

Handbook of modules
for the
Master of Science program Materials Science

according to the old examination regulations from 27th July 2007

Summer term 2015

As from: 27th February 2015

Chairman of Examinations Board

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Part I.

Objectives and profile of the program

Priorities in the activity of the materials scientist are applied research in science and technology, the development of modern materials, supervision of production processes, and the technical distribution of materials. Also, the program aims towards well trained graduates to perform organizational, planning and management duties in research institutes, industry and public administration.

The structure of typical operational areas of material scientists requires a broad knowledge and education in natural sciences that will enable him / her to solve new and not yet resolved problems of applied research and technology.

A solid background in the manufacture and processing, characterization, development and use of new materials is a key parameter in the education. In addition to good knowledge of the physical and chemical principles, materials scientists have to have a profound background of the various classes of materials and must be well acquainted with the fundamentals and problems of materials technology. For this purpose he / she must have a thorough knowledge of various processing, fabrication and analysis methods and has to be able to recognize the essentials.

The Masters degree in Materials Science is meant to supplement the Bachelor's degree in the form of an in-depth recessment to achieve a second professional and qualifying status, and provides the opportunity to work and excel in an experimental environment, general materials science, and selected specialty areas. It provides important practice skills to pursue academic work in industrial or governmental research and development.

The Masters degree provides a professional and qualifying education in material science, usually based upon a successful Bachelor's degree. Holding a Master's degree, it is secured that the candidate is in power of an enhanced expertise in material sciences and has the ability, by using modern scientific methods to tackle Materials Science problems independently and efficiently.

The master program consists of the following module groups. The respective Credit Points (CP) and the respective number of hours per week (SWS) are indicated. Note: 1 SWS has a duration of 45 minutes.

| Module group | | hrs per week | CP |
|--------------|-------------------------------------|--------------|----|
| 1 | Basics of Materials Science | 16 | 23 |
| 2 | Methods in Materials Science | 23 | 33 |
| 3 | Materials Science Seminar | 2 | 4 |
| 4 | Specialization in Materials Science | 20 | 30 |
| 5 | Finals | | 30 |

The total of credentials is 120 credit points.

The anticipated learning outcomes in the Masters program go far beyond the ones of the Bachelor's degree program. The following technical and social knowledge, skills and competencies are essential for the professional qualification of the Masters Graduates:

- The graduates have sound working knowledge of scientific fundamentals of materials science, good knowledge of mathematics (in terms of its application to scientific problems), and practical skills in modern materials research. Based on this knowledge, they are able to identify relations between materials science and various economic issues.

- Generally, they are well prepared for demanding tasks, whose processing goes well beyond a schematic application of existing concepts only. They are moreover able to analyze and deliberately modify the tasks according to the respective needs. They have acquired a wide range of material knowledge, scientific methods, and techniques and are qualified to use these accordingly and well adapted to the specific problem.
- The graduates have an understanding of the impact of their activities as material scientists in a company, including resource and environmental issues and are aware of their own scientific and social responsibilities.
- The graduates are able to judge and understand the effects of their actions as materials scientists and to estimate their impact on social, environmental, and society issues. They have acquired an awareness for resource management and smart resource handling.
- The program graduates are able to work in a variety of scientific and technical surroundings to organize and carry out projects in several different areas. They are familiar with the learning strategies that lead them and others to professional and social competences and they know how to make this an ongoing and deepening process.
- They are able to appropriately present both their own results as well as general questions of modern materials research in front of professional colleagues as well as to the broader public.
- They are prepared for flexible use in various professional fields around and in particular on the work in an occupational or academic field. Successful graduates are well prepared to follow an appropriate PhD program.

Social skills are acquired primarily integrated into the specialized modules, such as team skills in exercises and in internships and project organization during the final thesis work. The Master's degree Materials Science is an international program, the teaching language of the courses is English.

Part II.

Official Documents

The international Masters program Materials Science was officially opened to students in the winter term 2003/04. The actual examination regulation was enacted on 25. July 2007. It may be downloaded at:

<http://www.zv.uni-augsburg.de/de/sammlung/download/>

<http://www.physik.uni-augsburg.de/studium/>

Part III.

List of modules

1. Basics of Materials Science

| MaMawi-11-01 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Materials Physics I |
| 2. Module group/s | Basics of Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | PD Dr. Helmut Karl |
| 5. Content | <p>IA. Preliminaries</p> <p>IB. Electrons in solids</p> <ul style="list-style-type: none"> - Free electron gas - Reciprocal lattice - Band structure <p>IC. Phonons</p> <ul style="list-style-type: none"> - Lattice vibrations <p>ID. General properties of materials</p> <ul style="list-style-type: none"> - Electrical conductivity - Thermal properties - Optical properties <p>II. Metals</p> <p>III. Semiconductors</p> <ul style="list-style-type: none"> - Pure SC - Intrinsic conditions - SC in equilibrium - Doping - Heterogeneous structures - Metal-SC interfaces, Schottky contact - pn-junctions - Devices - Diode - Transistor - Solar cell - Technology <p>IV. Dielectric solids, optical properties</p> <ul style="list-style-type: none"> - Introduction, phenomenology - Polarization - Propagation of EM waves in solids - Ferro electricity - Optically active point defects |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> ● know the basic terms of solid state and semi-conductor physics like electrical band structure, doping, charge carrier statistics or optical properties, ● are capable to apply derived approximations as the effective mass or quasi Fermi-levels to describe the basic characteristics of semi-conductive materials, ● have the competence to apply these concepts for the description of semi-conducting components as diodes, transistors and optical components and to describe their functionality, ● know the most important technological procedures for manufacturing of micro- and nanoelectronic components. |

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|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7. Curriculum inclosures | MaAFM-11-01 / Master Advanced Functional Materials MaMawi-11-01 / Master Materialwissenschaften |
| 8. Recommended semester | 1st semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 90 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: lecture: slides/blackboard with help of other media and experiments tutorial: intensive support in small groups, seminar presentations by students self-study |
| 17. Application | none |
| 18. Further information | COMPULSORY MODULE |

No courses are provided for this module in the current term

| MaMawi-12-01 | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Materials Physics II |
| 2. Module group/s | Basics of Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | PD Dr. Helmut Karl |
| 5. Content | <ol style="list-style-type: none"> 1. Magnetic materials [4] <ol style="list-style-type: none"> a) Magnetization b) Atomic origin of magnetic moments c) Paramagnetism d) Ferromagnetism e) Anisotropy f) Ferromagnetic materials, hard and soft magnets g) Magnetooptics 2. Superconductivity [4] <ol style="list-style-type: none"> a) Basic phenomena b) Meissner effect c) Energy gap d) London equation e) Basic ideas of the BCS theory, Cooper pairs f) Type I/II superconductors g) High temperature superconducting materials, flux pinning 3. Thermodynamics of materials [7] <ol style="list-style-type: none"> a) Review of basic terms b) Equilibrium conditions c) Phase diagrams d) Multiphase-multicomponent equilibria e) Thermodynamics of point defects f) Thermodynamics of interfaces 4. Thermal Properties [4] <ol style="list-style-type: none"> a) Specific heat b) Thermal expansion c) Thermal transport d) Thermal radiation e) Thermoelectricity 5. Atomic transport[3] <ol style="list-style-type: none"> a) Diffusion b) Electro-, thermo-, stress migration |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the physical and chemical fundamentals and the different resulting material properties, • are able to characterize Materials according to their magnetic, thermal, and transportation properties, and to do correspondent calculations using simple models, • have the competence to deal extensively autonomous with scientific problems of the above mentioned areas. • Integrated acquirement of soft skills. |
| 7. Curriculum inclosures | MaAFM-12-01 / Master Advanced Functional Materials MaMawi-12-01 / Master Materialwissenschaften MaPhy-42-02 / Master Physik |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |

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|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: beamer presentation, blackboard (occasionally) |
| 17. Application | none |
| 18. Further information | COMPULSORY MODULE - summer term 2014: an examination will be offered for this module - starting in summer term 2015, the lecture will be replaced by "Dielectric and Optical Materials" |

No courses are provided for this module in the current term

| MaMawi-13-01 | |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Materials Chemistry |
| 2. Module group/s | Basics of Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Henning Höppe |
| 5. Content | <ul style="list-style-type: none"> • Revision of basic chemical concepts [2] • Solid state chemical aspects of selected materials, such as: <ul style="list-style-type: none"> – Thermoelectrics [3] – Battery electrode materials, ionic conductors [2] – Hydrogen storage materials [2] – Data storage materials [2] – Phosphors and pigments [3] – Ferroelectrics and piezoelectrics [2] – Heterogeneous catalysis [2] – Nanoscale materials [2] |
| 6. Acquired skills and knowledge | <p>The students will</p> <ul style="list-style-type: none"> • be able to apply basic chemical concepts on materials science problems, • broaden their ability to derive structure-property relations of materials combining their extended knowledge about symmetry-related properties, chemical bonding in solids, and chemical properties of selected compound classes, • be able to assess synthetic approaches towards relevant materials, • acquire skills to perform literature research using online data bases. |
| 7. Curriculum inclosures | MaAFM-13-01 / Master Advanced Functional Materials MaMawi-13-01 / Master Materialwissenschaften MaPhy-41-04 / Master Physik MaPhy-42-06 / Master Physik |
| 8. Recommended semester | 1st semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: The lecture course is based on the Bachelor of Materials Science courses Chemistry I (new signature: BaMawi-31 / old signature: BaMawi-51-01) and Chemistry III (solid state chemistry, new signature: BaMawi-33 / old signature: BaMawi-53-01). |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: blackboard, beamer presentation (occasionally) |
| 17. Application | none |
| 18. Further information | COMPULSORY MODULE |

No courses are provided for this module in the current term

| MaMawi-14-01 | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Physics of Surfaces and Interfaces |
| 2. Module group/s | Basics of Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Siegfried Horn |
| 5. Content | <p>1. Introduction [1]</p> <ul style="list-style-type: none"> - The importance of surfaces and interfaces <p>2. Some basic facts from solid state physics [3]</p> <ul style="list-style-type: none"> - Crystal lattice and reciprocal lattice - Electronic structure of solids - Lattice dynamics <p>3. Physics at surfaces and interfaces [14]</p> <ul style="list-style-type: none"> - Structure of ideal and real surfaces - Relaxation and reconstruction - Transport (diffusion, electronic) on interfaces - Thermodynamics of interfaces - Electronic structure of surfaces - Chemical reactions on solid state surfaces (catalysis) - Interface dominated materials (nano scale materials) <p>4. Methods to study chemical composition and electronic structure, application examples [4]</p> <ul style="list-style-type: none"> - Scanning electron microscopy - Scanning tunneling and scanning force microscopy - Auger – electron – spectroscopy - Photo electron spectroscopy |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • have knowledge of the structure, the electrical properties, the thermodynamics, and the chemical reactions on surfaces and interfaces, • acquire the skill to solve problems of fundamental research and applied sciences in the field of surface and interface physics, • have the competence to solve certain problems autonomously based on the thought physical basics. • Integrated acquirement of soft skills. |
| 7. Curriculum inclosures | <p>MaAFM-14-01 / Master Advanced Functional Materials MaMawi-14-01 / Master Materialwissenschaften MaPhy-42-03 / Master Physik</p> |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every year |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none recommended prerequisites: The module "Physics IV - Solid State Physics" (new signature: BaMawi-14 / old signature: BaMawi-14-01) of the Bachelor of Materials Science program should be completed first.</p> |
| 13. Credit points | 5 |

1. Basics of Materials Science

| | |
|------------------------------|----------------------------------|
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | tutorial, lecture |
| 17. Application | none |
| 18. Further information | COMPULSORY MODULE |

The following courses are provided for this module in the current term:

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|----------------------------------------|------------------------------|
| Surfaces and Interfaces (see page 148) | 3 hours of workload per week |
|----------------------------------------|------------------------------|

2. Methods in Materials Science

| MaMawi-21-01 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Characterization of Materials |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Markus Sause |
| 5. Content | <ol style="list-style-type: none"> 1. X-ray diffraction [2] 2. Mechanical characterization [2] 3. Optical methods [2] 4. Electrical measurements and characterization [2] 5. NMR spectroscopy [2] 6. Spectroscopy using synchrotron radiation[2] 7. Thermal analysis [2] 8. Ion beam methods [2] 9. Charakterization of organic systems [2] 10. Electron microscopy [2] |
| 6. Acquired skills and knowledge | <p>Basic characterization methods will be introduced to the students in a lecture series with a workload of 4 hrs each.</p> <p>The students:</p> <ul style="list-style-type: none"> • know the basic characterization methods of materials science, • acquire knowledge how to apply these methods, • acquire the competence to use these techniques for the analysis of structural, chemical, electronical, magnetical, and optical properties of materials. |
| 7. Curriculum inclosures | MaAFM-21-01 / Master Advanced Functional Materials MaMawi-21-01 / Master Materialwissenschaften |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 60 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge in Materials Science |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: transparencies / blackboard with additional media self-study |
| 17. Application | none |
| 18. Further information | COMPULSORY MODULE starting from summer term 2014 this compulsory lecture is replaced by "Characterization of Composite Materials" |

The following courses are provided for this module in the current term:

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|-------------------------------------------------------------------|------------------------------|
| Characterization of Composite Materials (see page 110) | 3 hours of workload per week |
| Characterization of Composite Materials (Tutorial) (see page 111) | 1 hours of workload per week |

| MaMawi-22-01 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Processing of Materials |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Ferdinand Haider |
| 5. Content | <ol style="list-style-type: none"> 1. Processing of polymers 2. Processing of thin films 3. Processing of semiconductors 4. Processing of composites 5. Processing of metals and alloys |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the most important methods of processing and treatment of materials for different material classes; semiconductors, thin film materials, polymers, metals, and composite materials, • handle besides industrial processes also methods which are so far realized rather on bench scale, and • have the competence to deal autonomously with current problems of the above mentioned subject areas. • Integrated acquirement of soft skills. |
| 7. Curriculum inclosures | <p>MaAFM-22-01 / Master Advanced Functional Materials MaMawi-22-01 / Master Materialwissenschaften MaPhy-42-05 / Master Physik</p> |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every year |
| 11. Work load (total) | compulsory attendance: 56 hours / self-study: 56 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none</p> <p>recommended prerequisites: good knowledge of basics of Materials Science</p> |
| 13. Credit points | 5 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture</p> <p>media and methods: beamer presentation</p> |
| 17. Application | none |
| 18. Further information | <p>COMPULSORY MODULE</p> <p>in the summer term 2014 an examination will be offered for this module</p> <p>from summer term 2015, the corresponding lecture will be replaced by "Processing of Composite Materials"</p> |

No courses are provided for this module in the current term

| MaMawi-23-01 | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Theoretical Concepts and Simulation |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Michael Dzierzawa |
| 5. Content | <ol style="list-style-type: none"> 1. Introduction: operating systems, programming languages, data visualization tools 2. Basic numerical methods: interpolation, integration 3. Ordinary and Partial Differential Equations (e.g., diffusion equation, Schrödinger equation) 4. Molecular dynamics 5. Monte Carlo simulations |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the principal concepts of thermodynamics and statistical physics as well as the numerical methods relevant in material science, • are able to solve simple problems numerically. They are able to write the codes and to present the results, • have the expertise to find the numerical method appropriate for the given problem and to judge the quality and validity of the numerical results, • Integrated acquirement of soft skills: independent handling of hard- and software while using English documentations, ability to investigate abstract circumstances with the help of a computer and present the results in written and oral form, capacity for team-work. |
| 7. Curriculum inclosures | MaAFM-23-01 / Master Advanced Functional Materials MaMawi-23-01 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge of quantum mechanics, thermodynamics, and numerical methods as well as of a programming language |
| 13. Credit points | 6 |
| 14. Requirements for credits | Seminar talk with discussion project work in small groups, including a written summary of the results (ca. 10-20 pages) as well as an oral presentation |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, practical course media and methods: blackboard presentation, occasionally supplemented by beamer or overhead presentations; in the project work with a computer in order to numerically implement a given concrete problem. |
| 17. Application | none |

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| 18. Further information | COMPULSORY MODULE Links to software related to the course: <ul style="list-style-type: none">● http://www.bloodshed.net/● http://www.cplusplus.com/doc/tutorial/● http://www.cygwin.com/● http://xmd.sourceforge.net/download.html● http://www.rasmol.org/● http://felt.sourceforge.net/ |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

No courses are provided for this module in the current term

| MaMawi-24-02 | |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Electron Microscopy |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Ferdinand Haider |
| 5. Content | 1. Scanning electron microscopy (SEM) 2. Transmission electron microscopy (TEM) |
| 6. Acquired skills and knowledge | The students: <ul style="list-style-type: none"> • get introduced to the basics of scanning electron microscopy and transmission electron microscopy, using lectures to teach the theoretical basics, which are afterwards deepened using practical courses, • are able to characterize materials using different electron microscopy techniques and to decide, if the technique is feasible for a certain problem. |
| 7. Curriculum inclosures | MaAFM-24-02 / Master Advanced Functional Materials MaMawi-24-02 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 72 hours / self-study: 146 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: knowledge of solid-state physics, reciprocal lattice |
| 13. Credit points | 8 |
| 14. Requirements for credits | written report (one report per group) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, practical course |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE |

No courses are provided for this module in the current term

| MaMawi-24-04 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Electronics for Physicists and Materials Scientists |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Andreas Hörner |
| 5. Content | <ol style="list-style-type: none"> 1. Basics in electronic and electrical engineering [4] 2. Quadrupole theory [2] 3. Analog technique, transistor and opamp circuits [5] 4. Boolean algebra and logic [4] 5. Digital electronics and calculation circuits [6] 6. Microprocessors and Networks [4] 7. Basics in Electronic [8] 8. Implementation of transistors [8] 9. Operational amplifiers [8] 10. Digital electronics [8] 11. Practical circuit arrangement [8] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basic terms, concepts and phenomena of electronic and electrical engineering for the use in the laboratory, • have skills in easy circuit design, measuring and control technology, analog and digital electronics, • have expertise in independent working on circuit problems. They can calculate and develop easy circuits. |
| 7. Curriculum inclosures | MaAFM-24-04 / Master Advanced Functional Materials MaMawi-24-04 / Master Materialwissenschaften |
| 8. Recommended semester | 1st semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every semester |
| 11. Work load (total) | compulsory attendance: 100 hours / self-study: 140 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 8 |
| 14. Requirements for credits | oral examination (30 minutes) written report (one per group) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, practical course media and methods: lectures: slides/blackboard talk with help of other media and experiments self-study |
| 17. Application | none |

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|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18. Further information | <p>ELECTIVE COMPULSORY MODULE</p> <p>Attendance in the Method Course: Electronics for Physicists and Materials Scientists (new signature: MaMatsci-2-03 /old signature: MaMawi-24-04;combined lab course AND lecture) excludes credit points for the lecture Electronics for Physicists and Materials Scientists(new signature: MaMatsci-5-08 /old signature: MaMawi-41-03)SEPERATELY.</p> |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

The following courses are provided for this module in the current term:

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|------------------------------------------------------------------------------------------------------|------------------------------|
| Method Course: Electronics for Physicists and Materials Scientists (see page 126) | 4 hours of workload per week |
| Method Course: Electronics for Physicists and Materials Scientists (Practical Course) (see page 127) | 3 hours of workload per week |

| MaMawi-24-05 | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Materials Synthesis |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Wolfgang Scherer |
| 5. Content | <p>Content of the practical course and the lecture are the theoretical basics, the synthesis and characterization of the following functional materials:</p> <ol style="list-style-type: none"> 1. Organic polymers [4+2] 2. Zeolites and mesoporous materials [4+2] 3. Porous coordination polymers [4+2] 4. Ionic liquids [4+2] 5. Bio materials [4+2] 6. Oxides „sol-gel processing and ceramic methods” [4+2] 7. Lower dimensional structure materials [4+2] 8. Ferrofluides [2+1] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • gain basic practical knowledge about chemical materials synthesis and analytical methods (e.g. ICP / EA / REM-EDX), including the characterization via X-ray diffraction and spectroscopic techniques (e.g. IR / NMR) as well as physical methods (e.g. thermoelectric properties, magnetism), • possess the ability to perform materials syntheses under instruction, • are able to choose the appropriate characterization method for certain materials. |
| 7. Curriculum inclosures | MaAFM-24-05 / Master Advanced Functional Materials MaMawi-24-05 / Master Materialwissenschaften |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 90 hours / self-study: 150 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none recommended prerequisites: the practical course is based on the modules</p> <ul style="list-style-type: none"> • Chemistry I (new signature: BaMawi-31 / old signature: BaMawi-51-01) • Chemistry II (new signature: BaMawi-32 / old signature: BaMawi-52-01) • Chemistry III (new signature: BaMawi-13 / old signature: BaMawi-53-01) • and the practical course in physical chemistry |
| 13. Credit points | 8 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture, practical course media and methods: beamer presentation, blackboard, handouts</p> |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE |

No courses are provided for this module in the current term

| MaMawi-24-06 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Methods in Biophysics |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | PD Dr. Stefan Thalhammer |
| 5. Content | 1. Unit radiation biophysics - Concepts in radiation protection - Low-dose irradiation biophysics - DNA repair dynamics of living cells after ionizing radiation - Confocal scanning laser microscopy 2. Unit microfluidic - Microfluidic systems - Acoustic driven microfluidics - Calculation of microfluidic problems 3. Unit analysis |
| 6. Acquired skills and knowledge | The students: <ul style="list-style-type: none"> • know basic terms, concepts and phenomena in radiation biophysics, • acquire basic knowledge of fluidic and biophysical phenomena on small length scales and applications and technologies of microfluidic analytical systems, • learn skills in tissue culture and immun-histochemical staining procedures, • learn skills in fluorescence and confocal scanning microscopy, • learn skills to calculate fluidic problems on small length scales, • learn skills to handle microfluidic channel systems. |
| 7. Curriculum inclosures | MaAFM-24-06 / Master Advanced Functional Materials MaMawi-24-06 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | upon request |
| 11. Work load (total) | compulsory attendance: 85 hours / self-study: 95 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: attendance of the lecture "Biophysics and Biomaterials" (new signature: MaMatsci-4A-01 / old signature: MaMawi-41-04) |
| 13. Credit points | 8 |
| 14. Requirements for credits | 1 written lab report |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial, practical course media and methods: intensive mentoring in small groups self-study |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE The course will partly take place at the Helmholtz Center Munich. |

The following courses are provided for this module in the current term:

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| Method Course: Methods in Biophysics (Practical Course) (see page 131) | 1 hours of workload per week |
|------------------------------------------------------------------------|------------------------------|

| MaMawi-24-07 | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Optical Properties of Solids |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Alois Loidl |
| 5. Content | <ol style="list-style-type: none"> 1. Electrodynamics of solids <ul style="list-style-type: none"> - Maxwell equations - Electromagnetic waves - Refraction and interference, Fresnel equations 2. FTIR spectroscopy <ul style="list-style-type: none"> - Fourier transformation - Michelson-Morley and Genzel interferometer - Sources and detectors 3. Terahertz Time Domain spectroscopy <ul style="list-style-type: none"> - Generation of pulsed THz radiation - Gated detection, Austin switches 4. Elementary excitations in solids <ul style="list-style-type: none"> - Infrared-active phonons - Magnetic-dipole excitations - Crystal-field excitations |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> ● get to know the basic principles of far-infrared spectroscopy, terahertz time-domain spectroscopy and submillimeter-wave spectroscopy with coherent sources, ● learn about fundamental physical excitations in condensed matter that can be studied by these methods, ● learn to plan and carry out complex experiments. They learn how to critically analyze the data, ● specifically learn to analyze the experimental results in the light of models and modern theories of condensed matter physics. |
| 7. Curriculum inclosures | MaAFM-24-07 / Master Advanced Functional Materials MaMawi-24-07 / Master Materialwissenschaften |
| 8. Recommended semester | 1st and 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every semester |
| 11. Work load (total) | compulsory attendance: 90 hours / self-study: 150 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge in solid-state physics, basic knowledge in electrodynamics and optics |
| 13. Credit points | 8 |
| 14. Requirements for credits | written report on the experiments (editing time 3 weeks, max. 30 pages) |
| 15. Examination | general examination for module |

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| 16. Teaching methods | lecture, practical course media and methods: projector, slides, blackboard, web resources |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE |

The following courses are provided for this module in the current term:

| | |
|-------------------------------------------------------------------------------|------------------------------|
| Method Course: Optical Properties of Solids (see page 132) | 2 hours of workload per week |
| Method Course: Optical Properties of Solids (Practical Course) (see page 133) | 4 hours of workload per week |

| MaMawi-24-09 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Spectroscopy on Condensed Matter |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Stephan Krohns |
| 5. Content | 1. Dielectric Spectroscopy [8] - Methods - Cryo-techniques - Measurement quantities - Relaxation processes - Dielectric phenomena 2. Ferroelectric Materials [7] - Mechanism of ferroelectric polarization - Hysteresis loop measurements - Dielectric spectroscopy 3. Glassy Matter [8] - Introduction - Glassy phenomena - Dielectric spectroscopy 4. Multiferroic Materials [7] - Introduction - Microscopic origins of multiferroicity - Pyrocurrent measurements - Dielectric spectroscopy |
| 6. Acquired skills and knowledge | The students: <ul style="list-style-type: none"> • learn about the basic concepts of dielectric spectroscopy and the phenomena examined with it. Therefore they are instructed in experimental methods for the investigation of the dielectric properties of condensed matter, • are trained in planning and performing complex experiments. They learn to evaluate and analyze the collected data, • are taught to work on problems in experimental solid state physics, including analysis of measurement results and their interpretation in the framework of models and theories. |
| 7. Curriculum inclosures | MaAFM-24-09 / Master Advanced Functional Materials MaMawi-24-09 / Master Materialwissenschaften |
| 8. Recommended semester | 1st and 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every semester |
| 11. Work load (total) | compulsory attendance: 90 hours / self-study: 90 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge in solid state physics, basic knowledge in physics of glasses and supercooled liquids |
| 13. Credit points | 8 |
| 14. Requirements for credits | written examination (120 minutes) written report on the experiments (editing time 2 weeks) |
| 15. Examination | general examination for module |

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|-------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 16. Teaching methods | lecture, practical course media and methods: slides/blackboard talk with help of other media and experiments self-study |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE |

The following courses are provided for this module in the current term:

| | |
|-----------------------------------------------------------------------------------|------------------------------|
| Method Course: Spectroscopy on Condensed Matter (see page 134) | 2 hours of workload per week |
| Method Course: Spectroscopy on Condensed Matter (Practical Course) (see page 135) | 4 hours of workload per week |

| MaMawi-24-11 | |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Thin Film Analysis with Ion Beams |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | PD Dr. Helmut Karl |
| 5. Content | <ol style="list-style-type: none"> 1. Introduction to ion beam analysis techniques and concepts 2. Rutherford backscattering spectroscopy 3. Theory of particle scattering and cross-section 4. Experimental setup 5. Dynamic secondary ion mass spectroscopy (SIMS) 6. Simulation and data evaluation of Rutherford backscattering spectrometry (RBS) experiments |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know basic terms, skills and concepts to plan and perform analysis of thin films by ion beams, • prepare themselves for successful research during their Master thesis. |
| 7. Curriculum inclosures | MaAFM-24-11 / Master Advanced Functional Materials MaMawi-24-11 / Master Materialwissenschaften |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every year |
| 11. Work load (total) | compulsory attendance: 90 hours / self-study: 150 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: solid knowledge in solid state and experimental physics |
| 13. Credit points | 8 |
| 14. Requirements for credits | Seminar talk with discussion 1 written report |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, practical course |
| 17. Application | none |
| 18. Further information | <p>ELECTIVE COMPULSORY MODULE</p> <p>Experimental work in the laboratory in the Institute of Physics has to be conducted within 3 months.</p> |

No courses are provided for this module in the current term

| MaMawi-24-12 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: X-ray and Neutron Diffraction Techniques |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Wolfgang Scherer |
| 5. Content | <p>Subjects of the practical training and the accompanying lecture are the theoretical basics and the practical application of X-ray and neutron diffraction techniques:</p> <p>Basic introduction to X-ray and neutron crystallography [4+2] X-ray/neutron scattering [4+2] Data collection and reduction techniques [4+2] Symmetry and space group determination [4+2] Structural refinements:</p> <ul style="list-style-type: none"> • The Rietveld method • Difference Fourier synthesis [4+2] <p>Structure determination:</p> <ul style="list-style-type: none"> • Patterson method • Direct methods [4+2] <p>Interpretation of structural refinement results [4+2] Electronic structure determination and analysis [2+1]</p> |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • gain basic practical knowledge on structural characterization methods for single-crystalline and powder samples employing X-ray and neutron diffraction techniques, • have the skill to, under guidance, perform phase-analyses and structure determinations, • are competent to analyze the structure-property relationships of new materials. |
| 7. Curriculum inclosures | MaAFM-24-12 / Master Advanced Functional Materials MaMawi-24-12 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 90 hours / self-study: 150 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: The practical course is based on the module "Chemisch-Physikalisches Praktikum für Materialwissenschaftler". |
| 13. Credit points | 8 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, practical course media and methods: beamer presentation, blackboard, handouts |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE |

No courses are provided for this module in the current term

| MaMawi-24-13 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Coordination Materials |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Dirk Volkmer |
| 5. Content | <ol style="list-style-type: none"> 1. Synthesis of metal complexes: 2. Analytical characterization of metal complexes (thermal analysis, UV/vis spectroscopy, cyclic voltammetry, X-ray diffraction) 3. Functional coordination materials (spin-crossover materials, information storage materials) 4. Catalysis (oxidation reactions) |
| 6. Acquired skills and knowledge | <p>The students will learn how to:</p> <ul style="list-style-type: none"> • prepare transition metal complexes employing modern preparation techniques (e.g. microwave synthesis), inert synthesis conditions (Schlenk technique), • characterize coordination compounds by selected analytical techniques, • develop functional coordination materials based on organic / inorganic hybrid compounds, • screen metal complexes in catalytic reactions, • employ X-ray diffraction methods for structural analysis. |
| 7. Curriculum inclosures | MaAFM-24-13 / Master Advanced Functional Materials MaMawi-24-13 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 120 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 8 |
| 14. Requirements for credits | Seminar talk with discussion written report (protocols) |
| 15. Examination | general examination for module |
| 16. Teaching methods | practical course, lecture media and methods: presentation, publications, self-study |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE further information upon request |

The following courses are provided for this module in the current term:

| | |
|-------------------------------------------------------------------------|------------------------------|
| Method Course: Coordination Materials (Practical Course) (see page 124) | 4 hours of workload per week |
| Method Course: Coordination Materials (Seminar) (see page 125) | 2 hours of workload per week |

| MaMawi-24-15 | |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Characterization of Porous Materials |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Dirk Volkmer |
| 5. Content | <ol style="list-style-type: none"> 1. Synthesis of porous functional materials (e.g. Metal-Organic Frameworks, zeolites) 2. Characterization methods 3. <ul style="list-style-type: none"> • Thermal analysis (TGA, EGA) • Structure determination (XRD, VTXRPD) • Absorption and diffusion (BET, pulse chemisorption) • Catalytic properties (UV/VIS, TPO, TPR) • Computational Modeling (calculation and predictions of framework structures) |
| 6. Acquired skills and knowledge | <p>The students will learn how to</p> <ul style="list-style-type: none"> • use modern solid state preparation techniques (e.g. microwave synthesis), • employ analytical methods dedicated to porous materials. |
| 7. Curriculum inclosures | MaAFM-24-15 / Master Advanced Functional Materials MaMawi-24-15 / Master Materialwissenschaften |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 120 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: lecture Porous Materials (new signature: MaMatsci-5-07 / old signature: MaMawi-41-18) |
| 13. Credit points | 8 |
| 14. Requirements for credits | written examination (45 minutes) written report (editing time 1 week) |
| 15. Examination | general examination for module |
| 16. Teaching methods | practical course media and methods: slices / blackboard, face to face tutorial, self-study |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE further information upon request |

No courses are provided for this module in the current term

| MaMawi-24-16 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Modern Solid State NMR Spectroscopy |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Leo van Wüllen |
| 5. Content | 1. Physical foundations of NMR spectroscopy [6] 2. Internal interactions in NMR spectroscopy [6] <ul style="list-style-type: none"> - Chemical shift interaction - Dipole interaction and - Quadrupolar interaction 3. Magic Angle Spinning techniques [4] 4. Modern applications of NMR in materials science [14] 5. Experimental work at the Solid-State NMR spectrometers, computer-aided analysis and interpretation of acquired data [60] |
| 6. Acquired skills and knowledge | The students: <ul style="list-style-type: none"> • gain basic knowledge of the physical foundations of modern Solid-State NMR spectroscopy, • gain basic practical knowledge of operating a solid-state NMR spectrometer, • can – under guidance – plan, perform, and analyze modern solid-state NMR experiments for the structural characterization of advanced materials. |
| 7. Curriculum inclosures | MaAFM-24-16 / Master Advanced Functional Materials MaMawi-24-16 / Master Materialwissenschaften |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every semester |
| 11. Work load (total) | compulsory attendance: 90 hours / self-study: 150 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 8 |
| 14. Requirements for credits | written examination (90 minutes) written report on the experiments (editing time approx. 2 weeks) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, practical course media and methods: beamer presentation, blackboard, handouts |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE |

No courses are provided for this module in the current term

| MaMawi-24-17 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Functional Silicate-analogous Materials |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Henning Höppe |
| 5. Content | Synthesis and characterization of functional materials according to the topics: 1. Silicate-analogous compounds 2. Luminescent materials / phosphors 3. Pigments 4. Characterization methods: XRD, spectroscopy (luminescence, UV/vis, FT-IR), thermal analysis |
| 6. Acquired skills and knowledge | The students will know how to: <ul style="list-style-type: none"> • develop functional materials based on silicate-analogous materials, • apply classical and modern preparation techniques (e.g. solid state reaction, sol-gel reaction, precipitation, autoclave reactions, use of silica ampoules), • work under non-ambient atmospheres (e.g. reducing, inert conditions), • solve and refine crystal structures from single-crystal data, • describe and classify these structures properly. |
| 7. Curriculum inclosures | MaAFM-24-17 / Master Advanced Functional Materials MaMawi-24-17 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every semester |
| 11. Work load (total) | compulsory attendance: 120 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: attendance to the lecture "Advanced Solid State Materials" (new signature: MaMatsci-4B-03 / old signature: MaMawi-41-17) |
| 13. Credit points | 8 |
| 14. Requirements for credits | Seminar talk with discussion written report (protocol) |
| 15. Examination | general examination for module |
| 16. Teaching methods | practical course |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE |

The following courses are provided for this module in the current term:

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|------------------------------------------------------------------------------------------|------------------------------|
| Method Course: Functional Silicate-analogous Materials (Practical Course) (see page 128) | 6 hours of workload per week |
|------------------------------------------------------------------------------------------|------------------------------|

| MaMawi-24-18 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Finite element modeling of multiphysics phenomena |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Markus Sause |
| 5. Content | <ul style="list-style-type: none"> • Modeling and simulation of physical processes and phenomena • Basic concepts of FEM programs • Generation of meshes • Optimization strategies • Selection of solvers • Examples from electrodynamics • Examples from thermodynamics • Examples from continuum mechanics • Examples from fluid dynamics |
| 6. Acquired skills and knowledge | <ul style="list-style-type: none"> • Students know established numerical procedures to model and simulate physical processes and systems • Students acquire abilities to build numerical models based on real world challenges • Students learn basic operational principles of FEM tools based on the program „COM-SOL Multiphysics“ |
| 7. Curriculum inclosures | MaMawi-24-18 / Master Materialwissenschaften |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 120 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: lecture "Numerische Verfahren" (BaMawi-43-01) |
| 13. Credit points | 8 |
| 14. Requirements for credits | 1 written report on selected topic, editing time 2 weeks |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial Media and methods: Slides and Blackboard in combination with beamer presentation, self-study |
| 17. Application | none |
| 18. Further information | <p>ELECTIVE COMPULSORY MODULE</p> <p>This module is provided by external lecturers and lecturers from the mathematics and physics department. It is dedicated to materials scientists, physicists and engineers who intend to strengthen their background in numerical simulation using state-of-the-art FEM programs.</p> |

No courses are provided for this module in the current term

| MaMawi-24-19 | |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Method Course: Magnetic and Superconducting Materials |
| 2. Module group/s | Methods in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Philipp Gegenwart |
| 5. Content | <p>Methods of growth and characterization:</p> <ul style="list-style-type: none"> ● Sample preparation (bulk materials and thin films), e.g.: <ul style="list-style-type: none"> – arc-melting – flux-growth – sputtering and evaporation ● Sample characterization, e.g.: <ul style="list-style-type: none"> – X-ray diffraction – electron microscopy, scanning tunneling microscopy – magnetic susceptibility, electrical resistivity – specific heat |
| 6. Acquired skills and knowledge | <p>The students</p> <ul style="list-style-type: none"> ● get to know the basic methods of materials growth and characterization, such as poly- and single crystal growth, thin-film growth, X-ray diffraction, magnetic susceptibility, dc-conductivity, and specific heat measurements ● are trained in planning and performing complex experiments ● learn to evaluate and analyze the collected data, are taught to work on problems in experimental solid state physics, including analysis of measurement results and their interpretation in the framework of models and theories. |
| 7. Curriculum inclosures | MaMawi-24-19 / Master Materialwissenschaften |
| 8. Recommended semester | 1st and 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 90 hours / self-study: 150 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge in solid state physics and quantum mechanics |
| 13. Credit points | 8 |
| 14. Requirements for credits | 1 written report on the experiments (editing time 3 weeks, max. 30 pages) |
| 15. Examination | Modulgesamtprüfung |
| 16. Teaching methods | <p>lecture, practical course lecture, practical course media and methods: slides/blackboard talk with help of other media and experiments self-study</p> |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE |

The following courses are provided for this module in the current term:

| | |
|-----------------------------------------------------------------------------------------|------------------------------|
| Method Course: Magnetic and Superconducting Materials (see page 129) | 2 hours of workload per week |
| Method Course: Magnetic and Superconducting Materials (Practical Course) (see page 130) | 4 hours of workload per week |

3. Materials Science Seminar

| MaMawi-31-01 | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Introduction to Materials |
| 2. Module group/s | Materials Science Seminar |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Ferdinand Haider |
| 5. Content | Varying topics for each year, giving an overview into scope, application, requirements and preparation of all types of modern materials. |
| 6. Acquired skills and knowledge | The students: <ul style="list-style-type: none"> • know the major principles, applications and processes of modern materials, • acquire the competence to compile knowledge for examples of material specific topics and to present this knowledge in given time to an audience. |
| 7. Curriculum inclosures | MaAFM-31-01 / Master Advanced Functional Materials MaMawi-31-01 / Master Materialwissenschaften |
| 8. Recommended semester | 1st semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 28 hours / self-study: 80 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge in materials science |
| 13. Credit points | 4 |
| 14. Requirements for credits | presentation with term paper (30 - 45 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | seminar media and methods: powerpoint presentation |
| 17. Application | none |
| 18. Further information | COMPULSORY MODULE |

No courses are provided for this module in the current term

4. Specialization in Materials Science

| MaMawi-41-01 | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Physics and Technology of Semiconductor Devices |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Hubert Krenner |
| 5. Content | <ol style="list-style-type: none"> 1. Basic properties of semiconductors (electronic bandstructure, doping, carrier excitations and carrier transport) [10] 2. Semiconductor diodes and transistors [8] 3. Semiconductor technology [4] 4. Optoelectronics [4] |
| 6. Acquired skills and knowledge | <ul style="list-style-type: none"> • Basic knowledge of solid-state and semiconductor physics such as electronic bandstructure, doping, carrier excitations, and carrier transport. • Application of developed concepts (effective mass, quasi-Fermi levels) to describe the basic properties of semiconductors. • Application of these concepts to describe and understand the operation principles of semiconductor devices such as diodes, transistors, and optically active elements (LEDs, detectors and lasers). • Knowledge of the technologically relevant methods and tools in semiconductor micro- and nanofabrication. • Integrated acquisition of soft skills: autonomous working with specialist literature in English, acquisition of presentation techniques, capacity for teamwork, ability to document experimental results, and interdisciplinary thinking and working. |
| 7. Curriculum inclosures | BaMawi-64-01 / Bachelor Materialwissenschaften (Studienbeginn vor 1.10.2013) MaAFM-41-01 / Master Advanced Functional Materials MaMawi-41-01 / Master Materialwissenschaften MaPhy-24-01 / Master Physik |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge in solid-state physics and quantum mechanics. |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: lecture: slides/blackboard supported by other media and experiments tutorial: intensive support in small groups self-study |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

| | |
|---------------------------------------------------------------------------|------------------------------|
| Physics and Technology of Semiconductor Devices (see page 138) | 3 hours of workload per week |
| Physics and Technology of Semiconductor Devices (Tutorial) (see page 139) | 1 hours of workload per week |

| MaMawi-41-02 | |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Nanostructures / Nanophysics |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Hubert Krenner |
| 5. Content | <ol style="list-style-type: none"> 1. Semiconductor quantum wells, wires and dots, low dimensional electron systems [5] 2. Magnetotransport in low-dimensional systems, Quanten-Hall-Effect, Quantized conductance [5] 3. Optical properties of quantum wells and quantum dots and their application in modern optoelectronic devices [5] 4. Nanowires, Carbon Nanotubes, Graphene [3] 5. Nanophotonics, photonic band gap materials, photonic crystals 6. Emerging concepts such as Quantum Computing and Quantum Information Processing [4] |
| 6. Acquired skills and knowledge | <ul style="list-style-type: none"> • Basic knowledge of the fundamental concepts in modern nanoscale science • Profound knowledge of low-dimensional semiconductor structures and how these systems can be applied for novel functional devices for high-frequency electronics and optoelectronics • Knowledge of different fabrication approaches using bottom-up and top-down techniques • Application of these concepts to tackle present problems in nanophysics • Integrated acquisition of soft skills: autonomous working with specialist literature in English, acquisition of presentation techniques, capacity for teamwork, ability to document experimental results, and interdisciplinary thinking and working. |
| 7. Curriculum inclosures | MaAFM-41-02 / Master Advanced Functional Materials MaMawi-41-02 / Master Materialwissenschaften MaPhy-24-02 / Master Physik |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: knowledge in quantum mechanics and semiconductor physics. |
| 13. Credit points | 6 |
| 14. Requirements for credits | oral examination (30 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: lecture: slides/blackboard supported by other media and experiments tutorial: intensive support in small groups self-study |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

No courses are provided for this module in the current term

| MaMawi-41-03 | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Electronics for Physicists and Materials Scientists |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Andreas Hörner |
| 5. Content | <ol style="list-style-type: none"> 1. Basics in electronic and electrical engineering [4] 2. Quadrupole theory [2] 3. Analog technique, transistor and opamp circuits [5] 4. Boolean algebra and logic [4] 5. Digital electronics and calculation circuits [6] 6. Microprocessors and Networks [4] 7. Basics in Electronic [8] 8. Implementation of transistors [8] 9. Operational amplifiers [8] 10. Digital electronics [8] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basic terms, concepts and phenomena of electronic and electrical engineering for the use in the Lab, • have skills in easy circuit design, measuring and control technology, analog and digital electronics, • have expertise in independent working on circuit problems. They can calculate and develop easy circuits. • Integrated acquirement of soft skills: autonomous working with specialist literature in English, acquisition of presentation techniques, capacity for teamwork, ability to document experimental results, and interdisciplinary thinking and working. |
| 7. Curriculum inclosures | <p>BaMawi-64-02 / Bachelor Materialwissenschaften (Studienbeginn vor 1.10.2013) MaAFM-41-03 / Master Advanced Functional Materials MaMawi-41-03 / Master Materialwissenschaften MaPhy-24-03 / Master Physik</p> |
| 8. Recommended semester | 1st semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every semester |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 130 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 6 |
| 14. Requirements for credits | oral examination (30 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture media and methods: lectures: slides / blackboard talk with help of other media and experiments self-study</p> |
| 17. Application | none |

| | |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18. Further information | <p>ELECTIVE MODULE</p> <p>Attendance in the Method Course: Electronics for Physicists and Materials Scientists (new signature: MaMatsci-2-03 /old signature: MaMawi-24-04;combined lab course AND lecture) excludes credit points for the lecture Electronics for Physicists and Materials Scientists(new signature: MaMatsci-5-08 /old signature: MaMawi-41-03)SEPERATELY.</p> |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

The following courses are provided for this module in the current term:

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| Electronics for Physicists and Materials Scientists (see page 117) | 4 hours of workload per week |
|--------------------------------------------------------------------|------------------------------|

| MaMawi-41-04 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Biophysics and Biomaterials |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | PD Dr. Stefan Thalhammer |
| 5. Content | <ol style="list-style-type: none"> 1. Radiation Biophysics <ol style="list-style-type: none"> a) Radiation sources b) Interaction of radiation with biological matter c) Radiation protection principles d) Low dose radiation e) LNT model in radiation biophysics 2. Microfluidics <ol style="list-style-type: none"> a) Life at low Reynolds numbers b) The Navier-Stokes equation c) Low Reynolds numbers – the Stokes equation d) Breaking the symmetry 3. Membranes <ol style="list-style-type: none"> a) Thermodynamics and fluctuations b) Thermodynamics of interfaces c) Phase transitions – 2 state model d) Lipid membranes and biological membranes, membrane elasticity 4. Membranal transport <ol style="list-style-type: none"> a) Random walk, friction and diffusion b) Transmembranal ionic transport and ion channels c) Electrophysiology of cells d) Neuronal dynamics |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • learn basic terms, concepts and phenomena of biological physics, • learn models of the (bio)polymer-theory, microfluidic, radiation biophysics, nanobiotechnology, membranes and neuronal networks, • adapt skills in the independent processing of problems and deal with current literature. They will be able to translate a biological observation into a physical question. • Integrated acquirement of soft skills: autonomous working with specialist literature in english, acquisition of presentation techniques, capacity for teamwork, ability to document experimental results, and interdisciplinary thinking and working. |
| 7. Curriculum inclosures | MaAFM-41-04 / Master Advanced Functional Materials MaMawi-41-04 / Master Materialwissenschaften MaPhy-24-04 / Master Physik |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every semester |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: mechanics, thermodynamics, statistical physics, basic knowledge in molecular biology |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |

4. Specialization in Materials Science

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| 16. Teaching methods | lecture, tutorial media and methods: lecture: transparencies / blackboard with additional media tutorial: talks to current problems in biophysics |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE This module is part and requirement for the Method Course "Methods in Biophysics" (new signature: MaMatsci-2-06 / old signature: MaMawi-24-06). Lecture and Tutorial alone will be awarded 6 CP, Method Course 8 CP. |

No courses are provided for this module in the current term

| MaMawi-41-05 | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Solid State Spectroscopy with Synchrotron Radiation |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Christine Kuntscher |
| 5. Content | <ol style="list-style-type: none"> 1. Electromagnetic radiation: description, generation, detection [5] 2. Spectral analysis of electromagnetic radiation: monochromators, spectrometer, interferometer [2] 3. Excitations in the solid state: Dielectric function [2] 4. Infrared spectroscopy [3] 5. Ellipsometry [2] 6. Photoemission spectroscopy [2] 7. X-ray absorption spectroscopy [1] 8. Neutrons: Sources, detectors [2] 9. Neutron scattering [2] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basics of spectroscopy and important instrumentation and methods, • have acquired the skills of formulating a mathematical-physical ansatz in spectroscopy and can apply these in the field of solid state spectroscopy, • have the competence to deal with current problems in solid state spectroscopy autonomously, and are able to judge proper measurement methods for application. • Integrated acquirement of soft skills.. |
| 7. Curriculum inclosures | <p>BaMawi-64-03 / Bachelor Materialwissenschaften (Studienbeginn vor 1.10.2013) MaAFM-41-05 / Master Advanced Functional Materials MaMawi-41-05 / Master Materialwissenschaften MaPhy-24-05 / Master Physik</p> |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every year |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge in solid-state physics</p> |
| 13. Credit points | 6 |
| 14. Requirements for credits | oral examination (30 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture, tutorial media and methods: beamer presentation</p> |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

4. Specialization in Materials Science

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|-------------------------------------------------------------------------------|------------------------------|
| Solid State Spectroscopy with Synchrotron Radiation (see page 145) | 3 hours of workload per week |
| Solid State Spectroscopy with Synchrotron Radiation (Tutorial) (see page 146) | 1 hours of workload per week |

| MaMawi-41-06 | |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Chemical Physics I |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Wolfgang Scherer |
| 5. Content | <ol style="list-style-type: none"> 1. Basics of quantum chemical methods [8] <ol style="list-style-type: none"> a) Extended Hueckel method (EHM) b) Modern quantum chemical methods of chemical physics c) Application: exemplary calculations and interpretation of simple electronic structures 2. Molecular symmetry and group theory <ol style="list-style-type: none"> a) Symmetry operations and matrix transformations b) Point groups c) Reducible and irreducible representations d) Character tables e) Application: infrared- and raman-spectroscopy, NMR-spectroscopy 3. The electronic structure of transition metal complexes <ol style="list-style-type: none"> a) Ligand field theory and angular-overlap model (AOM) b) The physical basics of the spectrochemical series c) Molecular orbital theory of transition metal complexes d) Application: UV/vis-spectroscopy, molecular magnetism |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basics of the extended-Hückel-method and the density functional theory, • know the basics of group theory, • are able to apply the knowledge gained through consideration of symmetry from vibration-, NMR-, and UV/Vis-spectroscopy, and • are able to interpret and predict the basic geometric, electronic and magnetic properties of transition metal complexes. • Integrated acquisition of soft skills: ability to specialize in a scientific topic and to apply the acquired knowledge for solving scientific problems. |
| 7. Curriculum inclusions | BaMawi-64-04 / Bachelor Materialwissenschaften (Studienbeginn vor 1.10.2013) MaAFM-41-06 / Master Advanced Functional Materials MaMawi-41-06 / Master Materialwissenschaften MaPhy-24-06 / Master Physik MaPhy-41-02 / Master Physik |
| 8. Recommended semester | 1st semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: It is recommended to complete the experiments FP11 (IR-spectroscopy) and FP17 (Raman-spectroscopy) of the module "Physikalisches Fortgeschrittenenpraktikum" (BaPhy-18-01) of the bachelor of science physics program. |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |

4. Specialization in Materials Science

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|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16. Teaching methods | lecture, tutorial media and methods: beamer presentation, blackboard |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE It is possible for students to do EHM calculations autonomously and analyze electronical structures of molecules on a computer cluster within the scope of the tutorial. The lecture Chemical Physics I is one of the regular lectures of the physics master program and is therefore only offered in German language. |

No courses are provided for this module in the current term

| MaMawi-41-07 | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Chemical Physics II |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Wolfgang Scherer |
| 5. Content | <ol style="list-style-type: none"> 1. Charge density distribution from experiment and theory 2. Analysis der topology of spin- and charge density distribution <ol style="list-style-type: none"> a) Quantum theory of atoms in molecules (QTAIM) b) Electron localization function (ELF) and electron localizability indicator (ELI) 3. The nature of chemical bondings 4. Analysis of wave functions with localized orbitals 5. Modern quantum chemical methods: configuration interaction |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basic quantum chemical methods of chemical physics to interpret electrical structures in molecules and solid-state bodies, • have therefore the ability to apply amongst other things the quantum theory of atoms in molecules (QTAIM) and established electron localization functions (such as ELF) to analyze charge- and spin density distributions, • have the competence to do autonomously simple quantum chemical calculations using the density functional theory (DFT) and to interpret the electronical structure of functional molecules and materials with regard to chemical and physical properties. • Integrated acquirement of soft skills: ability to specialize in a scientific topic and to apply the the acquired knowledge for solving scientific problems. |
| 7. Curriculum inclosures | BaMawi-64-05 / Bachelor Materialwissenschaften (Studienbeginn vor 1.10.2013) MaAFM-41-07 / Master Advanced Functional Materials MaMawi-41-07 / Master Materialwissenschaften MaPhy-24-07 / Master Physik MaPhy-41-03 / Master Physik |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: It is highly recommended to complete the module Chemical Physics I (new signature MaMatsci-1B-02 / old signature: MaMawi-41-07) first. |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: beamer presentation, blackboard |
| 17. Application | none |

| | |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18. Further information | <p>ELECTIVE MODULE</p> <p>It is possible for students to do quantum chemical calculations autonomously and analyze electronical structures of molecules on a computer cluster within the scope of the tutorial.</p> |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

The following courses are provided for this module in the current term:

| | |
|-----------------------------------------------|------------------------------|
| Chemical Physics II (see page 112) | 3 hours of workload per week |
| Chemical Physics II (Tutorial) (see page 113) | 1 hours of workload per week |

| MaMawi-41-08 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Ion-Solid Interaction |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | PD Dr. Helmut Karl |
| 5. Content | <ol style="list-style-type: none"> 1. Introduction (areas of scientific and technological application, principles) 2. Fundamentals of atomic collision processes (scattering, cross-sections, energy loss models, potentials in binary collision models) 3. Ion-induced modification of solids (integrated circuit fabrication with emphasis on ion induced phenomena) 4. Ion implantation, radiation damage, ion milling and etching (RIE), sputtering, erosion, deposition 5. Mass transport phenomena 6. Analysis with ion beams |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the physical principles and the basic mechanisms of the interaction between particles and solid state bodies in the energy range of eV to MeV, • are able to choose adequate physical models for specific technological and scientific applications, and • have the competence to work extensively autonomous on problems concerning the interaction between ions and solid state bodies. • Integrated acquirement of soft skills. |
| 7. Curriculum inclosures | MaAFM-41-08 / Master Advanced Functional Materials MaMawi-41-08 / Master Materialwissenschaften MaPhy-24-09 / Master Physik |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: beamer presentation, blackboard, transparencies |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

4. Specialization in Materials Science

| | |
|-------------------------------------------------|------------------------------|
| Ion-Solid Interaction (see page 120) | 3 hours of workload per week |
| Ion-Solid Interaction (Tutorial) (see page 121) | 1 hours of workload per week |

| MaMawi-41-09 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Physics of Thin Films |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Wolfgang Brütting |
| 5. Content | 1. Layer growth [2] 2. Thin film technology [10] 3. Analysis of thin films [8] 4. Properties and applications of thin films [10] |
| 6. Acquired skills and knowledge | The students: <ul style="list-style-type: none"> • know methods of thin film technology and material properties and applications of thin films, • have acquired skills of grouping the various technologies for producing thin layers with respect to their properties and applications, and • have the competence to deal with current problems in the field of thin film technology largely autonomous. • Integrated acquirement of soft skills: practicing technical English, working with English specialist literature, ability to interpret experimental results. |
| 7. Curriculum inclosures | BaMawi-64-07 / Bachelor Materialwissenschaften (Studienbeginn vor 1.10.2013) MaAFM-41-09 / Master Advanced Functional Materials MaMawi-41-09 / Master Materialwissenschaften MaPhy-24-10 / Master Physik |
| 8. Recommended semester | 2nd or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every 2nd year |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture media and methods: beamer presentation, blackboard |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

| | |
|--------------------------------------|------------------------------|
| Physics of Thin Films (see page 140) | 4 hours of workload per week |
|--------------------------------------|------------------------------|

| MaMawi-41-10 | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Organic Semiconductors |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Wolfgang Brütting |
| 5. Content | <p>1. Introduction [15]</p> <ul style="list-style-type: none"> - Materials and preparation - Structural properties - Electronic structure - Optical and electrical properties <p>2. Devices and Applications [15]</p> <ul style="list-style-type: none"> - Organic metals - Light-emitting diodes - Field-effect transistors - Solar cells and laser |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basic structural and electronic properties of organic semiconductors as well as the essential function of organic semiconductor devices, • have acquired skills for the classification of the materials taking into account their specific features in the functioning of components, • and have the competence to comprehend and attend to current problems in the field of organic electronics. • Integrated acquirement of soft skills: practicing technical English, working with English specialist literature, ability to interpret experimental results |
| 7. Curriculum inclosures | <p>MaAFM-41-10 / Master Advanced Functional Materials MaMawi-41-10 / Master Materialwissenschaften MaPhy-24-11 / Master Physik</p> |
| 8. Recommended semester | 2nd or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every 2nd year |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none recommended prerequisites: it is strongly recommended to complete the module solid-state physics first. In addition, knowledge of molecular physics is desired.</p> |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture media and methods: beamer presentation, blackboard</p> |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

| | |
|---------------------------------------|------------------------------|
| Organic Semiconductors (see page 137) | 4 hours of workload per week |
|---------------------------------------|------------------------------|

| MaMawi-41-11 | |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Magnetism |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | PD Dr. Hans-Albrecht Krug von Nidda |
| 5. Content | <ol style="list-style-type: none"> 1. History, basics [1] 2. Magnetic moments, classical and quantum phenomenology [4] 3. Exchange interaction and mean-field theory [3] 4. Magnetic anisotropy and magnetoelastic effects [3] 5. Thermodynamics of magnetic systems and applications [2] 6. Magnetic domains and domain walls [2] 7. Magnetization processes and micro magnetic treatment [2] 8. AC susceptibility and ESR [2] 9. Spintransport / spintronics [2] 10. Recent problems of magnetism [2] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basic properties and phenomena of magnetic materials and the most important methods and concepts for their description, like mean-field theory, exchange interactions and micro magnetic models, • have the ability to classify different magnetic phenomena and to apply the corresponding models for their interpretation, and • have the competence independently to treat fundamental and typical topics and problems of magnetism. • Integrated acquirement of soft skills. |
| 7. Curriculum inclosures | BaMawi-64-10 / Bachelor Materialwissenschaften (Studienbeginn vor 1.10.2013) MaAFM-41-11 / Master Advanced Functional Materials MaMawi-41-11 / Master Materialwissenschaften MaPhy-24-12 / Master Physik |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every year |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basics of solid-state physics and quantum mechanics |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: beamer presentation, transparencies, blackboard |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

| | |
|-------------------------------------|------------------------------|
| Magnetism (see page 122) | 3 hours of workload per week |
| Magnetism (Tutorial) (see page 123) | 1 hours of workload per week |

| MaMawi-41-12 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Low Temperature Physics |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | PD Dr. Reinhard Tidecks |
| 5. Content | <ol style="list-style-type: none"> 1. Introduction <ul style="list-style-type: none"> - History, methods, realizations, and significance 2. Thermodynamic fundamentals <ul style="list-style-type: none"> - Temperature, working cycles, real gases, Joule-Thomson-Effect 3. Gas liquefaction <ul style="list-style-type: none"> - Air, hydrogen, helium - Separation of Oxygen and nitrogen - Storage and transfer of liquefied gases, superinsulation 4. Properties of liquid helium <ul style="list-style-type: none"> - Production and thermodynamic properties of ^4He and ^3He - Phase diagrams (^4He, ^3He) - Superfluidity of ^4He <ul style="list-style-type: none"> - Experiments, Two-Fluid-Model - Bose-Einstein-Condensation - Excitation spectrum, critical velocity - Rotating Helium - Normal and superfluid ^3He - ^4He / ^3He-mixtures 5. Cryogenic engineering <ul style="list-style-type: none"> - Bath-Cryostats (Helium-4, Helium-3), - ^4He / ^3He-Dilution-Refrigerators - Pomeranchuk-Cooling - Adiabatic demagnetization - Primary and secondary thermometers |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basic properties of matter at low temperatures and the corresponding experimental techniques, • have acquired the theoretical knowledge to perform low-temperature measurements, • and know how to experimentally investigate current problems in low-temperature physics. |
| 7. Curriculum inclosures | MaAFM-41-12 / Master Advanced Functional Materials MaMawi-41-12 / Master Materialwissenschaften MaPhy-24-14 / Master Physik |
| 8. Recommended semester | 2nd or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every 2nd year |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |

| | |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: Physik IV - Solid-state physics (new signature: BaMawi-14 / old signature: BaMawi-14-01) |
| 13. Credit points | 6 |
| 14. Requirements for credits | oral examination (30 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: beamer presentation, blackboard, and transparencies |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

No courses are provided for this module in the current term

| MaMawi-41-13 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Spintronics |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | N.N. |
| 5. Content | <ol style="list-style-type: none"> 1. Introduction into magnetism [4] 2. Basic spintronic effects and devices [4] 3. Novel materials for spintronic applications [4] 4. Spin-sensitive experimental methods [4] 5. Semiconductor based spintronics [4] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the fundamental properties of magnetic materials, the basic spintronic effects, and the related device structures, • have acquired skills in identifying materials with respect to their applicability for spintronic devices, • and have the competence to deal with current problems in the field of semi-conductor and metal based spintronics largely autonomously. |
| 7. Curriculum inclosures | MaAFM-41-13 / Master Advanced Functional Materials MaMawi-41-13 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every 2nd year |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture media and methods: beamer presentation, blackboard |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

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|----------------------------|------------------------------|
| Spintronics (see page 147) | 4 hours of workload per week |
|----------------------------|------------------------------|

| MaMawi-41-15 | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Oxidation and Corrosion |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Ferdinand Haider |
| 5. Content | <ol style="list-style-type: none"> 1. Introduction 2. Review of thermodynamics 3. Chemical equilibria 4. Electrochemistry 5. Electrode kinetics 6. High temperature oxidation 7. Localized corrosion <ul style="list-style-type: none"> - Shallow pit corrosion - Pitting corrosion - Crevice corrosion - Intercrystalline corrosion - Stress corrosion cracking - Fatigue corrosion - Erosion corrosion - Galvanic corrosion 8. Water and seawater corrosion 9. Corrosion monitoring 10. Corrosion properties of specific materials 11. Specific corrosion problems in certain branches <ul style="list-style-type: none"> - Oil and Gas industry - Automobile industry - Food industry 12. Corrosion protection <ul style="list-style-type: none"> - Passive layers - Reaction layers (Diffusion layers ...) - Coatings (organic, inorganic) - Cathodic, anodic protection - Inhibitors |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the the fundamental basics, mechanics, and types of corrosion processes, • obtain specific knowledge of one type of corrosion. |
| 7. Curriculum inclosures | MaAFM-41-15 / Master Advanced Functional Materials MaMawi-41-15 / Master Materialwissenschaften |
| 8. Recommended semester | 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 68 hours / self-study: 100 hours |

4. Specialization in Materials Science

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|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: good knowledge in materials science, basic knowledge in physical chemistry |
| 13. Credit points | 6 |
| 14. Requirements for credits | Seminar talk with discussion (45 minutes) practical course, written report |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, practical course media and methods: powerpoint presentation |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

No courses are provided for this module in the current term

| MaMawi-41-17 | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Advanced Solid State Materials |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Henning Höppe |
| 5. Content | <ol style="list-style-type: none"> 1. Luminescent materials [5] 2. Pigments [3] 3. Ion conductors [3] 4. Magnetic/data storage materials [3] 5. Thermoelectric materials [2] 6. Catalysts [4] 7. Hard materials [2] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • are aware of correlations between composition, structures and properties of functional materials, • acquire skills to predict the properties of chemical compounds, based on their composition and structures, • gain competence to evaluate the potential of functional materials for future technological developments, • will know how to measure the properties of these materials. • Integrated acquirement of soft skills. |
| 7. Curriculum inclosures | MaAFM-41-17 / Master Advanced Functional Materials MaMawi-41-17 / Master Materialwissenschaften MaPhy-41-07 / Master Physik |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: content of the modules "Chemistry I" (new signature: BaMawi-31 / old signature: BaMawi-51-01) and "Chemistry II" (new signature: BaMawi-32 / old signature: BaMawi-52-01) of the Bachelor of Science "Materials Science" program |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: beamer presentation, blackboard |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

4. Specialization in Materials Science

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|----------------------------------------------------------|------------------------------|
| Advanced Solid State Materials (see page 107) | 3 hours of workload per week |
| Advanced Solid State Materials (Tutorial) (see page 108) | 1 hours of workload per week |

| MaMawi-41-18 | |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Porous Functional Materials |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Dirk Volkmer |
| 5. Content | <ol style="list-style-type: none"> 1. Overview and historical developments [1] 2. Structural families of porous frameworks [2] 3. Structure Determination and Computer Modelling [3] 4. Synthesis strategies [2] 5. Adsorption and diffusion [3] 6. Thermal analysis methods [3] 7. Catalytic properties [3] 8. Advanced applications and current trends [1] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • shall acquire knowledge about design principles and synthesis of porous functional materials, • broaden their capabilities to characterize porous solid state materials with special emphasis laid upon sorption and thermal analysis, • become introduced into typical technical applications of porous solids. • Integrated acquirement of soft skills. |
| 7. Curriculum inclosures | <p>MaAFM-41-18 / Master Advanced Functional Materials MaMawi-41-18 / Master Materialwissenschaften MaPhy-41-08 / Master Physik MaPhy-42-08 / Master Physik</p> |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none recommended prerequisites: participation in the course "Materials Chemistry" (new signature: MaMatsci-1A-02 / old signature: MaMawi-13-01)</p> |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (120 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture, tutorial media and methods: beamer presentation, blackboard</p> |
| 17. Application | none |
| 18. Further information | <p>ELECTIVE MODULE</p> <p>Subsequent to the lecture course, the students can take part in a hands-on method course "Porous Materials Synthesis and Characterization"(new signature: MaMatsci-2-08 / old signature: MaMawi-24-15) to practice their knowledge.</p> |

4. Specialization in Materials Science

The following courses are provided for this module in the current term:

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|-------------------------------------------------------|------------------------------|
| Porous Functional Materials (see page 141) | 3 hours of workload per week |
| Porous Functional Materials (Tutorial) (see page 142) | 1 hours of workload per week |

| MaMawi-41-19 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Superconductivity |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | PD Dr. Reinhard Tidecks |
| 5. Content | <ol style="list-style-type: none"> 1. Introductory Remarks and Literature[1] 2. History and Main Properties of the Superconducting State, an Overview [1] 3. Phenomenological Thermodynamics and Electrodynamics of the SC [4] 4. Ginzburg-Landau Theory [4] 5. Microscopic Theories[4] 6. Fundamental Experiments on the Nature of the Superconducting State [3] 7. Josephson-Effects [4] 8. High Temperature Superconductors [5] 9. Application of Superconductivity [4] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • will get an introduction to superconductivity, • by a presentation of experimental results they will learn the fundamental properties of the superconducting state, • are informed about the most important technical applications of superconductivity. • Special attention will be drawn to the basic concepts of the main phenomeno-logical and microscopic theories of the superconducting state, to explain the experimental observations. • For self-studies a comprehensive list of further reading will be supplied. |
| 7. Curriculum inclosures | MaAFM-41-19 / Master Advanced Functional Materials MaMawi-41-19 / Master Materialwissenschaften MaPhy-24-18 / Master Physik |
| 8. Recommended semester | 2nd or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every 2nd year |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: <ul style="list-style-type: none"> • Physik IV – Solid-state physics (new signature: BaMawi-14 / old signature: BaMawi-14-01) • Theoretical physics I (new signature: BaMawi-21 / old signature: BaMawi-21-01) • Theoretical physics II (new signature: BaMawi-22 / old signature: BaMawi-22-01) • Theoretical physics III (BaPhy-23-01) |
| 13. Credit points | 6 |
| 14. Requirements for credits | oral examination (30 minutes) oral examination, 20-30 min |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture media and methods: handwritten lecture at the overhead projector, occasional use of transparencies |
| 17. Application | none |

4. *Specialization in Materials Science*

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|-------------------------|------------------------|
| 18. Further information | ELECTIVE MODULE |
|-------------------------|------------------------|

No courses are provided for this module in the current term

| MaMawi-41-20 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Sustainable Resource Management |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Armin Reller |
| 5. Content | <ol style="list-style-type: none"> 1. Introduction (global resource consumption) 2. Overview of resource types 3. Definition of mineral resources 4. Introduction to resource management 5. Identification of resource price risks 6. Measurement of resource price risks 7. Management of resource price risks 8. Introduction in basics of environmental management 9. Corporate environmental management 10. Economical closed-loop systems |
| 6. Acquired skills and knowledge | <ul style="list-style-type: none"> • The students know the basics of geographic distribution and the technical relevancy of different resources like energy sources and metals. • Furthermore, the students know risk management methods, which are used to identify, measure and manage resource price risks. For this purpose, resource scarcity indicators, risk measures and instruments for risk protection are being presented, which enable the students to make economically well-grounded decisions in dealing with resources. • Moreover, the students know how resource-based strategies with the help of environmental management contribute to environmental risk management. All topics are being illustrated with examples (from practical projects). |
| 7. Curriculum inclosures | MaAFM-41-20 / Master Advanced Functional Materials MaMawi-41-20 / Master Materialwissenschaften |
| 8. Recommended semester | 2. oder 4. Semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 40 hours / self-study: 140 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (60 minutes) practice sheets |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: slides / blackboard with the help of other media |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

No courses are provided for this module in the current term

| MaMawi-41-21 | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Characterization of Composite Materials |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Markus Sause |
| 5. Content | The following topics are presented: <ul style="list-style-type: none"> ● Introduction to composite materials ● Applications of composite materials ● Mechanical testing ● Thermophysical testing ● Nondestructive testing |
| 6. Acquired skills and knowledge | The students: <ul style="list-style-type: none"> ● acquire knowledge in the field of materials testing and evaluation of composite materials. ● are introduced to important concepts in measurement techniques, and material models applied to composites. ● are able to independently acquire further information of the scientific topic using various forms of information. |
| 7. Curriculum inclosures | MaAFM-41-21 / Master Advanced Functional Materials MaMawi-41-21 / Master Materialwissenschaften |
| 8. Recommended semester | 2. oder 4. Semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge in materials science, particularly in composite materials |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: lecture: slides and blackboard in combination with beamer presentation tutorial: talks and exercises on recent topics, specialization of lecture contents |
| 17. Application | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

| | |
|-------------------------------------------------------------------|------------------------------|
| Characterization of Composite Materials (see page 110) | 3 hours of workload per week |
| Characterization of Composite Materials (Tutorial) (see page 111) | 1 hours of workload per week |

| MaMawi-41-22 | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Fiber Reinforced Composites: Processing and Materials Properties |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Siegfried Horn Dr. Judith Moosburger-Will |
| 5. Content | The following topics are treated: <ul style="list-style-type: none"> • production of fibers (e.g. glass, carbon, or ceramic fibers) • Physical and chemical properties of fibers and their precursor materials • Physical and chemical properties of commonly used polymeric and ceramic matrix materials • Semi-finished products • Composite production technologies • Application of fiber reinforced materials |
| 6. Acquired skills and knowledge | The students: <ul style="list-style-type: none"> • know the application areas of composite materials. • know the basics of production technologies of fibers, polymeric, and ceramic matrices and fiber reinforced materials. • are introduced to physical and chemical properties of fibers, matrices, and fiber reinforced materials. • are able to independently acquire further knowledge of the scientific topic using various forms of information. |
| 7. Curriculum inclosures | MaAFM-41-22 / Master Advanced Functional Materials MaMawi-41-22 / Master Materialwissenschaften |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge in materials science |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: lecture: slides and blackboard in combination with beamer presentation tutorial: exercises on recent topics, specialization of lecture contents |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

No courses are provided for this module in the current term

| MaMawi-41-23 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Carbon-based functional Materials (Carboterials) |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Vorsitzender/Vorsitzende des Prüfungsausschusses |
| 5. Content | <ol style="list-style-type: none"> 1. Introduction to carbon allotropes and porous carbon materials [4] 2. Physical properties of fullerenes, carbon nanotubes and graphene [4] 3. Solid state NMR spectroscopy of carbon materials [4] 4. Metal carbides [4] 5. Carbon thin films and coatings [4] 6. Manufacturing and processing technology of carbon fibres [4] 7. Carbon-fibre reinforced polymer composites [4] 8. Carbon-fibre reinforced aluminium (Metal Matrix Composites, MMC) [4] 9. Energy storage in carbon materials [4] 10. Carbon-based materials for opto-electronics [4] 11. Quantum transport phenomena relating to carbon materials [4] 12. Manipulating heat flow with carbon-based electronic analogs: phononics in place of electronics [2] 13. Carbon-based spintronics [2] 14. Fabrication and processing of carbon-based nanostructures [4] |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basics of the chemistry and physics of carbon materials and their applications, • acquire knowledge about the structural characterization, physical properties and engineering of functional materials and carbon based devices, • learn to work with specialist literature in english. |
| 7. Curriculum inclosures | <p>MaAFM-41-23 / Master Advanced Functional Materials MaMatsci-5-04 / Master Materials Science MaMawi-41-23 / Master Materialwissenschaften</p> |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none recommended prerequisites: none</p> |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (120 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture Media and methods: Beamer presentation, blackboard (occasionally)</p> |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

| | |
|-----------------------------------------------------------------|------------------------------|
| Carbon-based functional Materials (Carboterials) (see page 109) | 4 hours of workload per week |
|-----------------------------------------------------------------|------------------------------|

| MaMawi-41-24 | |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Dielectric and Optical Materials |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Joachim Deisenhofer |
| 5. Content | <p>Optical materials:</p> <ul style="list-style-type: none"> • Fundamentals of electromagnetic wave propagation in homogenous media (refraction, reflection, transmission, absorption) • Evanescent phenomena, optical waveguides, photonic crystals, plasmonics • Luminescence, optoelectronics, laser • Anisotropic media, non-linear optics <p>Dielectric materials:</p> <ul style="list-style-type: none"> • Dielectric properties of polar oxides: mechanism of polarization, piezoelectricity, ferroelectric polarization • Ferroelectric materials: application of ferroelectric and relaxor-ferroelectric materials (e.g. capacitors, actuators, sensors) • Multiferroic materials: mechanisms, materials, applications (e.g. sensors, integrated circuits) • Supercapacitors: fundamentals of capacitance (e.g. Helmholtz- Gouy-, Chapman-, Stern-Layers), pseudo- and electrostatic capacitance, materials for supercapacitors (e.g. ionic liquids) |
| 6. Acquired skills and knowledge | Students know the fundamentals of electromagnetic wave propagation and have a sound background for a broad spectrum of dielectric and optical phenomena. They are able to analyze materials requirements and have the competence to select materials for different kinds of applications. |
| 7. Curriculum inclosures | MaAFM-41-24 / Master Advanced Functional Materials MaMatsci-4A-03 / Master Materials Science MaMawi-41-24 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | recommended prerequisites: Basic knowledge of solid state physics. |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture blackboard, beamer presentation |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

| | |
|-------------------------------------------------|------------------------------|
| Dielectric and Optical Materials (see page 116) | 4 hours of workload per week |
|-------------------------------------------------|------------------------------|

| MaMawi-41-25 | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Coordination Materials |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Dirk Volkmer |
| 5. Content | <p>A)</p> <ul style="list-style-type: none"> • Historical development of coordination chemistry [1] • Structures and nomenclature rules [2] • Chemical bonds in transition metal coordination compounds [3] • Stability of transition metal compounds [2] • Characteristic reactions [4]B <p>B) Selected classes of functional materials</p> <ul style="list-style-type: none"> • Bioinorganic chemistry [2] • Coordination compounds in medical applications [1] • Coordination polymers / metal-organic frameworks [4] • Cluster compounds [2] |
| 6. Acquired skills and knowledge | <p>The students</p> <ul style="list-style-type: none"> • shall acquire knowledge about concepts of chemical bonding in coordination chemistry (main emphasis: d-block transition metal compounds), • broaden their capabilities to interpret UV/vis absorption spectra and to predict stability and reactivity of coordination compounds, • learn how to transfer concepts of coordination chemistry onto topics of materials sciences. • Integrated acquirement of soft skills. |
| 7. Curriculum inclosures | <p>MaAFM-41-25 / Master Advanced Functional Materials MaMatsci-4B-03 / Master Materials Science MaMawi-41-25 / Master Materialwissenschaften</p> |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none recommended prerequisites: The lecture course is based on the courses "Chemistry I" (new signature: BaMawi-31 / old signature: BaMawi-51-01) and "Chemistry II" (new signature: BaMawi-32 / old signature: BaMawi-52-01) of the Bachelor of Science "Materials Science" program.</p> |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture, tutorial Media and methods: Beamer presentation, blackboard (occasionally)</p> |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

| | |
|--------------------------------------------------|------------------------------|
| Coordination Materials (see page 114) | 3 hours of workload per week |
| Coordination Materials (Tutorial) (see page 115) | 1 hours of workload per week |

| MaMawi-41-26 | |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Introduction to Mechanical Engineering |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Siegfried Horn |
| 5. Content | <p>The following topics are treated:</p> <ul style="list-style-type: none"> • Statics and dynamics of objects • Transmissions and mechanisms • Tension, shear and bending moment • Hydrostatics • Hydrodynamics • Strength of materials and solid mechanics • Instrumentation and measurement • Mechanical design (including kinematics and dynamics) |
| 6. Acquired skills and knowledge | <p>The students understands and is able to apply basic concepts of physics and materials science to:</p> <ul style="list-style-type: none"> • Engineering applications • Mechanical testing • Instrumentation • Mechanical design |
| 7. Curriculum inclosures | <p>MaAFM-41-26 / Master Advanced Functional Materials MaMatsci-4C-04 / Master Materials Science MaMawi-41-26 / Master Materialwissenschaften</p> |
| 8. Recommended semester | 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none recommended prerequisites: basic knowledge of materials science and physics</p> |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture, tutorial media and methods: lecture: slides and blackboard in combination with beamer presentation tutorial: excercises on recent topics, specialization of lecture contents</p> |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

No courses are provided for this module in the current term

| MaMawi-41-27 | |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Functional Polymers |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Klaus Ruhland |
| 5. Content | <ul style="list-style-type: none"> • Introduction to polymer science • Elastomers and elastoplastic materials • Memory-shape polymers • Piezoelectric polymers • Electrically conducting polymers • Ion-conducting polymers • Magnetic polymers • Photoresponsive polymers • Polymers with second order non-linear optical properties • Polymeric catalysts • Self-healing polymers • Polymers in bio sciences |
| 6. Acquired skills and knowledge | The students learn how polymeric materials can be designed and applied to act in a smart manner on an external mechanical, magnetic, electric, optical, thermal or chemical impact. |
| 7. Curriculum inclosures | MaAFM-41-27 / Master Advanced Functional Materials MaMatsci-5-01 / Master Materials Science MaMawi-41-27 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | recommended prerequisites: attendance to the modules "Chemistry I" (new signature: BaMawi-31 / old signature: BaMawi-51-01) and "Chemistry II" (new signature: BaMawi-32 / old signature: BaMawi-52-01) of the Bachelor of Science "Materials Science" program |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

The following courses are provided for this module in the current term:

4. Specialization in Materials Science

| | |
|-----------------------------------------------|------------------------------|
| Functional Polymers (see page 118) | 3 hours of workload per week |
| Functional Polymers (Tutorial) (see page 119) | 1 hours of workload per week |

| MaMawi-41-28 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Solid State NMR Spectroscopy and Diffraction Methods |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Georg Eickerling Prof. Dr. Wolfgang Scherer Prof. Dr. Leo van Wüllen |
| 5. Content | <ul style="list-style-type: none"> • Physical foundations of NMR spectroscopy • Internal Interactions in solid state NMR spectroscopy • Magic Angle Spinning NMR • Basic Introduction to X-ray and neutron diffraction and crystallography • X-ray/neutron scattering • Data collection and reduction techniques • Symmetry and space group determination • Structure determination and refinement <ul style="list-style-type: none"> – The Patterson method – Direct methods – Rietveld refinements – Difference Fourier techniques – Charge density determination/analysis |
| 6. Acquired skills and knowledge | |
| 7. Curriculum inclosures | MaAFM-41-28 / Master Advanced Functional Materials MaMatsci-4B-04 / Master Materials Science MaMawi-41-28 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: none |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial media and methods: blackboard, power point presentation |
| 17. Application | none |
| 18. Further information | ELECTIVE COMPULSORY MODULE |

The following courses are provided for this module in the current term:

4. Specialization in Materials Science

| | |
|--------------------------------------------------------------------------------|------------------------------|
| Solid State NMR Spectroscopy and Diffraction Methods (see page 143) | 3 hours of workload per week |
| Solid State NMR Spectroscopy and Diffraction Methods (Tutorial) (see page 144) | 1 hours of workload per week |

| MaMawi-41-29 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Non-Destructive Testing |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Dr. Markus Sause |
| 5. Content | <p>The following topics are presented:</p> <ul style="list-style-type: none"> ● Introduction to nondestructive testing methods ● Visual inspection ● Ultrasonic testing ● Guided wave testing ● Acoustic emission analysis ● Thermography ● Radiography ● Eddy current testing ● Specialized nondestructive methods |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> ● acquire knowledge in the field of nondestructive evaluation of materials, ● are introduced to important concepts in nondestructive measurement techniques, ● are able to independently acquire further knowledge of the scientific topic using various forms of information. |
| 7. Curriculum inclosures | MaMawi-41-29 / Master Materialwissenschaften |
| 8. Recommended semester | 1st or 3rd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | <p>requirements acc. to the regulations of study: none</p> <p>recommended prerequisites: Basic knowledge on materials science, in particular composite materials</p> |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | <p>lecture, tutorial</p> <p>Lecture: Slides and Blackboard in combination with beamer presentation</p> <p>Exercise: Talks and exercises on recent topics, specialization of lecture contents</p> |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

No courses are provided for this module in the current term

| MaMawi-41-30 | |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Applied Magnetic Materials and Methods |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Manfred Albrecht |
| 5. Content | <ul style="list-style-type: none"> • Ferromagnets - permanent magnets • Magnetic nanoparticles • Superparamagnetism • Exchange bias effect • Magnetoresistance, sensors • Measuring techniques |
| 6. Acquired skills and knowledge | <p>The students:</p> <ul style="list-style-type: none"> • know the basic terms and concepts of magnetism, • get a profound understanding of basic physical relations and their applications, • acquire the ability to describe qualitative observations, interpret quantitative measurements, and develop mathematical descriptions of physical effects of chosen magnetic material systems. • Integrated acquirement of soft skills: autonomous working with specialist literature in english, acquisition of presentation techniques, capacity for teamwork, ability to document experimental results, and interdisciplinary thinking and working. |
| 7. Curriculum inclosures | MaMawi-41-30 / Master Materialwissenschaften |
| 8. Recommended semester | 1st semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every winter term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: It is recommended to attend the lecture "Magnetism" (MaMawi-41-11) first. |
| 13. Credit points | 6 |
| 14. Requirements for credits | oral examination (30 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture, tutorial |
| 17. Application | none |
| 18. Further information | ELECTIVE MODULE |

No courses are provided for this module in the current term

| MaMawi-41-31 | |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Modern Metallic Materials |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Ferdinand Haider |
| 5. Content | <p>Introduction Review of physical metallurgy Steels:</p> <ul style="list-style-type: none"> • principles • common alloying elements • martensitic transformations • dual phase steels • TRIP and TWIP steels • maraging steel • electrical steel • production and processing <p>Aluminium alloys:</p> <ul style="list-style-type: none"> • 2xxx • 6xxx • 7xxx • Processing – creep forming, hydroforming, spinning <p>Titanium alloys Magnesium cast alloys Superalloys Intermetallics, high entropy alloys Copper, brass, bronzes Metallic glasses Alloy design</p> |
| 6. Acquired skills and knowledge | <p>Students</p> <ul style="list-style-type: none"> • learn about all kinds of actual metallic alloys, their properties and how these properties can be derived from basic concepts |
| 7. Curriculum inclosures | MaMawi-41-31 / Master Materialwissenschaften |
| 8. Recommended semester | 2nd semester |
| 9. Duration of module | 1 semester |
| 10. Recurrence of module | every summer term |
| 11. Work load (total) | compulsory attendance: 60 hours / self-study: 120 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: Knowledge of physical metallurgy and physical chemistry |
| 13. Credit points | 6 |
| 14. Requirements for credits | written examination (90 minutes) |
| 15. Examination | general examination for module |
| 16. Teaching methods | lecture Oral presentation with supporting powerpoint slides |
| 17. Application | none |

4. Specialization in Materials Science

| | |
|-------------------------|------------------------|
| 18. Further information | ELECTIVE MODULE |
|-------------------------|------------------------|

The following courses are provided for this module in the current term:

| | |
|------------------------------------------|------------------------------|
| Modern Metallic Materials (see page 136) | 4 hours of workload per week |
|------------------------------------------|------------------------------|

| MaMawi-42-01 | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Module title | Practical Laboratory Project |
| 2. Module group/s | Specialization in Materials Science |
| 3. Specific field | None |
| 4. Responsible for module | Prof. Dr. Dirk Volkmer |
| 5. Content | Experimental or theoretical work in a laboratory / research group in the Institute of Physics. Has to be conducted within 3 months. |
| 6. Acquired skills and knowledge | The students: <ul style="list-style-type: none"> • know the basic terms, skills and concepts to pursuit a real research project in the existing laboratories within the research groups, • experience the day to day life in a research group from within, • prepare themselves to conduct a research project during their Masters thesis. |
| 7. Curriculum inclosures | MaAFM-42-01 / Master Advanced Functional Materials MaMawi-42-01 / Master Materialwissenschaften |
| 8. Recommended semester | 3rd or 4th semester |
| 9. Duration of module | 3 months |
| 10. Recurrence of module | every semester |
| 11. Work load (total) | compulsory attendance: 180 hours / self-study: 0 hours |
| 12. Prerequisites | requirements acc. to the regulations of study: none recommended prerequisites: solid knowledge in (solid state) Physics, Chemistry and Materials Science, both experimentally and theoretically |
| 13. Credit points | 6 |
| 14. Requirements for credits | 1 written report (editing time 2 weeks) |
| 15. Examination | general examination for module |
| 16. Teaching methods | practical course Media and methods: Face to face tutoring |
| 17. Application | none |
| 18. Further information | ELECTIVE COURSE |

No courses are provided for this module in the current term

Part IV.

List of courses

| | |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Advanced Solid State Materials |
| Module assignment | MaAFM-41-17, MaMawi-41-17 (see page 79), MaPhy-41-07 |
| Teaching methods | lecture media and methods: beamer presentation, blackboard |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 40 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • A. West, Solid State Chemistry and Its Applications • L. Smart, E. Moore, Solid State Chemistry • Scripts Solid State Chemistry and Chemistry I and II |

| | |
|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Advanced Solid State Materials (Tutorial) |
| Module assignment | MaAFM-41-17, MaMawi-41-17 (see page 79), MaPhy-41-07 |
| Teaching methods | tutorial |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 80 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

| | |
|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Carbon-based functional Materials (Carboterials) |
| Module assignment | MaAFM-41-23, MaMatsci-5-04, MaMawi-41-23 (see page 88) |
| Teaching methods | lecture media and methods: beamer presentation, blackboard |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 120 hours |
| Examination/s, method/s of examination | 1 written examination, 120 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | will be announced by the lecturers |

| | |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Characterization of Composite Materials |
| Module assignment | MaAFM-41-21, MaMawi-41-21 (see page 86) MaAFM-21-01, MaMawi-21-01 (see page 24) |
| Teaching methods | lecture media and methods: slides and blackboard in combination with beamer presentation |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 75 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • Morgan: Carbon fibers and their composites • Henning, Moeller: Handbuch Leichtbau • Schürmann: Konstruieren mit Faser-Kunststoff-Verbunden • Neitzel, Mitschang: Handbuch Verbundwerkstoffe • Dowling: Mechanical behaviour of materials • Issler: Festigkeitslehre - Grundlagen • Landau, Lifschitz: Theoretische Physik Vol. 7 <p>Further literature - actual scientific papers and reviews - will be announced at the beginning of the lecture.</p> |

| | |
|----------------------------------------|------------------------------------------------------------------------------------------------------------|
| Title | Characterization of Composite Materials (Tutorial) |
| Module assignment | MaAFM-41-21, MaMawi-41-21 (see page 86) MaAFM-21-01, MaMawi-21-01 (see page 24) |
| Teaching methods | tutorial media and methods: talks and exercises on recent topics, specialization of lecture contents |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 45 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | see lecture |

| | |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Chemical Physics II |
| Module assignment | BaMawi-64-05, MaAFM-41-07, MaMawi-41-07 (see page 65), MaPhy-24-07, MaPhy-41-03 |
| Teaching methods | lecture teaching methods: beamer presentation, blackboard |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 75 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • J. Reinhold, Quantentheorie der Moleküle (Teubner) • H.-H. Schmidtke, Quantenchemie (VCH) • J. K. Burdett, Chemical Bonds: A Dialog (Wiley) • F. A. Kettle, Physical Inorganic Chemistry (Oxford University Press) • R. F. W. Bader, Atoms in Molecules: A Quantum Theory (Oxford University Press) • P. Popelier, Atoms in Molecules: An Introduction (Pearson Education Limited) • F. Weinhold, C. R. Landis, Valency and Bonding: A Natural Bond Orbital Do-nor-Acceptor Perspective (Cambridge University Press) • A. Frisch, Exploring Chemistry with Electronic Structure Methods (Gaussian Inc. Pittsburg, PA) |
| Further information | It is possible for students to do EHM calculations autonomously and analyze electronical structures of molecules on a computer cluster within the scope of the tutorial |

| | |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Chemical Physics II (Tutorial) |
| Module assignment | BaMawi-64-05, MaAFM-41-07, MaMawi-41-07 (see page 65), MaPhy-24-07, MaPhy-41-03 |
| Teaching methods | tutorial |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 45 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Further information | It is possible for students to do quantum chemical calculations autonomously and analyze electronical structures of molecules on a computer cluster within the scope of the tutorial. |

| | |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Coordination Materials |
| Module assignment | MaAFM-41-25, MaMatsci-4B-03, MaMawi-41-25 (see page 92) |
| Teaching methods | lecture Media and methods Beamer presentation, blackboard (occasionally) |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 30 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • Joan Ribas Gisbert, Coordination Chemistry, Wiley-VCH • Lutz H. Gade, Koordinationschemie, Wiley-VCH • As well as selected reviews and journals articles cited on the slides |

| | |
|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Coordination Materials (Tutorial) |
| Module assignment | MaAFM-41-25, MaMatsci-4B-03, MaMawi-41-25 (see page 92) |
| Teaching methods | tutorial |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 60 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

| | |
|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Dielectric and Optical Materials |
| Module assignment | MaAFM-41-24, MaMatsci-4A-03, MaMawi-41-24 (see page 90) |
| Teaching methods | lecture |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 120 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | Dr. Joachim Deisenhofer Dr. Stephan Krohns |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

| | |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Electronics for Physicists and Materials Scientists |
| Module assignment | BaMawi-64-02, MaAFM-41-03, MaMawi-41-03 (see page 57), MaPhy-24-03 |
| Teaching methods | lecture media and methods: slides / blackboard talk with help of other media and experiments |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 130 hours |
| Examination/s, method/s of examination | oral examination (max. 30 min) |
| Application | none |
| Lecturer | Dr. Andreas Hörner Prof. Dr. Achim Wixforth |
| Room / time | Montag, 10:00-11:30 (T-2003) Montag, 12:15-13:45 (T-2003) |
| Recommended literature | <ul style="list-style-type: none"> • Paul Horowitz: The Art of Electronics (Cambridge University Press) • National Instruments: MultiSim software package (available during) |
| Further information | none |

| | |
|----------------------------------------|-------------------------------------------------------------------------------------------|
| Title | Functional Polymers |
| Module assignment | MaAFM-41-27, MaMatsci-5-01, MaMawi-41-27 (see page 95) |
| Teaching methods | lecture media and methods: blackboard presentation supported by beamer and overhead |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 45 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

| | |
|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Functional Polymers (Tutorial) |
| Module assignment | MaAFM-41-27, MaMatsci-5-01, MaMawi-41-27 (see page 95) |
| Teaching methods | tutorial |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 75 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

| | |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Ion-Solid Interaction |
| Module assignment | MaAFM-41-08, MaMawi-41-08 (see page 67), MaPhy-24-09 |
| Teaching methods | lecture teaching methods: beamer presentation, blackboard with transparencies where appropriate |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 75 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> ● R. Smith, Atomic and ion collisions in solids and at surfaces (Cambridge University Press, 1997) ● E. Rimini, Ion implantation: Basics to device fabrication (Kluwer, 1995) ● W. Eckstein: Computer Simulation of Ion-Solid Interactions (Springer, 1991) ● H. Ryssel, I. Ruge: Ionenimplantation (Teubner, 1978) ● Y. H. Ohtsuki: Charged Beam Interaction with Solids (Taylor & Francis, 1983) ● J. F. Ziegler (Hrsg.): The Stopping and Range of Ions in Solids (Pergamon) ● R. Behrisch (Hrsg.): Sputtering by Particle Bombardment (Springer) ● M. Nastasi, J. K. Hirvonen, J. W. Mayer: Ion-Solid Interactions: Fundamentals and Applications (Cambridge University Press, 1996) ● http://www.SRIM.org |

| | |
|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Ion-Solid Interaction (Tutorial) |
| Module assignment | MaAFM-41-08, MaMawi-41-08 (see page 67), MaPhy-24-09 |
| Teaching methods | tutorial |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 45 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

| | |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Magnetism |
| Module assignment | BaMawi-64-10, MaAFM-41-11, MaMawi-41-11 (see page 72), MaPhy-24-12 |
| Teaching methods | lecture media and methods: beamer presentation, blackboard, overhead transparencies |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 60 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | None |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • D. H. Martin, Magnetism in Solids (London Iliffe Books Ltd.) • J. B. Goodenough, Magnetism and the Chemical Bond (Wiley) • P. A. Cox, Transition Metal Oxides (Oxford University Press) • C. Kittel, Solid State Physics (Wiley) • D. C. Mattis, The Theory of Magnetism (Wiley) • G. L. Squires, Thermal Neutron Scattering (Dover Publications Inc.) |

| | |
|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Magnetism (Tutorial) |
| Module assignment | BaMawi-64-10, MaAFM-41-11, MaMawi-41-11 (see page 72), MaPhy-24-12 |
| Teaching methods | tutorial |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 60 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

| | |
|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Method Course: Coordination Materials (Practical Course) |
| Module assignment | MaAFM-24-13, MaMawi-24-13 (see page 42) |
| Teaching methods | practical course |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 100 hours / self-study: 80 hours |
| Examination/s, method/s of examination | written report (protocols) |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

| | |
|----------------------------------------|------------------------------------------------------------------------------------------------------|
| Title | Method Course: Coordination Materials (Seminar) |
| Module assignment | MaAFM-24-13, MaMawi-24-13 (see page 42) |
| Teaching methods | lecture |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 20 hours / self-study: 40 hours |
| Examination/s, method/s of examination | Seminar talk |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • Chemical databases • Primary literature |

| | |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Method Course: Electronics for Physicists and Materials Scientists |
| Module assignment | MaAFM-24-04, MaMawi-24-04 (see page 30) |
| Teaching methods | lecture media and methods: slides / blackboard talk with help of other media and experiments self-study |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 130 hours |
| Examination/s, method/s of examination | Oral examination (max. 30 min) |
| Application | none |
| Lecturer | Dr. Andreas Hörner |
| Room / time | Montag, 10:00-11:30 (T-2003) Montag, 12:15-13:45 (T-2003) |
| Recommended literature | <ul style="list-style-type: none"> • Paul Horowitz: The Art of Electronics (Cambridge University Press) • National Instruments: MultiSim software package (available in lecture) |

| | |
|----------------------------------------|----------------------------------------------------------------------------------------------|
| Title | Method Course: Electronics for Physicists and Materials Scientists (Practical Course) |
| Module assignment | MaAFM-24-04, MaMawi-24-04 (see page 30) |
| Teaching methods | practical course |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 40 hours / self-study: 10 hours |
| Examination/s, method/s of examination | written report (one per group) |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

| | |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Method Course: Functional Silicate-analogous Materials (Practical Course) |
| Module assignment | MaAFM-24-17, MaMawi-24-17 (see page 46) |
| Teaching methods | practical course |
| Content of course | Synthesis and characterization of functional materials according to the topics: <ol style="list-style-type: none"> 1. Silicate-analogous compounds 2. Luminescent materials / phosphors 3. Pigments 4. Characterization methods: XRD, spectroscopy (luminescence, UV/vis, FT-IR), thermal analysis |
| Acquired skills and knowledge | The students will know how to: <ul style="list-style-type: none"> • develop functional materials based on silicate-analogous materials, • apply classical and modern preparation techniques (e.g. solid state reaction, sol-gel reaction, precipitation, autoclave reactions, use of silica ampoules), • work under non-ambient atmospheres (e.g. reducing, inert conditions), • solve and refine crystal structures from single-crystal data, • describe and classify these structures properly. |
| Work load | compulsory attendance: 120 hours / self-study: 120 hours |
| Examination/s, method/s of examination | written report (protocol) |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

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|----------------------------------------|------------------------------------------------------------------------------------------------|
| Title | Method Course: Magnetic and Superconducting Materials |
| Module assignment | MaMawi-24-19 (see page 48) |
| Teaching methods | lecture media and methods: slides/blackboard talk with help of other media self study |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 30 hours / self-study: 30 hours |
| Examination/s, method/s of examination | 1 written report on the experiments (editing time 3 weeks, max. 30 pages) |
| Application | none |
| Lecturer | Dr. Veronika Fritsch Prof. Dr. Philipp Gegenwart |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

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|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Method Course: Magnetic and Superconducting Materials (Practical Course) |
| Module assignment | MaMawi-24-19 (see page 48) |
| Teaching methods | practical course Media and methods: experiments and self-study |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 120 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | Dr. Veronika Fritsch Prof. Dr. Philipp Gegenwart |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

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|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Method Course: Methods in Biophysics (Practical Course) |
| Module assignment | MaAFM-24-06, MaMawi-24-06 (see page 33) |
| Teaching methods | practical course media and methods: intensive mentoring in small groups self-study |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 85 hours / self-study: 95 hours |
| Examination/s, method/s of examination | 1 written lab report |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • T. Herrmann, Klinische Strahlenbiologie – kurz und bündig, Elsevier Verlag, ISBN-13: 978-3-437-23960-1 • J. Freyschmidt, Handbuch diagnostische Radiologie – Strahlenphysik, Strahlenbiologie, Strahlenschutz, Springer Verlag, ISBN: 3-540-41419-3 • S. Haeberle und R. Zengerle, Microfluidic platforms for lab-on-a-chip applications, Lab-on-a-chip, 2007, 7, 1094-1110 • J. Berthier, Microdrops and digital microfluidics, William Andrew Verlag, ISBN:978-0-8155-1544-9 • Lecture notes |

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|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Method Course: Optical Properties of Solids |
| Module assignment | MaAFM-24-07, MaMawi-24-07 (see page 35) |
| Teaching methods | lecture media and methods: projector, slides, blackboard, web resources |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 30 hours / self-study: 65 hours |
| Examination/s, method/s of examination | written homework; short presentation, 20 min |
| Application | none |
| Lecturer | Dr. Joachim Deisenhofer |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • J.D. Jackson, Classical Electrodynamics (de Gruyter) • N.W. Ashcroft, N.D. Mermin, Solid state physics (Saunders) • Ch. Kittel, Introduction to solid state physics (Wiley) • E. Hecht, Optics (Addison-Wesley Longman) |

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|----------------------------------------|----------------------------------------------------------------------------------------|
| Title | Method Course: Optical Properties of Solids (Practical Course) |
| Module assignment | MaAFM-24-07, MaMawi-24-07 (see page 35) |
| Teaching methods | practical course media and methods: exercises, teamwork, students' presentations |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 85 hours |
| Examination/s, method/s of examination | written report on the experiments, editing time 3 weeks, max. 30 pages |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Further information | the practical course will take place after the end of lectures as a block course |

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|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Method Course: Spectroscopy on Condensed Matter |
| Module assignment | MaAFM-24-09, MaMawi-24-09 (see page 37) |
| Teaching methods | lecture media and methods: slides / blackboard talk with help of other media and experiments Self-study |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 30 hours / self-study: 30 hours |
| Examination/s, method/s of examination | 1 written examination (120 min) |
| Application | none |
| Lecturer | Dr. Stephan Krohns Prof. Dr. Alois Loidl |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • N.W. Ashcroft, N.D. Mermin, Festkörperphysik (Oldenbourg) • Ch. Kittel, Einführung in die Festkörperphysik (Oldenbourg) • C.J.F. Böttcher, P. Bordewijk, Theory of Electric Polarization (Elsevier) • J. R. Macdonald, Impedance Spectroscopy (Wiley) • H. Scholze, Glas (Springer) • S.R. Elliott, Physics of Amorphous Materials (Longman) • R. Zallen, The Physics of Amorphous Solids (Wiley) |

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|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Method Course: Spectroscopy on Condensed Matter (Practical Course) |
| Module assignment | MaAFM-24-09, MaMawi-24-09 (see page 37) |
| Teaching methods | practical course |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 60 hours |
| Examination/s, method/s of examination | 1 written report on the experiments (editing time 2 weeks) |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

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|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Modern Metallic Materials |
| Module assignment | MaMawi-41-31 (see page 101) |
| Teaching methods | lecture Oral presentation with supporting powerpoint slides |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 120 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | Prof. Dr. Ferdinand Haider |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | Cahn-Haasen-Kramer: Materials Science and Technology Original literature |

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|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Organic Semiconductors |
| Module assignment | MaAFM-41-10, MaMawi-41-10 (see page 70), MaPhy-24-11 |
| Teaching methods | lecture media and methods: beamer presentation, blackboard |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 120 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | Prof. Dr. Wolfgang Brütting |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • M. Schwoerer, H. C. Wolf, Organische Molekulare Festkörper (Wiley-VCH, 2005) • M. Schwoerer, H. C. Wolf, Organic Molecular Solids (Wiley-VCH, 2007) • M. Pope, C. E. Swenberg, Electronic Processes in Organic Crystals and Polymers (Oxford University Press 1999) • W. Brütting, Physics of Organic Semiconductors (lecture script) |

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|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Physics and Technology of Semiconductor Devices |
| Module assignment | BaMawi-64-01, MaAFM-41-01, MaMawi-41-01 (see page 54), MaPhy-24-01 |
| Teaching methods | lecture media and methods: slides / blackboard supported by other media and experiments |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 80 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • Yu und Cardona: Fundamentals of Semiconductors (Springer) • Sze: Physics of Semiconductor Devices (Wiley) • Sze: Semiconductor Devices (Wiley) • Madelung: Halbleiterphysik (Springer) • Singh: Electronic and Optoelectronic Properties of Semiconductor Structures (Cambridge University Press) |

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|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Physics and Technology of Semiconductor Devices (Tutorial) |
| Module assignment | BaMawi-64-01, MaAFM-41-01, MaMawi-41-01 (see page 54), MaPhy-24-01 |
| Teaching methods | tutorial media and methods: intensive support in small groups self study |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 40 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

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|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Physics of Thin Films |
| Module assignment | BaMawi-64-07, MaAFM-41-09, MaMawi-41-09 (see page 69), MaPhy-24-10 |
| Teaching methods | lecture media and methods: beamer presentation, blackboard |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 120 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | Dr. German Hammerl |
| Room / time | Dienstag, 12:15-13:45 (S-288) Mittwoch, 14:00-15:30 (S-288) |
| Recommended literature | <ul style="list-style-type: none"> • H. Frey, G. Kienel, Dünnschichttechnologie (VDI Verlag, 1987) • H. Lüth, Solid Surfaces, Interfaces and Thin Films (Springer Verlag, 2001) • A. Wagendristel, Y. Wang, An Introduction to Physics and Technology of Thin Films (World Scientific Publishing, 1994) • M. Ohring, The Materials Science of Thin Films (Academic Press, 1992) |

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|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Porous Functional Materials |
| Module assignment | MaAFM-41-18, MaMawi-41-18 (see page 81), MaPhy-41-08, MaPhy-42-08 |
| Teaching methods | lecture media and methods: beamer presentation, blackboard |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 30 hours |
| Examination/s, method/s of examination | 1 written examination, 120 min |
| Application | none |
| Lecturer | Prof. Dr. Dirk Volkmer |
| Room / time | Mittwoch, 12:15-13:45 (T-2004) Freitag, 12:15-13:45 (T-2004) |
| Recommended literature | <ul style="list-style-type: none"> • Paul A. Wright, Microporous Framework Solids (RSC Materials Monographs, 2008) • As well as selected reviews and journal articles cited on the slides |
| Further information | Subsequent to the lecture course, the students can take part in a hands-on method course (Characterization of Porous Materials, MaMawi-24-15, MaAFM-24-15) to practice their knowledge. |

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|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Porous Functional Materials (Tutorial) |
| Module assignment | MaAFM-41-18, MaMawi-41-18 (see page 81), MaPhy-41-08, MaPhy-42-08 |
| Teaching methods | tutorial |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 90 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

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|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Solid State NMR Spectroscopy and Diffraction Methods |
| Module assignment | MaAFM-41-28, MaMatsci-4B-04, MaMawi-41-28 (see page 97) |
| Teaching methods | lecture media and methods: blackboard, power point presentation |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 30 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ol style="list-style-type: none"> 1. M. H. Levitt, Spin Dynamics, John Wiley and Sons, Ltd., 2008. 2. H. Günther, NMR spectroscopy, Wiley 2001. 3. M.Duer, Introduction to Solid-State NMR spectroscopy, Blackwell Publishing Ltd., 2004. 4. D. Canet: NMR - concepts and methods, Springer, 1994. 5. C. Hammond, The Basis of Crystallography and Diffraction, Oxford University Press Inc., New York, 2001. 6. W. Clegg, A. J. Blake, R. O. Gould, P. Main, Crystal Structure Analysis, Principle and Practice, Oxford University Press Inc., New York, 2001. 7. G. Giacovazzo, Fundamentals of Crystallography, Oxford University Press Inc., New York, 1994. 8. R. A. Young, The Rietveld Method, Oxford University Press Inc., New York, 2002. 9. W. Massa, Crystal Structure Determination, Springer, Berlin, 2004. |

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|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Solid State NMR Spectroscopy and Diffraction Methods (Tutorial) |
| Module assignment | MaAFM-41-28, MaMatsci-4B-04, MaMawi-41-28 (see page 97) |
| Teaching methods | tutorial |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 90 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

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|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title | Solid State Spectroscopy with Synchrotron Radiation |
| Module assignment | BaMawi-64-03, MaAFM-41-05, MaMawi-41-05 (see page 61), MaPhy-24-05 |
| Teaching methods | lecture media and methods: beamer presentation |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 75 hours |
| Examination/s, method/s of examination | oral examination, 30 min |
| Application | none |
| Lecturer | Prof. Dr. Christine Kuntscher |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • H. Kuzmany, Solid State Spectroscopy (Springer) • N. W. Ashcroft, N. D. Mermin, Solid State Physics (Holt, Rinehart and Winston) • J. M. Hollas, Modern Spectroscopy |

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|----------------------------------------|--------------------------------------------------------------------------------------|
| Title | Solid State Spectroscopy with Synchrotron Radiation (Tutorial) |
| Module assignment | BaMawi-64-03, MaAFM-41-05, MaMawi-41-05 (see page 61), MaPhy-24-05 |
| Teaching methods | tutorial |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 15 hours / self-study: 45 hours |
| Examination/s, method/s of examination | see lecture |
| Application | none |
| Lecturer | Prof. Dr. Christine Kuntscher |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |

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|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Title | Spintronics |
| Module assignment | MaAFM-41-13, MaMawi-41-13 (see page 76) |
| Teaching methods | lecture media and methods: beamer presentation, blackboard |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 60 hours / self-study: 120 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • S. Bandyopadhyay, M. Cahay: Introduction to Spintronics (CRC Press, 2008) |

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| Title | Surfaces and Interfaces |
| Module assignment | MaAFM-14-01, MaMawi-14-01 (see page 21), MaPhy-42-03 |
| Teaching methods | lecture |
| Content of course | |
| Acquired skills and knowledge | |
| Work load | compulsory attendance: 45 hours / self-study: 45 hours |
| Examination/s, method/s of examination | 1 written examination, 90 min |
| Application | none |
| Lecturer | N.N. |
| Room / time | will be announced by notice or digitally in the university calendar or in Digicampus |
| Recommended literature | <ul style="list-style-type: none"> • Ertl, Küppers: Low Energy Electrons and Surface Chemistry (VCH) • Lüth: Surfaces and Interfaces of Solids (Springer) • Zangwill: Physics at Surfaces (Cambridge) • Feldmann, Mayer: Fundamentals of Surface and thin Film Analysis (North Holland) • Henzler, Göpel: Oberflächenphysik des Festkörpers (Teubner) • Briggs, Seah: Practical Surface Analysis I und II (Wiley) |