C | A | U Christian-Albrechts-Universität zu Kiel Technische Fakultät

Institute for Materials Science

Bachelor Degree program
in
Materials Science and Engineering

Module Handbook

General comments, Mandatory and Elective Compulsory Modules

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General comments

The Examination Office for the "Bachelor of Materials Science" degree programme is the Institute for Materials Science in the Faculty of Engineering on the Ostufer Campus.

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Modules

A module is the smallest evaluated unit. However, one module can consist of several lectures or courses. In this module handbook, each module basically consists of a lecture and an exercise. As such, both have the same name and the same module ID. Thus in univis, for example for the module mawi-102, you will find the entries "mawi-102 Mathematics for Materials Scientists 1" and "mawi-102 Mathematics for Materials Scientists 1 exercises". If different or additional courses are required for a module, they will be listed in the module description under the item "Course, if applicable".

ECTS credit points

All credit points (ECTS) in this module handbook are calculated on the basis of 30 hours of work required per credit point. So a module with a workload of 150 hours, for example, will have 5 ECTS credit points allocated.
Attendance at a teaching event or independent work are assessed as 15 hours per weekly SWS (teaching unit). A module with 2 hours of lectures and 1 hour of exercises thereby results in a workload of 45 hours per semester. In addition to the times spent in attendance at the university, the time for independent self-study in the form of preparation and follow-up work, and/or own research are also taken into account on the same basis. Thus, a module with 30 hours of self-study requires that students spend at least 2 hours per week working independently on the topic.

Examinations

At least one examination will be offered each semester for all modules.
The title of the examination corresponds with the title of the module. An additional tool for orientation purposes is the module code (mawi-… or BWL-…).
In principle, all examinations are mandatory and are graded.
Deviations from this rule are listed under the item Examinations.
In principle, the module grade is derived 100% from the grade achieved in the module examination. Deviations from this rule are also listed under the item Examinations.
All module grades with their respective ECTS credit points will be weighted and included in the calculation of the final grade, if they have a grade. This also applies to the Bachelor's thesis. An example calculation can be found in the degree-specific examination regulations (FPO).

Classification of the learning objectives

The learning objectives in this module handbook were defined on the basis of "Bloom's taxonomy". This is based on the following hierarchy:

It describes different levels at which every subject can be taught and learned. From the lowest to the highest level, the students deepen and broaden their knowledge, their competence related to this knowledge, and their ability to apply this knowledge creatively. This diagram illustrates that topics in the module handbook can also occur multiple times, in order to reach higher levels.

Inhalt

Mandatory Modules

Module description	**Physik 1: Mechanik und Thermodynamik**			
	Physics 1: Mechanics and Thermodynamics			
Module code	mawi-101			
Module level	Mathematical and natural science basics			
Abbreviation if applicable	Physik1			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr K. Rätzke			
Lecturer	Lecture: Prof. Dr M. Bauer Exercises: Prof. Dr K. Rätzke and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 1st semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Physik 1: Mechanik und Thermodynamik	Compulsory	5
	Practical exercises	Physik für Materialwissenschaftler	Compulsory	2
Workload	75 hrs of lectures 30 hrs of exercises 30 hrs of self-study 45 hrs of extra work 180 hrs total workload			
ECTS credit points	6 ECTS			
Requirements according to the Examination Regulations	None			
Recommended requirements	For preparation, we recommended attending the "Refresher course in school mathematics", which is jointly offered by the Physics department and the Faculty of Engineering before studies begin.			

Coursework	Solving exercises Presenting the solutions		
Examinations	Written or oral examination: Physics 1: Mechanics and thermodynamics		
	Compulsory/optional	*Graded/not graded*	*Weighting*
	Compulsory	Graded	100%
Learning objectives / competences	Students are able to summarise and present the main features of mechanics and thermodynamics, apply these to simple examples, calculate specific values, and independently solve further problems using literature sources. Students are able to justify and present their approach to the solution. They are familiar with key experiments in this area (oblique launch, gyro, thermometer, etc.), can describe them and provide reasons for them.		
Contents	<u>Mechanics</u> • Coordinate and reference systems • Kinematics • Special theory of relativity • Dynamics, Newton's laws • Oscillations • Hydrostatics and hydrodynamics, aerodynamics <u>Thermodynamics</u> • Gas laws • Main features of statistical thermodynamics • Transport phenomena • Heat radiation <u>Acoustics</u>		
Media forms	Blackboard and chalk, physics experiments live. Supported by screen projection of the experimental sequence (video cameras) and the measurement displays, screen projection of graphics, tables and function processes.		
Literature	• Demtröder, volumes I and II; Springer (2005) • Bergmann-Schäfer, volumes I, II and III; de Gruyter (1998-2006) • Feyman Lectures, volumes I and II; Oldenbourg (2001) • Other standard physics books such as Gerthsen, Tipler, Halliday and Resnik		

Module description	**Mathematik für Materialwissenschaftler 1**			
	Mathematics for Materials Scientists 1			
Module code	mawi-102			
Module level	Mathematical and natural science basics			
Abbreviation if applicable	Mathe1			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. R. Adelung			
Lecturer	Prof. Dr. R. Adelung and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 1st semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Mathematik für Materialwissenschaftler 1	Compulsory	4
	Practical exercises	Mathematik für Materialwissenschaftler 1	Compulsory	2
Workload	60 hrs of lectures 30 hrs of exercises 60 hrs of self-study 90 hrs of extra work 240 hrs total workload			
ECTS credit points	8 ECTS			
Requirements according to the Examination Regulations	None			
Recommended requirements	For preparation, we recommended attending the "Refresher course in school mathematics", which is jointly offered by the Physics department and the Faculty of Engineering before studies begin.			
Coursework	Solving exercises			

<table>
<tr><td></td><td colspan="3">Presenting the solutions</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written or oral examination:</td></tr>
<tr><td>Compulsory/optional</td><td>Compulsory/optional</td><td>Compulsory/optional</td></tr>
<tr><td>Compulsory</td><td>Compulsory</td><td>Compulsory</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students have mastered the school mathematical contents which are listed below. They can confidently apply calculus and algebraic functions, including the basics of complex numbers, to problems (knowledge, understanding).
They can solve simple algebraic and calculus problems without further technical aids. (Application)</td></tr>
<tr><td>Contents</td><td colspan="3"><u>Volume integrals</u>
• Rotating bodies
• Coordinate systems
• Spherical coordinates
• Cylindrical coordinates
• Function space
<u>Special functions</u>
• Gauss
• Gamma
• erf(x)
• Delta
<u>Differential equations:</u>
• Linear first order and second order / coupled ordinary differential equations
<u>Vector analysis</u>
• Potential fields
• Vector fields (theorem of Gauss, Stokes)
• Line integral
• Gradient
• Divergence
• Rotation
• Tensor calculus
<u>Statistics/error calculation</u>
• Gaussian error propagation
• Gauss curve
• Average deviation of the mean value
• Systematic and statistical errors</td></tr>
<tr><td>Media forms</td><td colspan="3">Beamer, Blackboard</td></tr>
<tr><td>Literature</td><td colspan="3">• Bamberg, G. und F. Baur, Statistik, Oldenbourg, 2002.
• Fahrmeir, L., Künstler, R., Pigeot, I., und G. Tutz, Statistik, Springer 1999.
• Hartung, J., Elpelt, B., und K.-H. Klösener: Statistik, Oldenbourg, 2002.
• Missong, M. und S. Mittnik, Deskriptive Statistik, Pro Business, 2005.
• Schira, J., Statistische Methoden der BWL und VWL, Pearson 2005.</td></tr>
</table>

Module description	**Einführung in die Materialwissenschaft 1**			
	Introduction to Materials Science 1			
Module code	mawi-110			
Module level	Basic in Materials Science			
Abbreviation if applicable	EMaWi1			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. K. Rätzke			
Lecturer	Prof. Dr. K. Rätzke			
Language	German			
Where in the curriculum	Compulsory module in the 1st semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Einführung in die Materialwissenschaft 1	Compulsory	2
	Practical exercises	Einführung in die Materialwissenschaft 1	Compulsory	1
	Seminar	Proseminar	Compulsory	1
Workload	30 hrs of lectures 15 hrs of exercises 15 hrs of seminar 30 hrs of self-study 30 hrs of extra work 120 hrs total workload			
ECTS credit points	6 ECTS			
Requirements according to the Examination Regulations	none			
Recommended requirements	Mastering the advanced calculation methods of logarithms, exponential functions, fractions, trigonometric functions. Reading and interpreting graphical representations of physical issues -			

<table>
<tr><td></td><td colspan="3">including the ability to convert different systems of units (SI, CGS, UK) into each other. Basic chemistry and physics knowledge from school.</td></tr>
<tr><td>Coursework</td><td colspan="3">Solving exercises
Presenting the solutions</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written or oral examination</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students are familiar with the elements, types of bonds, all material classes, simple crystallographic structures and crystal defects. They are familiar with the main features of mechanical and functional properties. They can explain the relationships between bonds, structure and properties, and the special role played by defects. They can explain simple processes, both chemically and physically. They can apply this knowledge, to explain the right material and the correct manufacturing method and microstructure for simple problems. Students can argue logically and with the use of fundamental knowledge, and understand such arguments.

Students know the structure of the degree programme, the faculty and the university. They are aware of the Bologna Process, and the structure of a Bachelor's and Master's degree programme. They are familiar with the principle of ECTS credit points and their awarding criteria, as well as the transfer possibilities. They know where to find all the necessary information about the degree programme. The students have learned about teaching and learning concepts, and are able to apply these to their own degree programme.</td></tr>
<tr><td>Contents</td><td colspan="3">The module provides an introduction to the concepts and main features of materials science, with the following topics:
• Structure of matter
• Ideal crystals
• Real crystals
• Lattice defects
• Structure of multiphase materials, microstructure
• Basic principles of heating
• Thermodynamics, phase diagrams, kinetics
• Elastic / plastic behaviour
• Breakage
• Plastic deformation and hardening

Proseminar - Studies
• Structure of the degree programme
• Institute, working groups and contact persons
• Examinations and credit points, ECTS, Bologna Process
• Structure of the university, contact persons
• Learning concepts
• Self-organisation</td></tr>
<tr><td>Media forms</td><td colspan="3">Blackboard, Overhead, PowerPoint, Script, Laboratory, interaktive Communication.</td></tr>
</table>

Literature	• E. Hornbogen, Werkstoffe, Springer Verlag • H.-J. Bargel Werkstoffkunde, Springer Verlag • C.R. Barrett et al., The Principles of Engineering Materials, Prentice Hall

Module description	**Computer als Werkzeuge**			
	Computers as Tools			
Module code	Mawi-108			
Module level	Overlapping contents/non-technical subjects			
Abbreviation if applicable	CoHaW			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. S. Wulfinghoff			
Lecturer	Prof. Dr. S. Wulfinghoff and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 1st semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Computer als Werkzeuge	Compulsory	1
	Practical exercises	Computer als Werkzeuge	Compulsory	2
Workload	15 hrs of lectures 30 hrs of exercises 30 hrs of self-study 45 hrs of extra work 150 hrs total workload			
ECTS credit points	5 ECTS			
Requirements according to the Examination Regulations	None			
Recommended requirements	For preparation, we recommended attending the "Refresher course in school mathematics", which is jointly offered by the Physics department and the Faculty of Engineering before studies begin.			
Coursework	Solving exercises			

	Presenting the solutions		
Examinations	Written or oral examination		
	Compulsory/optional	*Graded/not graded*	*Weighting*
	Compulsory	Graded	100%
Learning objectives / competences	Using the example of fundamental questions of mechanics and material modelling, students have learned the methods and gained the programming knowledge which enable computer-based solving of physical problems. They are able to apply the methods learned, and use a programming language to implement them in practice, and estimate numerical errors. Students are able to solve simple tasks in the field of modelling and simulation by independently developing computer programmes, without being tied to a special software. Students have the ability to develop basic skills for using modern programming languages to solve scientific problems.		
Contents	Mechanics: - Equilibrium conditions - Stresses and strains (1D) - Material modelling (1D) Computer-based methods: - Basics of programming - Solving systems of equations - Numerical solution of differential equations - Visualisation of solutions		
Media forms	Beamer, Blackboard, Computer		
Literature	• Will be announced in the lecture		

Module description	**Chemie für Studierende der Materialwissenschaft** ***The latest version by the department offering the course is valid!*** ***This extract is purely for informational purposes.***			
	Chemistry for Materials Science Students			
Module code	chem-0009			
Module level	Mathematical and natural science basics			
Abbreviation if applicable	Chemie			
Subtitle, if applicable				
Duration	2 Semester			
Repetition in the academic year	General Chemistry 1: Winter semester General Chemistry 2: Sommer semester			
Faculty responsible for the module	Faculty of Mathematics and Natural Science			
Institute responsible for the module	General Chemistry 1: Institute for Inorganic Chemistry General Chemistry 2: Institute for Organic Chemistry			
Lecturer responsible for the module	General Chemistry 1: Prof. Dr. W. Bensch General Chemistry 2: Prof. Dr. U. Lüning			
Lecturer	General Chemistry 1: Prof. Dr. W. Bensch General Chemistry 2: Prof. Dr. U. Lüning Exercises: Prof. Dr. L. Kienle			
Language	German			
Where in the curriculum	Compulsory module in the 1st and 2nd semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Allgemeine Chemie 1 (mnf-chem0101)	Compulsory	3
	Practical exercises	Chemie für Studierende der Materialwissenschaft 1	Compulsory	1
	Lecture	Allgemeine Chemie 2 (mnf-chem0201)	Compulsory	4
	Practical exercises	Chemie für Studierende der Materialwissenschaft 2	Compulsory	1
Workload	105 hrs of lectures 30 hrs of exercises 105 hrs of self-study 60 h hrs of extra work			

<table>
<tr><td></td><td colspan="3">300 hrs total workload</td></tr>
<tr><td>ECTS credit points</td><td colspan="3">10 ECTS</td></tr>
<tr><td>Requirements according to the Examination Regulations</td><td colspan="3">None</td></tr>
<tr><td>Recommended requirements</td><td colspan="3">School chemistry from the upper secondary level.
For preparation:
dtv-Atlas Chemie 1 – Allgemeine und anorganische Chemie (general and inorganic chemistry) dtv-Atlas Chemie 2 – Organische Chemie und Kunststoffe (organic chemistry and plastics).</td></tr>
<tr><td>Coursework</td><td colspan="3">Solving exercises
Presenting the solutions</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written examination after part 2</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students understand the basic principles of general, inorganic and organic chemistry. They are proficient in the language and nomenclature of general, inorganic and organic chemistry.</td></tr>
<tr><td>Contents</td><td colspan="3">Basic chemical laws and concepts, structure of atoms, structure of the periodic table, states of matter, types of chemical bonds, electrochemical voltage series, oxidation and reduction, basic chemistry of non-metals, reactivity of the chemical elements, periodic properties, simple representations, use of elements and compounds, acids, bases, pH value, chemical equilibrium, stoichiometry, energetics of chemical reactions, law of mass action, indicators.
Nomenclature and substance classes of organic chemistry, carbon compounds in everyday life, important natural substances, fundamentals of stereochemistry, basic reactions.
With experiments.</td></tr>
<tr><td>Media forms</td><td colspan="3">Beamer, experiments, Internet-Presentations:
http://www.chemievorlesung.ipn.uni-kiel.de/</td></tr>
<tr><td>Literature</td><td colspan="3">General Chemistry 1:
Holleman/Wiberg: Lehrbuch der Anorganischen Chemie.
Christen: Chemie, Verlag Sauerländer.
Mortimer: Chemie; Georg-Thieme-Verlag.
Danne/Wille: Kleines Chemisches Praktikum, VCH Verlag
G. Jander, E. Blasius: Lehrbuch der anorganischen und analytischen Chemie, S. Hirzel Verlag.
N. N. Greenwood, A. Earnshaw, Chemie der Elemente
D. F. Shriver, P. W. Atkins, C. H. Langford, Anorganische Chemie.
M. Binnewies, M. Jäckel, H. Willner, G. Rayner-Canham, Allgemeine und Anorganische Chemie.
J. Huheey, E. Keiter, R. Keiter, Anorganische Chemie, Prinzipien von Struktur und Reaktivität.</td></tr>
</table>

	General Chemistry 2: Als Textbook: • Streitwieser/Heathcock/Kosower, Organische Chemie, Wiley-VCH. • Vollhardt/Schore, Organische Chemie, Wiley-VCH. • Fox/Whitesell, Organische Chemie, Spektrum Akademischer Varlag. • Bruice, Organische Chemie, Pearson-Studium, • Buddrus, Grundlagen der Organischen Chemie, de Gruyter, • und viele mehr as compendium: • Beyer/Walter, Lehrbuch der Organischen Chemie, S. Hirzel.

Module description	**Chemisches Praktikum für Studierende der Materialwissenschaft** ***The latest version by the department offering the course is valid!*** ***This extract is purely for informational purposes.***			
	Practical Chemistry Lab Course for Materials Science Students			
Module code	chem0004			
Module level	Mathematical and natural science basics			
Abbreviation if applicable	ChemPrak			
Subtitle, if applicable				
Duration	2 weeks block			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Mathematics and Natural Science			
Institute responsible for the module	Institute for Inorganic Chemistry			
Lecturer responsible for the module	Prof. Dr. W. Bensch			
Lecturer	Prof. Dr. W. Bensch and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 1st semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials			
Assessment	Not graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Practical	Chemisches Praktikum für Studierende der Materialwissenschaften	Compulsory	2
	Seminar	Begleitendes Seminar zum Chemischen Praktikum für Studierende der Materialwissenschaften	Compulsory	1
Workload	30 hrs of lectures 15 hrs of exercises 15 hrs of self-study 30 hrs of extra work 90 hrs total workload			

<table>
<tr><td>ECTS credit points</td><td colspan="3">3 ECTS</td></tr>
<tr><td>Requirements according to the Examination Regulations</td><td colspan="3">None</td></tr>
<tr><td>Recommended requirements</td><td colspan="3">For preparation:
dtv-Atlas Chemie 1 – Allgemeine und anorganische Chemie (general and inorganic chemistry)</td></tr>
<tr><td>Coursework</td><td colspan="3">None</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Practical tasks (test setup and execution and protocol correction)</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Not graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students learn basic chemistry operations during the course with regard to good laboratory practice, and can link the practical results with the theory. They know the basics of working safely, and recognise hazards when handling chemicals and equipment.</td></tr>
<tr><td>Contents</td><td colspan="3">• Learning basic chemical operations
• Learning to handle chemicals safely</td></tr>
<tr><td>Media forms</td><td colspan="3">PowerPoint-Presentations; Experiments, Internet-Presentation: http://www.chemievorlesung.ipn.uni-kiel.de/, eigene Versuche</td></tr>
<tr><td>Literature</td><td colspan="3">• Holleman/Wiberg: Lehrbuch der Anorganischen Chemie
• Christen: Chemie, Verlag Sauerländer
• Mortimer: Chemie; Georg-Thieme-Verlag
• Danne/Wille: Kleines Chemisches Praktikum, VCH Verlag
• G. Jander, E. Blasius: Lehrbuch der anorganischen und analytischen Chemie, S. Hirzel Verlag
• N. N. Greenwood, A. Earnshaw, Chemie der Elemente
• D. F. Shriver, P. W. Atkins, C. H. Langford, Anorganische Chemie
• M. Binnewies, M. Jäckel, H. Willner, G. Rayner-Canham, Allgemeine und Anorganische Chemie
• J. Huheey, E. Keiter, R. Keiter, Anorganische Chemie, Prinzipien von Struktur und Reaktivität
• http://www.chemievorlesung.ipn.uni-kiel.de/</td></tr>
</table>

Module description	**Physik 2: Elektrizitätslehre und Optik**			
	Physics 2: Electricity and Optics			
Module code	mawi-201			
Module level	Mathematical and natural science basics			
Abbreviation if applicable	Physik2			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Summer semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. K. Rätzke			
Lecturer	Lecture: Prof. Dr. M. Bauer Exercises: Prof. Dr. K. Rätzke und Mitarbeiter			
Language	German			
Where in the curriculum	Compulsory module in the 2nd semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration			
Assessment	graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Physik 2: Elektrizitätslehre und Optik	Compulsory	5
	Practical exercises	Physik 2: Elektrizitätslehre und Optik	Compulsory	2
Workload	75 hrs of lectures 30 hrs of exercises 30 hrs of self-study 45 hrs of extra work 180 hrs total workload			
ECTS credit points	6 ECTS			
Requirements according to the Examination Regulations	None			
Recommended requirements	For preparation, we recommended attending the "Refresher course in school mathematics", which is jointly offered by the			

<table>
<tr><td></td><td colspan="3">Physics department and the Faculty of Engineering before studies begin</td></tr>
<tr><td>Coursework</td><td colspan="3">Solving exercises
Presenting the solutions</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written or oral examination</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students are able to summarise and present the main features of electricity and optics, apply these to simple examples, calculate specific values, and independently solve further problems using literature sources. Students are able to justify and present their approach to the solution. They are familiar with key experiments in this area (e.g. parallel and serial connection, circuits, alternating current, Milikan and Michelson-Morley experiments, lens systems, etc.), can describe them and provide reasons for them.</td></tr>
<tr><td>Contents</td><td colspan="3"><u>Electricity</u>
• Electrostatics
• Magnetostatics
• Oscillations and oscillating circuits
• Maxwell's equations
• Electromagnetic waves
<u>Optics</u>
• Transition electrodynamics - optics
• Geometrical optics
• Diffraction and wave phenomena
• Optical instruments
• Fourier optics</td></tr>
<tr><td>Media forms</td><td colspan="3">Blackboard and chalk, physics experiments live. Supported by screen projection of the experimental sequence (video cameras) and the measurement displays, screen projection of graphics, tables and function processes.</td></tr>
<tr><td>Literature</td><td colspan="3">• Demtröder, Band I und II; Springer (2005)
• Bergmann-Schäfer, Band I, II und III; de Gruyter (1998-2006)
• Feyman Lectures, Band I und II; Oldenbourg (2001) weitere Standardwerke der Physik wie Gerthsen, Tipler, Halliday und Resnik</td></tr>
</table>

Module description	**Mathematik für Materialwissenschaftler 2**			
	Mathematics for Materials Scientists 2			
Module code	mawi-202			
Module level	Mathematical and natural science basics			
Abbreviation if applicable	Mathe2			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Summer semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. R. Adelung			
Lecturer	Prof. Dr. R. Adelung and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 2nd semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Mathematik für Materialwissenschaftler 2	Compulsory	4
	Practical exercises	Mathematik für Materialwissenschaftler 2	Compulsory	2
Workload	60 hrs of lectures 30 hrs of exercises 60 hrs of self-study 90 hrs of extra work 240 hrs total workload			
ECTS credit points	8 ECTS			
Requirements according to the Examination Regulations	None			
Recommended requirements	Mawi-102: Mathematik für Materialwissenschaftler 1			
Coursework	Solving exercises Presenting the solutions			

<table>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written or oral examination</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students have mastered the further contents of higher mathematics which are listed below. They can apply these to accurately and effectively solve problems (knowledge, understanding).
They can understand and analyse mathematical descriptions as used in materials science, electrical engineering, physics or thermodynamics. Students are able to connect this with their knowledge in new contexts (analyse, apply).
They are able to develop, prove or disprove new mathematical statements (assessment).</td></tr>
<tr><td>Contents</td><td colspan="3"><u>Distribution functions</u>
• Boltzmann
• Maxwell
• Bose-Einstein
• Fermi
• Dirac
<u>Series expansions</u>
• Taylor
• Fourier
<u>Complex numbers</u>
• Complex functions
• Unit circle
<u>Transformations</u>
• Fourier
• Laplace
• Legendre
<u>Numerics</u>
• Newton's method
• Gradient method
<u>Computer Science</u>
• Number system</td></tr>
<tr><td>Media forms</td><td colspan="3">Beamer, Blackboard</td></tr>
<tr><td>Literature</td><td colspan="3">• Joos Richter: Höhere Mathematik. ("Höhere Mathematik für den Praktiker")
• Bronstein: Taschenbuch der Mathematik.</td></tr>
</table>

Module description	**Einführung in die Materialwissenschaft 2**			
	Introduction to Materials Science 2			
Module code	mawi-206			
Module level	Basics in Materials Science			
Abbreviation if applicable	EMaWi2			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Summer semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. K. Rätzke			
Lecturer	Prof. Dr. K. Rätzke			
Language	German			
Where in the curriculum	Compulsory module in the 2nd semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Einführung in die Materialwissenschaft 2	Compulsory	2
	Practical exercises	Einführung in die Materialwissenschaft 2	Compulsory	1
	Seminar	Proseminar	Compulsory	1
Workload	30 hrs of lectures 15 hrs of exercises 15 hrs of Seminar 30 hrs of self-study 30 hrs of extra work 120 hrs total workload			
ECTS credit points	4 ECTS			
Requirements according to the Examination Regulations	None			

<table>
<tr><td>Recommended requirements</td><td colspan="3">The module "Introduction to Materials Science 1" should have been successfully completed.
Basic knowledge of differential and integral calculus, differentiation, partial derivatives, what is a differential equation?
Basics of organic and polymer chemistry.</td></tr>
<tr><td>Coursework</td><td colspan="3">Solving exercises
Presenting the solutions</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written or oral examination</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students have a deeper understanding of the structure of the individual material classes or composite materials. They are familiar with the most important models of chemistry and physics to describe solids and their macroscopic properties. Students can therefore understand the derivation of procedures, to influence or change them.

Students are aware of the main aspects of working safely in the laboratory, and the specific rules of the Institute for Materials Science. They can recognise hazards and take appropriate protective measures. Students know the structure of practical experiment, and how to specifically prepare for it. They have learned how to write technical reports. Students are familiar with national and international standards for special processes of material testing.</td></tr>
<tr><td>Contents</td><td colspan="3">The module provides an introduction to the concepts and main features of materials science, with the following topics:
• Chemical and tribological properties
• Electronic properties
• Conductivity in metals
• Free electron gas
• Semiconductors
• Energy-band model
• Intrinsic / extrinsic conduction
• Polymer materials
• Composite materials
• Forming
• Special materials

Proseminar - Practical experiment
• Preparation
• Safety instructions
• Writing reports
• DIN/ISO standards
• Working safely in the laboratory</td></tr>
<tr><td>Media forms</td><td colspan="3">Blackboard, Chalk, Overhead, PowerPoint, Script, Tour oft the lab, interactive Communication</td></tr>
</table>

Literature	• Hornbogen, Werkstoffe • Hans-Jürgen Bargel Werkstoffkunde • C.R. Barrett et al.: The Principles of Engineering Materials

Module description	**Physikalische Chemie 1** ***The latest version by the department offering the course is valid!*** ***This extract is purely for informational purposes.***			
	Physical Chemistry 1			
Module code	chem0204			
Module level	Mathematical and natural science basics			
Abbreviation if applicable	PC1			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Summer semester			
Faculty responsible for the module	Faculty of Mathematics and Natural Science			
Institute responsible for the module	Institute for Physical Chemistry			
Lecturer responsible for the module	Directors of the Institute for Physical Chemistry			
Lecturer	Various Lecturers of the Institute for Physical Chemistry			
Language	German			
Where in the curriculum	Compulsory module in the 2nd semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration, B.Sc. Chemie und B.Sc. Wirtschaftschemie			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Physikalische Chemie 1	Compulsory	3
	Practical exercises	Physikalische Chemie 1	Compulsory	1
Workload	42 hrs of lectures 14 hrs of exercises 124 hrs of self-study 180 hrs total workload *Basis for this calculation is a semester containing 14 weeks of lectures.*			
ECTS credit points	6 ECTS			

<table>
<tr><td>Requirements according to the Examination Regulations</td><td colspan="4">None</td></tr>
<tr><td>Recommended requirements</td><td colspan="4">None</td></tr>
<tr><td>Coursework</td><td colspan="4">None</td></tr>
<tr><td>Examinations</td><td colspan="4">The total score (P, in %) is calculated using the following formula: P = 0.3x(%Ü) + 0.3x(%T) + 0.4x(%K)
The module is considered "passed" when P ≥ 60% (version 1). Alternatively, a pass can also be awarded if at least 60% of possible points is achieved in the written examination (version 2).
The final grade is based on the total score P (version 1) or the score achieved in the written examination (version 2), whichever is better.
<table>
<tr><td>Type</td><td>Compulsory/ optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Solving exercises</td><td>optional</td><td>graded</td><td>30%</td></tr>
<tr><td>10 Min Questionaire every 2 weeks</td><td>optional</td><td>graded</td><td>30%</td></tr>
<tr><td>Written</td><td>compulsory</td><td>graded</td><td>40%</td></tr>
</table></td></tr>
<tr><td>Learning objectives / competences</td><td colspan="4">Students are familiar with the thermodynamic equilibrium conditions in various systems. They are able to quantitatively describe, understand and predict the state of matter diagrams of materials, material mixtures and chemical equilibriums.
Students are familiar with the concepts for the quantitative description of material properties and states, and for the description and prediction of chemical equilibriums.</td></tr>
<tr><td>Contents</td><td colspan="4">• Material states and state changes: ideal and real gases, kinetic gas theory; state variables and state equations;
• Main principles of thermodynamics and their application to reversible and irreversible processes: internal energy, enthalpy, entropy and Gibbs and Helmholtz free energies;
• Thermodynamic equilibrium conditions, chemical potential and chemical equilibrium;
• Law of mass action and its application to homogeneous and heterogeneous equilibriums; temperature and pressure dependence of the equilibrium constants;
• Phase equilibriums of pure substances;
• Colligative properties;
• Basics of mixed-phase thermodynamics;
• Equilibrium electrochemistry;
• Basics of statistical thermodynamics: Statistical processes of adjustment and distribution in solids and ideal gases, Boltzmann equation for entropy, Boltzmann distribution, concept of the partition function, results for the thermodynamic partition functions.</td></tr>
<tr><td>Media forms</td><td colspan="4">Blackboard, Powerpoint, online Script</td></tr>
</table>

Literature	• P. W. Atkins, J. de Paula, Physikalische Chemie, Wiley/VCH, Weinheim, • G. Wedler, H.-J. Freund, Lehrbuch der Physikalischen Chemie, Wiley/VCH, Weinheim, • P. W. Atkins, J. de Paula, Physical Chemistry, Freeman, New York, • K. Denbigh, The Principles of Chemical Equilibrium, Cambridge University Press, Cambridge, 1997, • Vorlesungsskripte der Dozenten

Module description	**Ingenieurpraktikum Materialwissenschaft**			
	Engineering Practical for Materials Science			
Module code	mawi-205			
Module level	Subject specific basics			
Abbreviation if applicable	IPM			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Summer semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Dr. O. Riemenschneider			
Lecturer	Dr. O. Riemenschneider and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 2nd semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Not graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Practical	Ingenieurpraktikum Materialwissenschaft	Compulsory	4
Workload	60 hrs of practical 30 hrs of preparation 90 hrs of extra work 180 hrs total workload			
ECTS credit points	6 ECTS			
Requirements according to the Examination Regulations	none			
Recommended requirements	Modules „Einführung in die Materialwissenschaft 1 und 2“ should be completed.			
Coursework	None			
Examinations	12 test certificates including oral preliminary examination (colloquium), test set-up and execution and protocol correction.			

<table>
<tr><td></td><td>The module is passed when all certificates have been obtained. If up to 25% of the certificates are missing, they can be repeated in the following academic year. If more than 25% of the certificates are missing, the module has not been passed.
<table>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Not graded</td><td>100%</td></tr>
</table></td></tr>
<tr><td>Learning objectives / competences</td><td>Students are able to put the theoretical knowledge learned in the modules "Introduction to Materials Science 1 and 2" into practice. Students are able to properly use the relevant devices, equipment and measuring instruments for material testing, and have expanded their own experiences and skills in this regard. They recognise the interdisciplinary character of materials science in the experiments, and thus understand the requirements of related disciplines.
Students know that not only professional competence is required for the success of an experimental task, but to a great extent also team spirit, organisational skills and time management. They can document their work according to the usual laboratory specifications, and present this in a technical report.</td></tr>
<tr><td>Contents</td><td>Experiments, the oral examinations on the experiments, as well as the submission and correction of the technical reports, is carried out in groups of 2-3 students.
The following experiments must be performed:
• Phase transformation, microstructure and properties
• Stress and strain
• Sudden loads
• Compressive strength
• Corrosion
• Ultrasound
• Metallography
• Melting and solidification
• Hardening
• Ageing
• Excretory processes
• Sensors</td></tr>
<tr><td>Media forms</td><td>Test setups, instructions</td></tr>
<tr><td>Literature</td><td>Test instructions on the Internet at http://www.tf.uni-kiel.de/servicezentrum/de/studium/praktika with further literature references.</td></tr>
</table>

Module description	**Materialwissenschaft 1**			
	Materials Science 1			
Module code	mawi-308			
Module level	Basics in Materials Science			
Abbreviation if applicable	MaWi1			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. C. Selhuber-Unkel			
Lecturer	Prof. Dr. C. Selhuber-Unkel and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 3rd semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Materialwissenschaft 1	Compulsory	3
	Practical exercises	Materialwissenschaft 1	Compulsory	1
	Seminar	Proseminar	Compulsory	1
Workload	45 hrs of lectures 15 hrs of exercises 15 hrs of seminar 30 hrs of extra work 75 hrs of self-study 180 hrs total workload			
ECTS credit points	6 ECTS			
Requirements according to the Examination Regulations	None			

<table>
<tr><td>Recommended requirements</td><td colspan="3">The modules "Introduction to Materials Science 1 and 2", "Physics 1 and 2", "Mathematics for Materials Scientists 1 and 2" and "Physical Chemistry 1" should be successfully completed.</td></tr>
<tr><td>Coursework</td><td colspan="3">Solving exercises
Presenting the solutions
Multiple Choise Tests
Creating a presentation</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written or oral examination</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students are able to represent the structure of matter and the associated principles of quantum mechanics. They are able to sketch, use and assess bonding potential. Students can distinguish the types of crystal and name them correctly. They can summarise the basic concepts of thermodynamics, and can apply these in selected examples. They can interpret phase diagrams, and can therefore deduce the consequences for certain materials.
They can accurately perform calculations for diffusion and kinetics, as well for the mechanical properties of materials, from basic parameters. Based on this, students can classify the various materials.

Students are able to equip their electronic workplace with appropriate software for creating texts, graphs and graphics, as well as presentations, and use them effectively. They are familiar with databases and their benefits, for example in literature research, but also for their own use. Students have gained insight into programmes for data acquisition and evaluation.</td></tr>
<tr><td>Contents</td><td colspan="3">• Structure of matter
• Elementary quantum theory
• Bonding potential and types
• Crystals
• Crystallography
• Crystal defects
• Thermodynamics in statistical impression
• Main principles of thermodynamics
• Boltzmann distribution
• Phase diagrams
• Kinetics
• Diffusion
• "Random Walk"
• Mechanical properties
• Elastic modules
• Breakage
• Plastic deformation
• Yield stress
• Amorphous materials
• Deformation</td></tr>
</table>

	• Rubber elasticity Proseminar - Scientific software • Creating texts • Drawing graphs • Creating graphics • Preparing presentations • Literature research • Databases • Measurement software
Media forms	The module is completely available on the Internet ("Hyperscripts") with numerous supplementary modules for basic terms and advanced contents as well as classic exercises and "Multiple Choice" tasks. The blackboard and a beamer are used in classroom teaching. Presentations are made using PowerPoint and must be supplemented by written elaborations.
Literature	• "Hyperscripte von AMAT" http://www.tf.uni-kiel.de/matwis/amat/mw1_ge/index.html • J. F. Shackelford, Introduction to Materials Science for Engineers, 3th edition, Pearson Education International 2005 • W. Gonzales-Vinas, H.L. Mancini, An Introduction to Materials Science, Princeton University Press 2004 • J. W. Mayer, S.S. Lau, Electronic Materials Science, Macmillan Publ. Co.1990 • K Stierstadt, Physik der Materie, VCH 1989 • G. Fasching, Werkstoffe für die Elektrotechnik: Mikrophysik, Struktur, Eigenschaften, Springer 1994 • H. G. Rubahn, Nanophysik und Nanotechnologie, Teubner 2002 • Bergmann-Schaefer, Lehrbuch der Experimentalphysik, Band 6 Festkörper, de Gruyter 1992

Module description	**Physikalisches Anfängerpraktikum Teil 1** ***The latest version by the department offering the course is valid!*** ***This extract is purely for informational purposes.***			
	Physical Lab for Beginners Part 1			
Module code	phys-mawi-403			
Module level	Mathematical and natural science basics			
Abbreviation if applicable	PhysPrak1			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Mathematics and Natural Sciences			
Institute responsible for the module	Institute for Experimental and Applied Physics			
Lecturer responsible for the module	Dr. V. de Manuel Gonzalez			
Lecturer	Dr. V. de Manuel Gonzalez and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 3rd semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration, B.Sc. Physics and B.Sc. Physics of the Earth System			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/optional*	*SWS*
	Practical	Physikalisches Anfängerpraktikum Teil 1	Compulsory	6
	Seminar	Proseminar zum physikalischen Anfängerpraktikum Teil 1	Compulsory	1
Workload	84 hrs pracctical 14 hrs of seminar 52 h hrs of self-study 120 hrs of extra work 270 hrs total workload			
ECTS credit points	9 ECTS			

<table>
<tr><td>Requirements according to the Examination Regulations</td><td colspan="3">Successful completion of the modules mawi-101 Physics 1 and mawi-201 Physics 2.</td></tr>
<tr><td>Recommended requirements</td><td colspan="3">None</td></tr>
<tr><td>Coursework</td><td colspan="3">None</td></tr>
<tr><td>Examinations</td><td colspan="3">4 oral test interviews, 8-10 test certificates including colloquium, test set-up and execution and protocol correction. The module is passed when all certificates for the practical course protocols have been obtained and the oral examination interviews have been successfully completed within the framework of the accompanying seminar. The grade is given by the grade of the examination interviews. If a maximum of two test certificates are missing, an additional oral examination is required to pass the module. If more than two certificates are missing, the module has not been passed.</td></tr>
<tr><td></td><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td></td><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students are able to apply the previously-acquired theoretical knowledge to the topics listed below. They have expertise in the use of physical measurement devices, and in the planning and recording of measurement series. They can apply common methods of evaluation and assessment to these measurement series, and have methodical skills in systematic logging and error evaluation. Students know that teamwork and discussion play a central role in the work methodology. They can document, correct and evaluate their work results in the form of detailed reports. This enables them to present physical facts and the carrying out of experiments.</td></tr>
<tr><td>Contents</td><td colspan="3">Experiments in the areas of
• Optics
• Thermodynamics
• Atomic physics</td></tr>
<tr><td>Media forms</td><td colspan="3">Printed test instructions, some of which are physical experiments that can be set up by the user.</td></tr>
<tr><td>Literature</td><td colspan="3">• Walcher: Praktikum der Physik (Teubner-Verlag)
• Westphal: Physikalisches Praktikum (Vieweg-Verlag)</td></tr>
</table>

Module description	**Grundlagen der Elektrotechnik** ***The latest version by the department offering the course is valid!*** ***This extract is purely for informational purposes.***			
	Basics in Electrical Engineering			
Module code	etit-007			
Module level	Subject related basics			
Abbreviation if applicable	GET			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Wintersemester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute of Electrical Engineering and Information Technology			
Lecturer responsible for the module	Prof. Dr. M. Gerken			
Lecturer	Dr.-Ing. K. Scholz and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 3rd semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Grundlagen der Elektrotechnik	Compulsory	2
	Practical exercises	Grundlagen der Elektrotechnik	Compulsory	1
Workload	30 hrs of lectures 15 hrs of exercises 45 hrs of self-study 60 hrs of extra work 150 hrs total workload			
ECTS credit points	5 ECTS			

<table>
<tr><td>Requirements according to the Examination Regulations</td><td colspan="3">None</td></tr>
<tr><td>Recommended requirements</td><td colspan="3">Knowledge of electric and magnetic fields at the level of the module mawi-201: Physics 2: Electrics and Optics</td></tr>
<tr><td>Coursework</td><td colspan="3">Solving exercises
Presenting the solutions</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written examination</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students are able to analyse static current and voltage values in technical systems, as well as time-dependent current and voltage processes with sinusoidal excitation. Students understand that the electrical behaviour of technical systems can be approximately modelled with the help of the ideal two-terminal circuit R, L and C, as well as ideal sources. They can simplify larger linear electrical networks by combining elements, and the creation of substitute two-terminal circuits. Students have mastered the method of complex alternating current calculation, for the analysis of sinusoidal time-dependent processes.</td></tr>
<tr><td>Contents</td><td colspan="3">• Modelling of linear technical systems with networks from the ideal two-terminal circuit R, L and C, as well as ideal sources.
• Static network calculation (Kirchhoff's laws, simplification, conversion, overlay, substitute two-terminal circuits).
• Network calculation for temporal sinusoidal current and voltage curves (complex representation of sinusoidal variables, complex variables for two-terminal circuits, complex equivalent circuits, active power, reactive power, apparent power).
• Analysis of the frequency-dependent behaviour of linear electrical networks (locus, Bode diagram, pole-zero diagram).
• Modelling of the small-signal behaviour of non-linear systems in the operating point with linear electrical networks.</td></tr>
<tr><td>Media forms</td><td colspan="3">Beamer, Blackboard</td></tr>
<tr><td>Literature</td><td colspan="3"><u>Textbooks</u>
• A. R. Hambley: Electrical Engineering, Principles and Applications, Pearson
• G. Hagmann: Grundlagen der Elektrotechnik, Aula-Verlag
• A. Führer, K. Heidemann und W. Nerreter, Grundgebiete der Elektrotechnik Band 1: Stationäre Vorgänge, Hanser Fachbuchverlag
• A. Führer, K. Heidemann und W. Nerreter, Grundgebiete der Elektrotechnik Band 2: Zeitabhängige Vorgänge, Hanser Fachbuchverlag</td></tr>
</table>

	• M. Albach: Grundlagen Elektrotechnik 1: Erfahrungssätze, Bauelemente, Gleichstromschaltungen, Pearson Studium • M. Albach: Grundlagen der Elektrotechnik 2: Periodische und nicht periodische Signalformen, Pearson Studium • R. Busch: Elektrotechnik und Elektronik: für Maschinenbauer und Verfahrenstechniker, Vieweg+Teubner • H. Frohne, K.-H. Löcherer, H. Müller und T. Harriehausen: Moeller Grundlagen der Elektrotechnik, Vieweg+Teubner • R. Pregla: Grundlagen der Elektrotechnik, Hüthig <u>Exercise Books</u> • G. Hagmann: Aufgabensammlung zu den Grundlagen der Elektrotechnik: mit Lösungen und ausführlichen Lösungswegen, Aula-Verlag • A. Führer, K. Heidemann, W. Nerreter: Grundgebiete der Elektrotechnik Band 3: Aufgaben, Hanser Fachbuchverlag • C. Kautz: Tutorien zur Elektrotechnik, Pearson Studium

Module description	**Materialwissenschaft 2**			
	Materials Science 2			
Module code	mawi-412			
Module level	Basics in Materials Science			
Abbreviation if applicable	MaWi2			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Summer semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. C. Selhuber-Unkel			
Lecturer	Prof. Dr. C. Selhuber-Unkel and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 4th semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Materialwissenschaft 2	Compulsory	3
	Practical exercises	Materialwissenschaft 2	Compulsory	1
	Seminar	Proseminar	Compulsory	1
Workload	45 hrs of lectures 15 hrs of exercises 15 hrs of seminar 30 hrs of extra work 75 hrs of self-study 180 hrs total workload			
ECTS credit points	6 ECTS			
Requirements according to the Examination Regulations	None			

<table>
<tr><td>Recommended requirements</td><td colspan="3">The modules "Introduction to Materials Science 1 and 2", "Physics 1 and 2", "Mathematics for Materials Scientists 1 and 2" and "Physical Chemistry 1" should be successfully completed.</td></tr>
<tr><td>Coursework</td><td colspan="3">Solving exercises
Presenting the solutions
Multiple Choise Tests
Creating a presentation</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written or oral examination</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students understand and can explain the behaviour of electrons in solids. They can depict the background of waves in materials, and perform various tasks in this context, especially with the reciprocal lattice. Students have the expertise to demonstrate electronic energy bands, and explain the most common forms of interband transitions. They are aware of the important properties of semiconductors for materials science, can summarise them, and calculate them in simple tasks. Students can formulate the functional principles of semiconductor-based electronic components, can compare them, and explain the behaviour of semiconductor contacts.

Students know how data such as measured values can be recorded electronically. They are familiar with the popular digital formats, and can use appropriate programmes to utilise the data on any required platform. They can assess the data from both statistical and physical perspectives, and evaluate this in the context of a project.</td></tr>
<tr><td>Contents</td><td colspan="3">• Conductivity in general
• Scattering and mobility
• Hall effect
• Free electron gas
• State density and Fermi distribution
• Oscillations and waves
• Waves in crystals
• Reciprocal lattices
• Bragg law
• Structural analysis
• Periodic potential
• Origin of energy bands
• Classification of conductors, semiconductors and insulators
• Law of conservation
• Interband transitions
• Semiconductors
• Intrinsic charge carrier density
• Doping
• Fermi energy
• Durability
• Dynamic charge carrier balance</td></tr>
</table>

	• Semiconductor devices • PN junction • Characteristic curves • Solar cells • Bipolar junction transistor • MOS transistors Proseminar - Data analysis • Data recording • Sorting and formatting • Statistical analysis • Evaluation software • Physical basis of evaluation • Context within the framework of a project
Media forms	The module is completely available on the Internet ("Hyperscripts") with numerous supplementary modules for basic terms and advanced contents as well as classic exercises and "Multiple Choice" tasks. In classroom teaching, blackboards and beamers are used. Presentations are made using PowerPoint and must be supplemented by written elaborations.
Literature	• "Hyperscripte von AMAT" http://www.tf.uni-kiel.de/matwis/amat/mw2_ge/index.html • J. F. Shackelford, Introduction to Materials Science for Engineers, 3th edition, Pearson Education International 2005 • W. Gonzales-Vinas, H.L. Mancini, An Introduction to Materials Science, Princeton University Press 2004 • J. W. Mayer, S.S. Lau, Electronic Materials Science, Macmillan Publ. Co.1990 • K Stierstadt, Physik der Materie, VCH 1989 • G. Fasching, Werkstoffe für die Elektrotechnik: Mikrophysik, Struktur, Eigenschaften, Springer 1994 • H. G. Rubahn, Nanophysik und Nanotechnologie, Teubner 2002 • Bergmann-Schaefer, Lehrbuch der Experimentalphysik, Band 6 Festkörper, de Gruyter 1992

Module description	**Physikalisches Anfängerpraktikum Teil 2** ***The latest version by the department offering the course is valid!*** ***This extract is purely for informational purposes.***			
	Physical Lab for Beginners Part 2			
Module code	phys-mawi-503			
Module level	Mathematical and natural science basics			
Abbreviation if applicable	PhysPrak2			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Summer semester			
Faculty responsible for the module	Faculty of Mathematics and Natural Sciences			
Institute responsible for the module	Institute for Experimental and Applied Physics			
Lecturer responsible for the module	Dr. V. de Manuel Gonzalez			
Lecturer	Dr. V. de Manuel Gonzalez and colleagues			
Language	German			
Where in the curriculum	Compulsory module in the 4th semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration, B.Sc. Physics and B.Sc. Physics of the Earth System			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Practical	Physikalisches Anfängerpraktikum Teil 2	Compulsory	6
	Seminar	Proseminar zum physikalisches Anfängerpraktikum Teil 2	Compulsory	1
Workload	90 hrs practical 15 hrs of seminar 45 hrs of self-study 120 hrs of extra work 270 hrs total workload			
ECTS credit points	9 ECTS			

<table>
<tr><td>Requirements according to the Examination Regulations</td><td colspan="3">Successful completion of the modules mawi-101 Physics 1 and mawi-201 Physics 2.</td></tr>
<tr><td>Recommended requirements</td><td colspan="3">None</td></tr>
<tr><td>Coursework</td><td colspan="3">None</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">4 oral test interviews, 8-10 test certificates including colloquium, test set-up and execution and protocol correction. The module is passed when all certificates for the practical course protocols have been obtained and the oral examination interviews have been successfully completed within the framework of the accompanying seminar. The grade is given by the grade of the examination interviews. If a maximum of two test certificates are missing, an additional oral examination is required to pass the module. If more than two certificates are missing, the module has not been passed.</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students are able to apply the previously-acquired theoretical knowledge to the topics listed below, and further deepen this knowledge. They have expertise in the use of physical measurement devices, and in the planning and recording of measurement series. They can apply common methods of evaluation and assessment to these measurement series, and have methodical skills in systematic logging and error evaluation. Students know that teamwork and discussion play a central role in the work methodology. They can document, correct and evaluate their work results in the form of detailed reports. This enables them to present physical facts and the carrying out of experiments.</td></tr>
<tr><td>Contents</td><td colspan="3">Experiments in the areas of
• Mechanics
• Electricity
• Physics with the computer</td></tr>
<tr><td>Media forms</td><td colspan="3">Printed test instructions, some of which are physical experiments that can be set up by the user.</td></tr>
<tr><td>Literature</td><td colspan="3">• Walcher: Praktikum der Physik (Teubner-Verlag)
• Westphal: Physikalisches Praktikum (Vieweg-Verlag)</td></tr>
</table>

Module description	**Materialanalytik**			
	Material Analysis			
Module code	mawi-420			
Module level	Material science specialisation			
Abbreviation if applicable	MatAna			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Summer semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. L. Kienle			
Lecturer	Prof. Dr. L. Kienle and colleagues			
Language	English			
Where in the curriculum	Compulsory module in the 4th semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science and B.Sc. Materials Science and Business Administration			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Materialanalytik	Compulsory	3
	Practical exercises	Materialanalytik	Compulsory	1
Workload	45 hrs of lectures 15 hrs of exercises 30 hrs of self-study 60 hrs of extra work 150 hrs total workload			
ECTS credit points	5 ECTS			
Requirements according to the Examination Regulations	None			
Recommended requirements	The modules "Introduction to Materials Science 1 and 2", "Physics 1 and 2", "Physical Chemistry 1", "Mathematics for Materials Scientists 1 and 2" should be successfully completed. In addition, the contents of the first two semesters of the module series "Materials Science" should be known.			

<table>
<tr><td>Coursework</td><td colspan="3">Solving exercises
Presenting the solutions</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written or oral examination</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">After successfully completing this module, students know the basics of the analysis methods presented, and can describe them. They understand which interactions occur between the radiation/method and material, and what information can be obtained from them about the material to be analysed. They know what possible restrictions there are related to the sample (geometry, surface, etc.) for the respective method of analysis. Students are able to select a suitable method of analysis or combinations of methods for a material and a specific question posed.</td></tr>
<tr><td>Contents</td><td colspan="3">• Basics of the interaction of particles and radiation with matter
• Electron beam methods
• Scanning electron microscopy (SE, BS, EBIC, CL, EDX)
• Electron microprobe
• Transmission electron microscopy
• High-resolution representation procedures
• Analytical TEM (HRTEM, STEM, EELS, XEDS, CBED)
• Ion beam methods
• Secondary-ion mass spectrometry (SIMS)
• Rutherford backscattering spectrometry (RBS)
• X-ray methods
• Diffraction methods
• Topography methods
• Absorption spectroscopy
• Electron spectroscopy methods
• Photoelectron spectroscopy (XPS, UPS, ESCA)
• Auger electron spectroscopy
• Scanning probe methods
• Scanning tunnelling microscopy
• Tunnel spectroscopy
• Atomic force microscopy</td></tr>
<tr><td>Media forms</td><td colspan="3">Beamer, Blackboard</td></tr>
<tr><td>Literature</td><td colspan="3">Selected chapters from the following books:
• E. Fuchs, H. Oppolzer, H. Rehme: Particle Beam Microanalysis - Fundamentals, Methods, Applications VCH 1990
• A R Clarke, C N Eberhardt, Microscopy Techniques for Materials Science, CRC Press 2002
• J. M. Walls (Ed.): Methods of Surface Analysis; Cambridge University Press 1989
• P. Goodhew, J. Humphreys, R. Beanland: Electron Microscopy and Analysis, Taylor and Francis 2001</td></tr>
</table>

	• P. E. J. Flewitt, R. K. Wild: Physical methods for Materials Characterization, IoP Publishing 1994 • R. Brundle, C.A. Evans Jr., S. Wilson (Eds.): Encyclopedia of Materials Characterization; Butterworth-Heinemann 1992 • D.J. O'Connor, B. A. Sexton, , R. St.C. Smart (Eds.) Surface Analysis Methods in Materials Science, Springer 2003 • H. Bubert and H. Jenett (Eds.) Surface and Thin Film Analysis, WILEY-VCH 2002 • B. Bhushan, H. Fuchs, S. Osaka (Eds.), Applied Scanning Probe Methods, Springer Nanoscience and Technology 2004 • P. F. Fewster, X-ray scattering from semiconductors, Imperial College Press 2000 • A. Putnis: Introduction to Mineral Sciences, Ch.3,4; Cambridge University Press 1992 Test instructions on the Internet at http://www.tf.uni-kiel.de/servicezentrum/de/studium/praktika with further literature references.

Module description	**Werkstoffe**			
	Materials			
Module code	mawi-422			
Module level	Subject related specialisation			
Abbreviation if applicable	WeSt			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Summer semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. F. Faupel			
Lecturer	Metalle: Prof. Dr. J. McCord and colleagues Polymere: Prof. Dr. F. Faupel and colleagues Keramiken: Prof. Dr. E. Quandt and colleagues Halbleiter: Prof. Dr. R. Adelung and colleagues			
Language	English			
Where in the curriculum	Compulsory module in the 4th semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Werkstoffe – Metalle	Compulsory	2
	Lecture	Werkstoffe – Polymere	Compulsory	2
	Lecture	Werkstoffe – Keramiken	Compulsory	2
	Lecture	Werkstoffe – Halbleiter	Compulsory	2
	Practical exercises	Werkstoffe	Compulsory	2
Workload	120 hrs of lectures 30 hrs of exercises 60 hrs of extra work 90 hrs of self-study 300 hrs total workload			
ECTS credit points	10 ECTS			

<table>
<tr><td>Requirements according to the Examination Regulations</td><td colspan="4">None</td></tr>
<tr><td>Recommended requirements</td><td colspan="4">The modules "Chemistry for Materials Science Students", "Introduction to Materials Science 1 and 2", "Physics 1 and 2", "General Chemistry", "Physical Chemistry 1", "Mathematics for Materials Scientists 1 and 2" and "Materials Science 1" should be successfully completed.</td></tr>
<tr><td>Coursework</td><td colspan="4">Solving exercises
Presenting the solutions
Presentation on a current topic</td></tr>
<tr><td rowspan="6">Examinations</td><td colspan="4">Combined examination consisting of a written exam or an oral examination for each lecture.</td></tr>
<tr><td>Lecture</td><td>Compulsory/ optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Metalle</td><td>Compulsory</td><td>Graded</td><td>25%</td></tr>
<tr><td>Polymere</td><td>Compulsory</td><td>Graded</td><td>25%</td></tr>
<tr><td>Keramiken</td><td>Compulsory</td><td>Graded</td><td>25%</td></tr>
<tr><td>Halbleiter</td><td>Compulsory</td><td>Graded</td><td>25%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="4">Students are familiar with the types of bonds, the structural characteristics on all length scales, and the relevant defects, for all material classes. They are familiar with the mechanical properties in detail, and have gained an initial insight into the functional properties. They are familiar with the main features of production and processing as well as the recycling of the individual material classes. They are aware that there are standards for material classification, and know how and where to find them, if required. They can apply this knowledge, to select the right material and the correct manufacturing method for simple problems, and set the microstructure so that the desired characteristics profile is achieved. They can independently search scientific literature and critically evaluate approaches to solve a materials science problem.</td></tr>
<tr><td>Contents</td><td colspan="4">Metals
• Chemical bonding
• Crystal structures
• Thermodynamics of alloys
• Phase diagrams
• Mechanical properties
• Thermally activated processes
• Solidification and solid-state transformation
• Hardening of alloys
• Corrosion
• High temperature oxidation
• Metal processing

Polymers
• Properties and classification
• Polymer synthesis
• Thermodynamics of polymer blends</td></tr>
</table>

	• Crystallisation, melting and glass transition • Mechanical and rheological properties • Dielectric and optical properties • Polymer processing • Polymer films *Ceramics* • Classical manufacturing of ceramic materials • Modern methods of manufacturing ceramic materials • Monoliths • Thin films • Structural properties • Difference to other materials • Functional applications *Semiconductors* • Basics of components physics • Single-process technology • Process integration • Microelectronic and nanoelectronic materials • Aspects of electronics • Aspects of plasmonics • NEMS • MEMS *General* • Comparison of materials • When is which material suitable? • Composite materials • Cost considerations • Recycling
Media forms	Beamer, Blackboard
Literature	• Kingery, W.D., Bowen, H.K., Uhlmann, D.R.: Introduction to Ceramics, Wiley-Interscience, New York • Moulson, A.J., Herbert, J. M.: Electroceramics (Materials, Properties, Applications); Chapman & Hall, London • Steele, B.C. H. (Hrsg.): Electronic Ceramics; Elsevier Applied Science, London Schaumburg • H. Hench, L.L (Hrsg.): Keramik; B.G. Teubner, Stuttgart. • West, J.K., Principles of Electronic Ceramics; Wiley-Interscience, New York

Module description	**Analytikpraktikum**			
	Analysis Practical			
Module code	mawi-512			
Module level	Material science specialisation			
Abbreviation if applicable	MatAnaPrak			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. L. Kienle			
Lecturer	Prof. Dr. L. Kienle and colleagues			
Language	English			
Where in the curriculum	Compulsory module in the 5th semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Not graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Practical	Analytikpraktikum	Compulsory	4
Workload	60 hrs practical 30 hrs of preparation 90 hrs of extra work 180 hrs total workload			
ECTS credit points	6 ECTS			
Requirements according to the Examination Regulations	None			
Recommended requirements	The modules "Materials Analysis", "Physics 1 and 2", "Physical Chemistry 1", "Mathematics for Materials Scientists 1 and 2" should be successfully completed. In addition, the contents of the first two semesters of the module series "Materials Science" should be known.			
Coursework	None			
Examinations	9 certificates including oral examination (colloquium)			

<table>
<tr><td></td><td colspan="3">Test setup and execution and protocol correction.
The module is passed when all certificates have been obtained. If up to 25% of the certificates are missing, they can be repeated in the following academic year. If more than 25% of the certificates are missing, the module has not been passed.</td></tr>
<tr><td></td><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td></td><td>Compulsory</td><td>Not graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students are familiar with state-of-the-art research equipment and their various analytical methods, and can use them independently.
They are aware of the importance of the methods presented for the research and development of modern functional materials, such as in nanotechnology, for example. In this regard, they have an overview of the most important methodological areas for the analysis of surfaces, interfaces, nanomaterials, layers and their processes.
Students know that not only professional competence is required for the success of an experimental task, but to a great extent also team spirit, organisational skills and time management. They can document their work according to the usual laboratory specifications, and present this in a technical report.</td></tr>
<tr><td>Contents</td><td colspan="3">Experiments, the oral examinations on the experiments, as well as the submission and correction of the technical reports, is carried out in groups of 2-3 students.
The following 9 experiments must be carried out:
• B501 Confocal light microscope
• B502 Spark emission spectroscopy
• B503 X-ray diffraction
• B507 UV/VIS spectroscopy
• B508 Ellipsometry
• B510 Functionalised surfaces
• B511 Scanning electron microscopy and energy dispersive X-ray spectroscopy
• B512 Vibrating sample magnetometry
• B513 Transmission electron microscopy</td></tr>
<tr><td>Media forms</td><td colspan="3">Beamer, Blackboard</td></tr>
<tr><td>Literature</td><td colspan="3">Selected chapters from the following books:
• E. Fuchs, H. Oppolzer, H. Rehme: Particle Beam Microanalysis - Fundamentals, Methods, Applications VCH 1990
• A R Clarke, C N Eberhardt, Microscopy Techniques for Materials Science, CRC Press 2002
• J. M. Walls (Ed.): Methods of Surface Analysis; Cambridge University Press 1989
• P. Goodhew, J. Humphreys, R. Beanland: Electron Microscopy and Analysis, Taylor and Francis 2001
• P. E. J. Flewitt, R. K. Wild: Physical methods for Materials Characterization, IoP Publishing 1994</td></tr>
</table>

	• R. Brundle, C.A. Evans Jr., S. Wilson (Eds.): Encyclopedia of Materials Characterization; Butterworth-Heinemann 1992 • D.J. O'Connor, B. A. Sexton, , R. St.C. Smart (Eds.) Surface Analysis Methods in Materials Science, Springer 2003 • H. Bubert and H. Jenett (Eds.) Surface and Thin Film Analysis, WILEY-VCH 2002 • B. Bhushan, H. Fuchs, S. Osaka (Eds.), Applied Scanning Probe Methods, Springer Nanoscience and Technology 2004 • P. F. Fewster, X-ray scattering from semiconductors, Imperial College Press 2000 • A. Putnis: Introduction to Mineral Sciences, Ch.3,4; Cambridge University Press 1992 Test instructions on the Internet at http://www.tf.uni-kiel.de/servicezentrum/de/studium/praktika with further literature references. 

Module description	**Technische Mechanik**			
	Technical Mechanics			
Module code	mawi-513			
Module level	Subject related specialisation			
Abbreviation if applicable	TechMech			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. S. Wulfinghoff			
Lecturer	Prof. Dr. S. Wulfinghoff and colleagues			
Language	English			
Where in the curriculum	Compulsory module in the 5th semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Technische Mechanik	Compulsory	2
	Practical exercises	Technische Mechanik	Compulsory	1
Workload	30 hrs of lectures 15 hrs of exercises 45 hrs of self-study 60 hrs of extra work 150 hrs total workload			
ECTS credit points	5 ECTS			
Requirements according to the Examination Regulations	None			
Recommended requirements	None			
Coursework	Solving exercises Presenting the solutions			
Examinations	Written or oral examination			

	Compulsory/optional	*Graded/not graded*	*Weighting*
	Compulsory	Graded	100%
Learning objectives / competences	Students are able to name the basic correlations of forces in statically-determined bedded systems of rigid bodies, and the basics of elastostatics. They know the theories and methods for calculating the forces in such systems, and can apply them appropriately.		
Contents	• Methods for calculating the forces in statically-determined bedded systems of rigid bodies • Newton-Euler method • Energy methods • Basics of elasticity theory • Forces and deformations in elastic systems		
Media forms	Beamer, Blackboard		
Literature	• Gross, D.; Hauger, W.; Schröder, J.; Wall, W.A.: Technische Mechanik 1: Statik, Springer Vieweg, 2013 • Gross, D.; Hauger, W.; Schröder, J.; Wall, W.A.: Technische Mechanik 2: Elastostatik, Springer Verlag, 2011 • Gross, D; Ehlers, W.; Wriggers, P.; Schröder, J.; Müller, R.: Formeln und Aufgaben zur Technischen Mechanik 1: Statik, Springer Vieweg, 2013 • Gross, D; Ehlers, W.; Wriggers, P.; Schröder, J.; Müller, R.: Formeln und Aufgaben zur Technischen Mechanik 2: Elastostatik, Springer Verlag, 2011		

Module description	**Festkörperchemie**			
	Solid State Chemistry			
Module code	mawi-514			
Module level	Subject specific specialisation			
Abbreviation if applicable	FKC			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. L. Kienle			
Lecturer	Prof. Dr. L. Kienle and colleagues			
Language	English			
Where in the curriculum	Compulsory module in the 5th semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Festkörperchemie	Compulsory	3
	Practical exercises	Festkörperchemie	Compulsory	1
	Seminar	Proseminar	Compulsory	1
Workload	45 hrs of lectures 15 hrs of exercises 15 hrs of seminar 60 hrs of self-study 45 hrs of extra work 180 hrs total workload			
ECTS credit points	6 ECTS			
Requirements according to the Examination Regulations	None			

<table>
<tr><td>Recommended requirements</td><td colspan="3">Knowledge from the modules: "Introduction to Materials Science 1 and 2", "Physics 1 and 2", "Mathematics for Materials Scientists 1 and 2", "Chemistry for Materials Scientists" and "Physical Chemistry 1", "Materials Science 1 and 2".</td></tr>
<tr><td>Coursework</td><td colspan="3">Solving exercises
Presenting the solutions</td></tr>
<tr><td rowspan="3">Examinations</td><td colspan="3">Written or oral examination</td></tr>
<tr><td>Compulsory/optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td>Compulsory</td><td>Graded</td><td>100%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="3">Students are familiar with the basics of chemical synthesis processes for solids, and can assess the underlying strategies, problems and their solutions.
They can identify the most important material structures and their variants, and can describe them.
They can identify and describe symmetries of materials on macroscopic (crystallographic classes) and nanoscopic (space group) scales, and have knowledge of the relationship of these symmetries to material properties.

Students are aware of the different format requirements of publishers for publications. They are able to ascertain and interpret them in an appropriate manner. They can create suitable format templates and can select and apply the appropriate writing style. Students create texts with an appropriate structure and associated indexes. They can formulate a scientific problem and its solution in precise language, and write this in compliance with the format template.</td></tr>
<tr><td>Contents</td><td colspan="3">• Periodic table
• Chemical synthesis of solids
o High-temperature synthesis: strategies, problems and solutions
o Chemical gas phase transport
o Low-temperature syntheses: soft chemical approaches, ionic liquids
o Special processes: ionic liquids, vapour-liquid-solid method, intercalation reactions
o Nanochemical synthesis through reduction
• Crystallography of periodic crystals
o The concept of the unit cell
o Crystal systems and crystallographic classes
o Space groups and application of the space group concept
• Structures of important materials
o Densely packed surfaces and filled structures
o Rock salt (sodium chloride) structure: phase change materials (PCM)
o Sphalerite structure: semiconductors, VEC rule
o Perovskite structure: ferroelectrics and high-temperature superconductors
o Spinel structure: magnetite
o Rutile structure and variations</td></tr>
</table>

	○ Flourite structure and YSZ • Selected material classes ○ Zintl phases ○ Silicates and zeolites ○ Zeotype materials ○ Metal-organic frameworks • Inorganic complexes ○ General properties of complexes ○ Bonds in complexes, crystal field theory ○ Complexes in medicine and biology Proseminar - Scientific writing • Format requirements • Style of writing • Structure • Results and analysis • Bibliography
Media forms	Beamer and Blackboard
Literature	• A.R. West, Grundlagen der Festkörperchemie, Wiley 1992 • E. Riedel, Moderne Anorganische Chemie, De Gruyter 2012 • Borchard-Ott, Kristallographie: Eine Einführung für Naturwissenschaftler, Springer 2013 • U. Müller, Anorganische Strukturchemie, Teubner 2008

Module description	**Funktionsmaterialien**			
	Functional Materials			
Module code	mawi-515			
Module level	Subject specific specialisation			
Abbreviation if applicable	FuMa			
Subtitle, if applicable				
Duration	1 Semester			
Repetition in the academic year	Winter semester			
Faculty responsible for the module	Faculty of Engineering			
Institute responsible for the module	Institute for Materials Science			
Lecturer responsible for the module	Prof. Dr. E. Quandt			
Lecturer	Nanomaterialien: Prof. Dr. E. Quandt Biomaterialien: Prof. Dr. C. Selhuber-Unkel Magnetische Materialien: Prof. Dr. J. McCord Optische Materialien: Prof. Dr. J. McCord			
Language	English			
Where in the curriculum	Compulsory module in the 5th semester			
Applicability of the module	1-subject degree programmes B.Sc. Materials Science			
Assessment	Graded			
Courses	*Type*	*Title*	*Compulsory/ optional*	*SWS*
	Lecture	Funktionsmaterialien – Nanomaterialien	Compulsory	2
	Lecture	Funktionsmaterialien – Biomaterialien	Compulsory	2
	Lecture	Funktionsmaterialien – Magnetische Materialien	Compulsory	2
	Lecture	Funktionsmaterialien – Optische Materialien	Compulsory	2
	Practical exercises	Funktionsmaterialien	Compulsory	2
Workload	120 hrs of lectures 30 hrs of exercises 90 hrs of extra work 120 hrs of self-study 360 hrs total workload			

<table>
<tr><td>ECTS credit points</td><td colspan="4">12 ECTS</td></tr>
<tr><td>Requirements according to the Examination Regulations</td><td colspan="4">None</td></tr>
<tr><td>Recommended requirements</td><td colspan="4">The modules "Inorganic Chemistry", "Introduction to Materials Science 1 and 2", "Physics 1 and 2", "Chemistry for Materials Scientists", "Physical Chemistry 1", "Mathematics for Materials Scientists 1 and 2" and "Materials Science 1 and 2" should be successfully completed.</td></tr>
<tr><td>Coursework</td><td colspan="4">Solving exercises
Presenting the solutions</td></tr>
<tr><td>Examinations</td><td colspan="4">Combined examination consisting of one written examination or one oral examination for each lecture.</td></tr>
<tr><td></td><td>Lecture</td><td>Compulsory/ optional</td><td>Graded/not graded</td><td>Weighting</td></tr>
<tr><td></td><td>Nanomaterialien</td><td>Compulsory</td><td>Graded</td><td>25%</td></tr>
<tr><td></td><td>Biomaterialien</td><td>Compulsory</td><td>Graded</td><td>25%</td></tr>
<tr><td></td><td>Magnetische Materialien</td><td>Compulsory</td><td>Graded</td><td>25%</td></tr>
<tr><td></td><td>Optische Materialien</td><td>Compulsory</td><td>Graded</td><td>25%</td></tr>
<tr><td>Learning objectives / competences</td><td colspan="4">Students are able to explain fundamental physical properties of different classes of functional materials. They can describe the material scientific importance and use of biomaterials, magnetic materials, optical materials and nanomaterials. They can give an overview of modern functional materials, and select optimum materials with desired functional properties on an application-specific basis.

• After successfully completing the sub-module "Nanomaterials" …

• After successfully completing the sub-module "Biomaterials", students will be able to illustrate biological systems and associated bioinspired systems. They can outline the basics of biochemistry and present the basics of anatomy, so that they can assign biomaterial classes. Students know how to create surface chemistry strategies, or classify surface morphology.

• After successfully completing the sub-module "Magnetic Materials", students will have specific knowledge of magnetism, of the magnetic material classes and their applications.

• After successfully completing the sub-module "Optical Materials", the students will have material-specific knowledge of optics and optoelectronics, as well as</td></tr>
</table>

	knowledge of their technological background and applications. Students are able to present their knowledge to specialists and in writing. Students are able to identify their own strengths and weaknesses, and independently gain the facts they need.

Contents	*Nanomaterials*
	• Interfaces and surfaces
	• Dimensionality
	• Fullerenes and nanotubes
	• Micropores and mesopores
	• Core-shell structure
	• Nanocomposites
	• Intercalation
	• Nanopatterning
	• Self-assembly and self-organisation
	• Nanoengineering
	• Green nanopatterning
	• Green nanosynthesis
	
	Biomaterials and bioinspired materials
	• Biological systems
	• Bioinspired systems
	• Basic anatomy
	• Biomaterial classes
	• Surface chemistry
	• Surface morphology
	
	Magnetic materials
	• Basics
	• Controlled magnetism
	• Magnetic anisotropies
	• Magnetic domains
	• Magnetisation processes
	• Soft magnetic materials
	• Hard magnetic materials
	• Magnetic data recording
	
	Optical materials
	• Properties of light
	• Basic concepts of optics
	• Optical materials for
	  ○ Optical components
	  ○ Optical waveguides
	  ○ Optoelectronic devices
	  ○ Lasers
	
	General
	• Comparison of materials
	• When is which material suitable?
	• Composite materials
	• Cost considerations
	• Recycling

Media forms	Beamer and blackboard
Literature	• B.D. Cullity & C.D. Graham: Introduction to Magnetic Materials, Wiley, New York (2009) • R.C. O'Handley: Modern magnetic materials - principles and applications, Wiley, New York (2000) • N. Spaldin: Magnetic Materials - Fundamentals and Device Applications, Cambridge University Press, Cambridge (2011) • M. Wakaki, Optical Materials and Applications, CRC Press, Boca Raton (2012)

Module description	**Praxisphase**		
	Practical Phase		
Module code	mawi-603		
Module level	Subject related specialisation		
Abbreviation if applicable	PP		
Subtitle, if applicable			
Duration	Min. 13 weeks		
Repetition in the academic year	Summer semester		
Faculty responsible for the module	Faculty of Engineering		
Institute responsible for the module	Institute for Materials Science		
Lecturer responsible for the module	Dr. O. Riemenschneider		
Lecturer	Professors of Materials Science		
Language	German		
Where in the curriculum	Compulsory module in the 6th semester		
Applicability of the module	1-subject degree programmes B.Sc. Materials Science		
Assessment	Not graded		
Courses	*n/a*		
Workload	13 weeks compulsory attendance at work (Comparative value for shift work: approx. 500 working hours) 540 hrs total workload		
ECTS credit points	18 ECTS		
Requirements according to the Examination Regulations	Min. 120 ECTS		
Recommended requirements	Students should have gained an insight into materials science by the start of the practical phase. Thus, at least all modules in materials science should have been successfully completed.		
Coursework	none		
Examinations	Written report		
	Compulsory/optional	*Graded/not graded*	*Weighting*
	Compulsory	Not graded	100%

Learning objectives / competences	Students have gained personal experience of the professional activity of a materials scientist through specific tasks and practical work in companies or other institutes. Students are able to apply the knowledge and skills to these problems which they acquired throughout their studies and to critically reflect upon and analyse these factors during the experience gained from the practical activities. By completing the practical phase, they have shown that they are able to carry out the practical work required in the field of a materials scientist.
Contents	*n/a*
Media forms	*n/a*
Literature	*n/a*

Module description	**Bachelorarbeit**		
	Bachelor's Thesis		
Module code	mawi-604		
Module level	Subject related specialisation		
Abbreviation if applicable	BA		
Subtitle, if applicable			
Duration	9 weeks		
Repetition in the academic year	Winter semester Summer semester		
Faculty responsible for the module	Faculty of Engineering		
Institute responsible for the module	Institute for Materials Science		
Lecturer responsible for the module	Dr. O. Riemenschneider		
Lecturer	Professors of Materials Science		
Language	German		
Where in the curriculum	Compulsory module in the 6th semester		
Applicability of the module	1-subject degree programmes B.Sc. Materials Science		
Assessment	Graded		
Courses	*n/a*		
Workload	9 weeks 360 hrs total workload		
ECTS credit points	12 ECTS		
Requirements according to the Examination Regulations	Min. 138 ECTS		
Recommended requirements	The Bachelor's thesis serves as the final thesis for the degree programme. Before starting their Bachelor's thesis, the student should have a fundamental understanding of materials science. Through insight into the daily practice, and by tackling practical questions, they should have gained an understanding of research and development.		
Coursework	Presentation in the working group		
Examinations	Written elaboration of the work		
	Compulsory/optional	*Graded/not graded*	*Weighting*
	Compulsory	Graded	100%

Learning objectives / competences	Students are able to apply their accumulated knowledge and experience from their studies to a specific question. They are able to understand this question, analyse it, develop a solution approach and verify this with theoretical and/or practical results. In a written evaluation, they can critically assess their thesis, and underpin and develop it further if necessary, or even correct it. Through their thesis, they have shown that they are able to carry out the scientific work required in the field of a materials scientist.
Contents	The Bachelor's thesis is usually an independent investigation on the basis of a planning, experimental, constructive or other task, with a detailed description and explanation of the solution. Topics for this thesis can come from the field of materials science, but can also be an interdisciplinary piece of work in the overlapping area between materials science and other sciences.
Media forms	*n/a*
Literature	*n/a*