer Science and Communications Engineering
- Bachelor of Science in Control and Information Systems
- Bachelor of Science in Electrical and Electronic Engineering
- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Material Technology

nr	courses	semester	sws	workload	ECTS-credits
1	Non-Technical Subject 1	1	2	60	2
2	Non-Technical Subject 2	2	2	60	2
total			**4**	**120**	**4**

description:

This module gives Bachelor-students the opportunity to demonstrate their participation in non-technical subjects. Students are free to choose from all offers of the University Duisburg-Essen, e.g. language courses or lectures on business administration and sociology and culture. From the catalogue at least one course of the field business administration has to be selected.

modul name	shorthand expression of module
Non-Technical Subjects 1	
lecture name	**shorthand expression of lecture**
Non-Technical Subject 1	
lecturer	**department**
NN	

semester	cycle	language	requirements
1			

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
remark

modul name	shorthand expression of module
Non-Technical Subjects 1	
lecture name	**shorthand expression of lecture**
Non-Technical Subject 2	
lecturer	**department**
NN	

semester	cycle	language	requirements
2			

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
remark

modul name	shorthand expression of module
Non-Technical Subjects 2	
course coordinator	**faculty**
Prof. Dr.-Ing. Axel Hunger Prof. Dr.-Ing. Uwe Maier Prof. Dr.-Ing. Paul Josef Mauk Prof. Dr.-Ing. Klaus Solbach Prof. Dr. rer. nat. Jan-Dirk Herbell	-

used in degree course

- Bachelor of Science in Computer Engineering
- Bachelor of Science in Computer Science and Communications Engineering
- Bachelor of Science in Control and Information Systems
- Bachelor of Science in Electrical and Electronic Engineering
- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Material Technology

nr	courses	semester	sws	workload	ECTS-credits
1	Non-Technical Subject 3	4	2	60	2
2	Non-Technical Subject 4	4	2	60	2
3	Non-Technical Subject 5	4	2	60	2
4	Non-Technical Subject 6	5	2	60	2
total			**8**	**240**	**8**

description:

This module gives Bachelor-students the opportunity to demonstrate their participation in non-technical subjects. Students are free to choose from all offers of the University Duisburg-Essen, e.g. language courses or lectures on business administration and sociology and culture. From the catalogue at least one course of the field business administration has to be selected.

modul name	shorthand expression of module
Non-Technical Subjects 2	
lecture name	**shorthand expression of lecture**
Non-Technical Subject 3	
lecturer	**department**
NN	

semester	cycle	language	requirements
4			

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
remark

modul name	shorthand expression of module
Non-Technical Subjects 2	
lecture name	**shorthand expression of lecture**
Non-Technical Subject 4	
lecturer	**department**
NN	

semester	cycle	language	requirements
4			

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
remark

modul name	shorthand expression of module
Non-Technical Subjects 2	
lecture name	**shorthand expression of lecture**
Non-Technical Subject 5	
lecturer	**department**
NN	

semester	cycle	language	requirements
4			

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
remark

modul name	shorthand expression of module
Non-Technical Subjects 2	
lecture name	**shorthand expression of lecture**
Non-Technical Subject 6	
lecturer	**department**
NN	

semester	cycle	language	requirements
5			

SWS	presence hours	self-study hours	workload	ECTS-Credits
2	30	30	60	2

description
kind of examination
According to § 17 of the examination regulation the type and duration of the examination will be defined from the lecturer before the semester starts. Therefore an examination can be a written test with a length of 30 to 120 minutes or an oral examination with a length of 30 to 60 minutes. The language of the examination is the same as the language of the lecture.
literature
remark

modul name	shorthand expression of module
Elective, Thesis	
course coordinator	**faculty**
Prof. Dr.-Ing. Axel Hunger Prof. Dr.-Ing. Uwe Maier Prof. Dr.-Ing. Paul Josef Mauk Prof. Dr.-Ing. Klaus Solbach Prof. Dr. rer. nat. Jan-Dirk Herbell	-

used in degree course

- Bachelor of Science in Computer Engineering
- Bachelor of Science in Computer Science and Communications Engineering
- Bachelor of Science in Control and Information Systems
- Bachelor of Science in Electrical and Electronic Engineering
- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Material Technology

nr	courses	semester	sws	workload	ECTS-credits
1	Bachelor Thesis	6	0	0	15
2	Project or 2 Electives	5	6	180	6
total			**6**	**180**	**21**

description:

Candidates of BSc in Mech. Eng. need to do a project in teamwork, before they may finish their bachelor’s thesis.

modul name	shorthand expression of module
Elective, Thesis	
lecture name	**shorthand expression of lecture**
Bachelor Thesis	
lecturer	**department**
NN	

semester	cycle	language	requirements
6		German/English	

SWS	presence hours	self-study hours	workload	ECTS-Credits
0	0	0	0	15

description
With the final thesis the candidates finish their course; they should prove their ability to solve an engineering task by themselves.
kind of examination
literature
remark

modul name	shorthand expression of module
Elective, Thesis	
lecture name	**shorthand expression of lecture**
Project or 2 Electives	
lecturer	**department**

semester	cycle	language	requirements
5			

SWS	presence hours	self-study hours	workload	ECTS-Credits
6	90	90	180	6

description
kind of examination
literature
remark