Module Descriptions

Master of Science Chemistry

Absorption:Chemistry

Examination Regulations in the Version of: 2013
Index

Core Subjects

Fourth Subject

Analytical Chemistry

Analytical Chemistry - Specialisation

Analytical Chemistry - Specialization 1

Analytical Chemistry - Modules

Analytical Spectroscopy 3
Project Work in Analytical Chemistry 5
Special Topics in Analytical Chemistry I 7
Special Topics in Analytical Chemistry II 9
Special Topics in Analytical Chemistry III 11
Special Topics in Analytical Chemistry IV 13
Special Topics in Analytical Chemistry V 15

Energy Technology

Energy Technology - Modules

Applied Electrochemistry 17
Catalysis - Fundamental Aspects and Common Principles 19
Characterization Techniques for Fuel Cells and Batteries 21
Introduction to Electrochemistry 24
Introduction to Energy Technology 26
Electrochemistry 29
Energy Science and Technology II 31
Energy Science and Technology III 34
Solid State Chemistry and Applications in Energy Materials 36
Interface Chemistry I - Surface Chemistry 38
Surface Chemistry II - Electorchemistry 40
Hydrogen as Energy Carrier 42
Lithium Ion Batteries 44
Multiscale-Modeling in Energy Research 46
Project Work in Energytechnology 48
Materials of Energy Management 50

Energy Technology - Specialisation

Energy Technology - Specialization 53

Macromolecular Chemistry

Macromolecular Chemistry - Specialisation

Macromolecular Chemistry - Specialisation 55
**Macromolecular Chemistry - Modules**

- Biomaterials 57
- Biopolymers 59
- Colloid Chemistry 61
- Functional Materials 63
- Ground Course I Macromolecular Chemistry 65
- Projekt Work in Macromolecular Chemistry 67
- Polymeric Materials 69
- Precision Macromolecules 71
- Soft Matter Nanoscience 73

**Theoretical Chemistry**

**Theoretical Chemistry - Specialisation**

- Macromolecular Chemistry - Specialization 75

**Theoretical Chemistry - Modules**

- Introduction in Quantum Chemistry 77
- Advanced Methods of Quantum Chemistry 79
- Group Theory 81
- Seminar of the Institute of Theoretical Chemistry 83
- Project Work in Theoretical Chemistry 85
- Exercises in Quantum Chemistry 87
- Programming Practical Course Quantum Chemistry I 89
- Programming Practical Course Quantum Chemistry II 91
- Theoretical Solid State Chemistry 93
- Theoretical Surface Chemistry 95
- Theoretical Physical Chemistry 97

**Inorganic Chemistry**

**Inorganic Chemistry - Modules**

- Inorganic Materials Synthesis/Inorganic Nanomaterials 99
- Inorganic Photochemistry/Photocatalysis 101
- Inorganic Structural Chemistry and Cristallography 103
- Bioanorganic Chemistry 105
- Biomaterials 107
- Solid State Chemistry and Applications in Energy Materials 109
- Functional Materials 111
- Modern Aspects of Inorganic Chemistry 113
- Project Work in Inorganic Chemistry 115

**Inorganic Chemistry - Specialisation**

- Inorganic Chemistry - Specialization 117
Organic Chemistry

Organic Chemistry - Modules

- Concepts of Drug Discovery and Design 119
- Introduction to the Chemistry of Natural Products 121
- Functional Materials 123
- Functional Materials 125
- Modern Physical Organic Chemistry 127
- Non-aromatic Carbo- and Heterocycles 129
- Organic Materials / Organic Materials 131
- Project Work in Organic Chemistry 133
- Polymeric Materials 135
- Stereocontrolled Synthesis 137
- Structural Analysis by NMR-Methods 139
- Supramolecular Chemistry 141
- Special Reaction Mechanisms 143

Organic Chemistry - Specialisation

- Organic Chemistry - Specialization 145

Physical Chemistry

Physical Chemistry - Modules

- Introduction to Electrochemistry 147
- Electrochemistry 149
- Interface Chemistry I - Surface Chemistry 151
- Surface Chemistry II - Electorchemistry 153
- Laser Spectroscopy 155
- Multiscale-Modeling in Energy Research 157
- Surface Analytic 159
- Project Work in Physical Chemistry 161
- Physical Chemistry Properties of Clusters from Atoms and Molecules 163
- Solar Energy Conversion: Fundamentals 165
- Solar Energy Conversion: Selected Topics 167
- Theoretical Physical Chemistry 169

Physical Chemistry - Specialisation

- Physical Chemistry - Specialisation 171

Subsidiary Subject

Multidisciplinary Subsidiary Subject

- Technical Chemistry 173
- Economic Topics 175

Subsidiary Subject Biology
<table>
<thead>
<tr>
<th>Subject</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemistry I</td>
<td>178</td>
</tr>
<tr>
<td>Biochemistry II</td>
<td>180</td>
</tr>
<tr>
<td>Biological Chemistry</td>
<td>182</td>
</tr>
<tr>
<td>Basics of Biology for Non-Biologists</td>
<td>185</td>
</tr>
<tr>
<td>Molecular Biology for Non-Biologists</td>
<td>188</td>
</tr>
<tr>
<td>Ecology for Non-Biologists</td>
<td>190</td>
</tr>
<tr>
<td><strong>Subsidiary Subject Computer Science</strong></td>
<td></td>
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<tr>
<td>Introduction to Computer Science and Programming I and II</td>
<td>192</td>
</tr>
<tr>
<td>Introduction to Programming</td>
<td>195</td>
</tr>
<tr>
<td><strong>Subsidiary Subject Philosophy</strong></td>
<td></td>
</tr>
<tr>
<td>Basics Philosophy A with 10 ECTS</td>
<td>197</td>
</tr>
<tr>
<td>Basics Philosophy A with 4 ECTS</td>
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</tr>
<tr>
<td>Basics Philosophy A with 6 ECTS</td>
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<tr>
<td>Basics Philosophy B with 4 ECTS</td>
<td>203</td>
</tr>
<tr>
<td><strong>Subsidiary Subject Physics</strong></td>
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<tr>
<td>Introduction to Physics of Condensed Matter</td>
<td>205</td>
</tr>
<tr>
<td><strong>Subsidiary Subject Toxicology</strong></td>
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<td>Toxicology for Chemistry</td>
<td>207</td>
</tr>
<tr>
<td><strong>Subsidiary Subject Management and Economics</strong></td>
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</tr>
<tr>
<td>Introduction to Business Administration</td>
<td>208</td>
</tr>
<tr>
<td>Introduction to Economics</td>
<td>210</td>
</tr>
<tr>
<td>Fundamentals of Management Accounting and Control</td>
<td>212</td>
</tr>
<tr>
<td>Information Society an Globalization II</td>
<td>215</td>
</tr>
<tr>
<td>Macroeconomics</td>
<td>217</td>
</tr>
<tr>
<td>Process Management II</td>
<td>219</td>
</tr>
<tr>
<td>Technology- and Innovationsmanagement I</td>
<td>221</td>
</tr>
<tr>
<td><strong>Master Thesis</strong></td>
<td></td>
</tr>
<tr>
<td>Master’s Thesis</td>
<td>223</td>
</tr>
<tr>
<td>Seminar Master Thesis</td>
<td>225</td>
</tr>
<tr>
<td><strong>Seminars and Practical Experience</strong></td>
<td></td>
</tr>
<tr>
<td>Seminar Master Thesis</td>
<td>227</td>
</tr>
<tr>
<td><strong>Additional Key Qualifications</strong></td>
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</tr>
<tr>
<td>Additional Key Qualifications</td>
<td>229</td>
</tr>
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<td><strong>Analytical Chemistry - Specialization</strong></td>
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<td><strong>Coordinator</strong></td>
<td>Instructors of the Analytical Chemistry</td>
</tr>
<tr>
<td><strong>Instructor(s)</strong></td>
<td>Instructors of the Analytical Chemistry</td>
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</table>
| **Allocation of study programmes** | Master Chemistry, Study Program Chemistry, deepening module 1.-3. semester  
Master Chemistry and Management, specialization / Module Group 2, 1.-3. semester |
| **Recommended prerequisites** | *Formal prerequisites (according to Study order and examination regulations):* none  
**Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject |
<p>| <strong>Learning objectives</strong> | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| <strong>Syllabus</strong> | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| <strong>Literature</strong> | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| <strong>Teaching and learning methods</strong> | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |</p>
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<th>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</th>
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<td><strong>Assessment</strong></td>
<td>The exam form is depending on the elective module. The single module descriptions of the electoral duty area regulate further details.</td>
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<td><strong>Grading procedure</strong></td>
<td>The result of exams in the deepening area is not relevant for the final mark (cf. study order and examination regulations)</td>
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<td><strong>Basis for</strong></td>
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# Analytical Spectroscopy

**Modules referring to Analytical Chemistry - Modules**

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<tr>
<td><strong>Duration</strong></td>
<td>1 Semester</td>
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<tr>
<td><strong>Cycle</strong></td>
<td>each Winter Semester</td>
</tr>
<tr>
<td><strong>Coordinator</strong></td>
<td>Prof. Dr. Boris Mizaikoff</td>
</tr>
<tr>
<td><strong>Instructor(s)</strong></td>
<td>Prof. Dr. Boris Mizaikoff</td>
</tr>
</tbody>
</table>

### Allocation of study programmes

- Master Chemistry, Study Programm Chemistry, compulsory module (Analytical Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Analytical Chemistry), 1.-3. semester

### Recommended prerequisites

**Formal prerequisites (according to Study order and examination regulations):** none

**Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

### Learning objectives

The interaction of electromagnetic radiation with molecules, ions, and atoms is among the fundamental physical principles for generating highly specific information on the species present within a solid, liquid or gaseous sample.

### Syllabus

This lecture will repeat and discuss in more depth the fundamentals of spectroscopic techniques, interaction of light with matter, and optical elements, and will then expand into advanced analytical spectroscopies including e.g., IR- and Raman and fluorescence spectroscopy, surface enhanced optical techniques, and laser-based measurement techniques.

### Literature

will be announced in the course
<table>
<thead>
<tr>
<th><strong>Teaching and learning methods</strong></th>
<th>Lecture (2 hours per week)</th>
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<tr>
<td><strong>Workload</strong></td>
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<td>Private study: 60 h</td>
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<td><strong>Assessment</strong></td>
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<tr>
<td><strong>Grading procedure</strong></td>
<td>The total grade for the module results of the Exam.</td>
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<tr>
<td><strong>Basis for</strong></td>
<td>If Analytical Chemistry is chosen as &quot;Fourth Subject&quot;, it is obligatory to pass Analytical Spectroscopy (to finish the respective module group).</td>
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</table>
Project Work in Analytical Chemistry
Modules referring to Analytical Chemistry - Modules

Code 8803271289

ECTS credits 9

Attendance time 12

Language of instruction German or English

Duration 1 Semester

Cycle each Semester

Coordinator Prof. Dr. Boris Mizaikoff

Instructor(s) Lecturers of the analytical chemistry

Allocation of study programmes Master Chemistry, Study Program Chemistry, elective, 1.-3. semester
Master Chemistry, Study Program Materials, elective, 1.-3. semester
Master Chemistry and Management, elective, 1.-3. semester

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): none
Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives The students who have finished this module successfully,
- earn the skill and competence to work independently on a project in theory and practise in the analytic chemistry, write it down, discuss it academically in a short treatise, and present it clearly.

Syllabus In this module the following contents are given:
Practical research project on a topical subject of the analytic chemistry from the working groups

Literature - it is made available
- independent literature search
<table>
<thead>
<tr>
<th><strong>Teaching and learning methods</strong></th>
<th>Project work (lab course) Analytic chemistry (12 hours per week, 9 CP) with written elaboration and presentation in the working group or institute</th>
</tr>
</thead>
</table>
| **Workload**                  | Presence: 180 h  
Private study: 90 h  
Total: 270 h |
| **Assessment**                | Written elaboration of the project. |
| **Grading procedure**         | None, because unmarked study achievement |
| **Basis for**                 | No data |
Increasingly, modern analytical chemistry relies on miniaturized instrumental devices for providing compact and portable analyzers that may be used in the field and on-site. Instead of collecting and isolating a discrete sample, which needs transport and storage prior to analysis, directly probing the species of interest (molecules, ions, etc.) may significantly improve the reliability of the analytical data.

In order to miniaturize analytical devices, we not only need to understand the fundamentals of micro- and nanofabrication, but also the advantages and disadvantages of miniaturizing individual components of analytical systems, or of integrating the entire analytical device (e.g., on-chip sensors, etc.). Hence, this lecture will discuss the fundamental implications of miniaturization, the principal concepts of micro- and nanofabrication and -structuring (e.g., lithography, wet and dry etching, thin film deposition, etc.), and enrich these fundamental
considerations with analytically relevant examples ranging from on-chip LC and GC to integrated optical sensors, lab-on-a-chip devices, and microfluidics.

<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
<th>will be announced in the course</th>
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<tbody>
<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Lecture (2 hours per week)</td>
</tr>
</tbody>
</table>
| **Workload** | Presence: 30 h  
                   Private study: 60 h  
                   Total: 90 h |
| **Assessment** | Presentation, Proposal or oral Exam. |
| **Grading procedure** | The total grade for the module results of the Exam. |
| **Basis for** | no data |
**Special Topics in Analytical Chemistry II**

Modules referring to Analytical Chemistry - Modules

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<td><strong>Language of instruction</strong></td>
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<tr>
<td><strong>Duration</strong></td>
<td>1 Semester</td>
</tr>
<tr>
<td><strong>Cycle</strong></td>
<td>each Winter Semester</td>
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<tr>
<td><strong>Coordinator</strong></td>
<td>Prof. Dr. Boris Mizaikoff</td>
</tr>
<tr>
<td><strong>Instructor(s)</strong></td>
<td>Dr. Christine Kranz</td>
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**Allocation of study programmes**

- Master Chemistry, Study Program Chemistry, elective or specialization (Analytical Chemistry), 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Analytical Chemistry), 1.-3. semester

**Recommended prerequisites**

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**

The general principles of electroanalytical chemistry will be revisited and expanded towards miniaturization in electrochemistry, high-throughput analysis, combined techniques (e.g., electrochemical quartz microbalance), electrochemical detection in separation techniques, and spectroelectrochemistry.

**Syllabus**

Furthermore, an introduction on bioelectrochemistry will be provided. Besides the physico-chemical principles, applications from a variety of research areas such as e.g., corrosion science, pharmaceutical research, and life sciences will be discussed.

**Literature**

will be announced in the course
<table>
<thead>
<tr>
<th><strong>Teaching and learning methods</strong></th>
<th>Lecture (2 hours per week)</th>
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<td><strong>Workload</strong></td>
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<td><strong>Assessment</strong></td>
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## Special Topics in Analytical Chemistry III

### Code
8803271291

### ECTS credits
3

### Attendance time
2

### Language of instruction
English

### Duration
1 Semester

### Cycle
each Winter Semester

### Coordinator
Prof. Dr. Boris Mizaikoff

### Instructor(s)
Prof. Dr. Boris Mizaikoff, Dr. Christine Kranz, Prof. Dr. Kerstin Leopold

### Allocation of study programmes
- Master Chemistry, Study Program Chemistry, elective or specialization (Analytical Chemistry), 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Analytical Chemistry), 1.-3. semester

### Recommended prerequisites
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

### Learning objectives
Given the rapid progress in the natural sciences, many novel techniques and principles that are of interest to the analytical disciplines are not covered within conventional analytical chemistry lectures. Hence, this lecture aims at supplementing “hot topics” of interest to the analytical community via lecture units comprising 3-6 classes focusing on selected highlight areas that may contribute to significant progress in the analytical sciences during the next decades.

### Syllabus
Such topics include introductions to e.g., nanophotonics, integrated optics, nanoparticles & nanomaterials, focused ion beam based analysis, etc.. The topics of the lecture remain flexible, and will be adapted each year to ensure the actuality of the selected areas.

### Literature
will be announced in the course
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## Special Topics in Analytical Chemistry IV

Modules referring to Analytical Chemistry - Modules

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<td>Instructor(s)</td>
<td>Dr. Christine Kranz</td>
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### Allocation of study programmes

- Master Chemistry, Study Program Chemistry, elective or specialization (Analytical Chemistry), 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Analytical Chemistry), 1.-3. semester

### Recommended prerequisites

**Formal prerequisites (according to Study order and examination regulations):** none

**Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

### Learning objectives

This lecture gives an introduction to the fundamental principles of scanning probe microscopy and their applications. A special focus is on techniques and application areas that are frequently used in analytical chemistry.

### Syllabus

Among these techniques, atomic force microscopy (AFM), scanning tunneling microscopy (STM), nearfield scanning optical microscopy (NSOM), and scanning electrochemical microscopy (SECM) along with hyphenated techniques combining some of these measurement principles will be discussed. Example from recent literature will furthermore highlight the importance of these tools in modern analytical chemistry.

### Literature

will be announced in the course
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<td><strong>Assessment</strong></td>
<td>Presentation, Proposal or oral Exam.</td>
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<tr>
<td><strong>Grading procedure</strong></td>
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## Special Topics in Analytical Chemistry V

**Modules referring to Analytical Chemistry - Modules**

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<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Kerstin Leopold</td>
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### Allocation of study programmes

- Master Chemistry, Study Program Chemistry, elective or specialization (Analytical Chemistry), 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Analytical Chemistry), 1.-3. semester

### Recommended prerequisites

- **Formal prerequisites (according to Study order and examination regulations):** none

- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

### Learning objectives

This lecture gives an overview of the methods applied in ultra trace analysis of elements, i.e. analytical procedures for the determination of elements in a concentration range lower than 1 mg L\(^{-1}\). Such methods are applied in a broad variety of fields, such as environmental analysis, forensic analysis, semiconductor technique, biology, medicine and medical analysis, archaeology, geology, etc.

### Syllabus

The lecture will give examples of different applications and will explain special working procedures, like for example working in a clean room, or how to collect a sample without contaminating it. Furthermore, possible sources of contamination and analyte losses will be shown as well as the methodology to identify such systematic errors. The analytical procedure, from collection of the sample to processing the data will be discussed in regard to the speciality of ultra trace concentration.
<table>
<thead>
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<th><strong>Literature</strong></th>
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<tbody>
<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Lecture (2 hours per week)</td>
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</table>
| **Workload** | Presence: 30 h  
Private study: 60 h  
Total: 90 h |
| **Assessment** | Presentation, Proposal or oral Exam. |
| **Grading procedure** | The total grade for the module results of the Exam. |
| **Basis for** | no data |
## Applied Electrochemistry

Modules referring to Energy Technology - Modules

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<td>Coordinator</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Dr. Mario Wachtler</td>
</tr>
</tbody>
</table>

### Allocation of study programmes

- Master Chemistry, Study program Chemistry, Fourth Subject Energy Technology, electoral duty module or specialization module, 1.-3. semester
- Master Chemistry and Management, Fourth Subject Energy Technology, specialization module, 1.-3. semester

### Recommended prerequisites

**Formal prerequisites (according to Study order and examination regulations):** none

**Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject, especially Lecture "Surface Chemistry II (Electrochemistry)"

### Learning objectives

Students who have finished this module successfully,
- have an overview about important electro-chemical applications
- understand the relevant electro-chemical concepts.

### Syllabus

In this module the following content is given:

1. Repetition and deepening of electro-chemical concepts:
   - Electrolytic conductivity
   - Electrode reactions and electrode potentials
   - Cell tension and potential trends in the cell
   - Electrode potentials in case of electrical current flow and electrode excess voltage
   - Introduction to the electrochemistry of the solid states

2. Uses of electro-chemical processes in
- Batteries
- Fuel cells
- Electro-chemical production procedures, electrolysis
- Sensors
- Corrosion
- Electroplating

<table>
<thead>
<tr>
<th>Literature</th>
<th>Hamann, Vielstich: Elektrochemie</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bard, Faulkner: Electrochemical Methods</td>
</tr>
<tr>
<td></td>
<td>Oldman, Myland, Bond: Electrochemical Science and Technology</td>
</tr>
</tbody>
</table>

| Teaching and learning methods     | Lecture (2 hours per week)       |

| Workload                          | Presence: 30 h                   |
|                                   | Self study: 60 h                 |
|                                   | Total: 90 h                      |

| Assessment                        | The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration. Duration: 120 min |

| Grading procedure                 | The grade of the module will be the grade of the exam. |

| Basis for                         | No data |


Catalysis - Fundamental Aspects and Common Principles
Modules referring to Energy Technology - Modules

Code 8803271322

ECTS credits 4

Attendance time 3

Language of instruction English

Duration 1 Semester

Cycle each Winter Semester

Coordinator Prof. Dr. Rolf-Juergen Behm

Instructor(s) Prof. Dr. Rolf-Juergen Behm

Allocation of study programmes
Master Chemistry, Study Programm Chemistry, elective (Energy Technology) or specialization (Physical Chemistry or Energy Technology), 1.-3. semester

Master Chemistry and Management, specialization / Module Group 2 (Physical Chemistry or Energy Technology), 1.-3. semester

Master Energy Science and Technology, elective, 1.-3. semester

Recommended prerequisites
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives
Students who have successfully completed this module,
- have knowledge about basic aspects of catalysis as well as several types of catalysts
- know synthesis and operating principles of catalysts
- are able to make statements about the kinetic course of catalytic reactions

Syllabus
This module provides the following content:

- Theory and kinetics
- Model catalysts
- Enantioselective catalysis and Organocatalysis
- Preparation of catalysts and homogeneous catalysis
- Deactivation of catalysts
- Types of catalytic reactions
- Characterization and catalytic reactors
- Biocatalysis
- Electrocatalysis

<table>
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<tr>
<th>Literature</th>
<th>will be announced in the course</th>
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<tr>
<td>Teaching and learning methods</td>
<td>Lecture and Seminar (2+1 hours per week)</td>
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</table>
| Workload | Presence: 45 h  
Private study: 75 h  
Total: 120 h |
| Assessment | The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration. |
| Grading procedure | The grade of the module will be the grade of the exam. |
| Basis for | no data |
## Characterization Techniques for Fuel Cells and Batteries

Modules referring to Energy Technology - Modules

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<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Head of the ZSW respective Head of the HIU</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Dr. Roswitha Zeis</td>
</tr>
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### Allocation of study programmes
- Master Chemistry, Study Program Chemistry, elective or specialization (Energy Technology), 1.-3. Semester
- Master Chemistry and Management, specialization / Module Group 2 (Energy Technology), 1.-3. semester
- Master Energy Science and Technology, elective, 1.-3. semester
- Master Advanced Materials, elective, 1.-3. semester

### Recommended prerequisites
- Formal prerequisites (according to Study order and examination regulations): none
- Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

### Learning objectives
- Student should be able to
  - describe and explain diagnostics employed in the characterization and determination of Proton Exchange Membrane (PEM) fuel cells and battery performance.
  - gain a more precise understanding of the physical and chemical processes that occur in PEM fuel cells and batteries based on knowledge of these diagnostic tools.
  - start working on a master thesis in the field of electrochemical energy converters and storage devices.
**Syllabus**

This module provides the following content:

1. In situ cell tests
   - Steady state voltage-current measurements
   - Polarisation and charge-discharge curves
   - Impedance spectroscopy
   - Neutron scattering
   - Synchrotron radiation

2. Evaluation of cell components (Membranes, Separators, Electrolytes, Electrodes, Catalysts, Gas Diffusion Layers …)
   - Structural analysis (SEM, TEM, XRD, microtomography, porosity determination)
   - Elemental analysis (XRF, ICP-MS, EDX)
   - Electrochemical surface area (BET, cyclic volammetry)
   - Catalytic activity (Rotating Ring Disk Electrode)
   - Membrane degradation (Neutron scattering, Fenton test)

**Literature**

- Handouts

**Teaching and learning methods**

Lecture (2 hours per week, 3 CP)

**Workload**

Presence: 30 h
Self Study: 60 h
Total: 90 h

**Assessment**

The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

**Grading procedure**

The grade of the module will be the grade of the exam.

**Basis for**

Research in field of Fuel cells and Batteries
Introduction to Electrochemistry
Modules referring to Energy Technology - Modules

Code 8803271652

ECTS credits 4

Attendance time 3

Language of instruction German

Duration 1 Semester

Cycle each Winter Semester

Coordinator Prof. Dr. Timo Jacob

Instructor(s) Prof. Dr. Timo Jacob

Allocation of study programmes
- Master Chemistry, Study Program Chemistry, Electoral duty or deepening module (Physical Chemistry or Energy Technology), 1.-3. semester
- Master Chemistry, Study Program Materials, electoral duty module, 1.-3. semester
- Master Chemistry and Management, Electoral duty (Physical Chemistry) or deepening module (Physical Chemistry or Energy Technology), 1.-3. semester

Recommended prerequisites
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives
The students who have finished this module successfully,
- dispose of basic knowledge in the area of the electrochemistry
- if the most important electro-chemical relations can apply to problem formulations
- own an overview about electro-chemical energy change and energy storage

Syllabus
In this module the following contents are given:
- Qualities and characterisation of the festival-liquidly interface
- Expiry of potential-controlled processes and reactions in the festival-liquidly interface

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<tr>
<th>Literature</th>
<th>Lecture scripts are made available in the lecture</th>
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<td>Lecture (2 hours per week)</td>
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| Workload | Presence: 30 h  
Private study: 60 h  
Total: 90 h |
| Assessment | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |
| Grading procedure | The grade of the module will be the grade of the exam. |
| Basis for | no data |
Introduction to Energy Technology

Modules referring to Energy Technology - Modules

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<td>Duration</td>
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<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr.-Ing. Jian Xie</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr.-Ing. Jian Xie</td>
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</table>

**Allocation of study programmes**
- Bachelor Chemistry, Fourth Subject Energy Technology, compulsory module, 6. semester
- Master Chemistry, Study Program Chemistry, compulsory module (Energy Technology), 1.-3. semester
  *(only compulsory if not already completed in the Bachelor's course of studies)*
- Master Chemistry and Management, specialization / Module Group 2 (Energy Technology), 1.-3. semester
- Bachelor Electrical Engineering, compulsory module
- Bachelor Informations Technology, subject Electrical engineering

**Recommended prerequisites**
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**
The students know the most important connections, facts and components in the area of the (electric) energy technology. They are able to describe the functionality of hydroelectric power plants and wind power plants as well as their most important components as for example different turbines and the operational areas. They also can explain the physical working principles. Also they are able to do basic quantitative calculations in the area of wind and water power use. The students are able to describe and to explain the functionalities of the different thermal power stations (gas turbines, steam process) with the physical effect principles.
as well as her most important components with her duties and specific features. Also they are able to do basic calculations in the area of the technical thermodynamics, e.g. to determine state parameters in cyclic processes. Further the students are able to do the working principles and functionalities of her three important E-Machines (direct current machine foreign-excited, parallel connection, Row end; asynchronous machine and synchronous machine) describe and explain as well as her spare diagrammes and identity lines outline. Also they are in the situation, basic calculations about the connections of stream, Tension, torque, speed and achievement with the different ones. To carry out electric machine types. They are able to do the structure of her different Stromversorgungsnetzzebenen return and the essential ones Company means / components name as well as describe her function.

**Syllabus**

In this lecture an overview about the whole width of the electric Energy technology is given. At the beginning stands the development and the state of energy consumption and - offer as well as the consequences linked with it and limitations. The bases become mechanically – electric energy change as a base for the image of the electric machines (direct current, Asynchronous machine and synchronous machine) discussed, complements around the usual ones Criteria for the machine choice and some tips to special forms wieWechselstrom-, Linear and electronically kommutierte engines. It shuts to a short representation of the dangers in dealing with Stream and her avoidance with a description of the preventive measures. There follows an overview of structure and functionality of the electric one Energy transfer and-verteilungssystems as well as the most important ones Company means.

Then the technologies are discussed to the production of electric energy: by means of thermal energy change in technical cyclic processes how in fossil and nuclear power stations on the one hand as well as invarianter Processes of change of water and wind, on the other hand. This is complemented finally around a short representation of the most important ones Procedures to the use of regenerative energy sources: Photovoltaik, Solarthermie, Geothermie, waves, tides.

**Literature**

- H. Kabza: Skript zur Vorlesung Einführung in die Energietechnik, Univ. Ulm
- Dirk Peier: Einführung in die elektrische Energietechnik, A. Hüthig Verlag Heidelberg, 1987 (vergriffen)
- Fritz Fraunberger: Illustrierte Geschichte der Elektrizität, Aulis-Verlag Deubner & Co. KG, Köln, 1985
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<th><strong>Teaching and learning methods</strong></th>
<th>Lecture (2 hours) and Seminar (1 hour)</th>
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<tr>
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<td>Self study: 75h</td>
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<td>Total: 120h</td>
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<tr>
<td><strong>Grading procedure</strong></td>
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<td>Master Chemistry / Chemistry and Management: If Energy Technology is chosen as &quot;Fourth Subject&quot;, it is obligatory to pass &quot;Introduction to Energy Technology&quot; (to complete the respective module group), except the exam is already passed during the Bachelor’s course of studies in the fourth subject Energy Technology.</td>
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Electrochemistry
Modules referring to Energy Technology - Modules

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<td>Duration</td>
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<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
</tbody>
</table>

Allocation of study programmes
- Master Chemistry, Study Program Chemistry, Elective (Physical Chemistry or Energy Technology) oder Specialization (Physical Chemistry or Energy Technology), 1.-3. semester
- Master Chemistry, Study Program Materials, Elective, 1.-3. semester
- Master Chemistry and Management, Elective/Module Group 1 (Physical Chemistry) or Specialization/Module Group 2 (Physical Chemistry or Energy Technology), 1.-3. semester
- Master Chemical Engineering, Elective, 1.-3. semester
- Master Energy Science and Technology, Elective, 1.-3. semester

Recommended prerequisites
- Formal prerequisites (according to Study order and examination regulations): none
- Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives
- Students, who have successfully completed this module,
  - dispose of knowledge in area of the electrochemistry and its related areas of application
  - can apply electrochemical relations to problem formulations
  - have an overview as well as detailed knowledge about systems and processes in the area of the electrochemical energy change / storage

Syllabus
- In this module, the following contents are given:
  (1) Repetition and deepening of electrochemical basics:
    - Electrolytic conductivity
- Electrode reactions and electrode potentials
- Cell tension and potential courses in the cell
- Electrode potentials with current flow and overvoltage of electrodes
- Introduction to the electrochemistry of the solid states
(2) Applications from electrochemical processes in
- Batteries
- Fuel cells
- Electrochemical production procedures
- Electrolysis
- Photo (electro) chemical systems
- Sensors
- Corrosion
- Electroplating

| Literature       | - Hamann, Vielstich: *Elektrochemie*
|                 | - Bard, Faulkner: *Electrochemical Methods*
|                 | - Oldman, Myland, bond: *Electrochemical Science and Technology*

<table>
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<tr>
<th>Teaching and learning methods</th>
<th>Lecture (2 hours) and Seminar (1 hour)</th>
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</table>

| Workload                        | Presence: 45 h                        |
|                                | Self study: 75 h                      |
|                                | Total: 120 h                          |

| Assessment                      | The credit points will be awarded once the written or oral exam has been passed (depending on the number of participants). The type of examination will be announced in time - at least 4 weeks prior to the date of the exam. No prerequisites are necessary for exam registration. |

| Grading procedure               | The grade of the module will be the grade of the exam. |

| Basis for                       | No data. |

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Master of Science Chemistry  
Date printed: 18. Juli 2018  
Page 30 of 230
Energy Science and Technology II  
Modules referring to Energy Technology - Modules

<table>
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<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Josef Kallo</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Josef Kallo</td>
</tr>
</tbody>
</table>
| Allocation of study programmes | Master Energy Science and Technology, compulsory module, 1.-3. Fachsemester  
Master Chemistry, Study Program Chemistry, elective or specialization (Energy Technology), 1.-3. semester  
Master Chemistry and Management, specialization / Module Group 2 (Energy Technology), 1.-3. semester |
| Recommended prerequisites | Formal prerequisites (according to Study order and examination regulations): none  
Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject |
| Learning objectives | Students will learn to  
- understand and explain the basic physical principles underlying mechanic and electric energy conversion  
- describe the functional mechanisms of the different thermal power plants and explain the basic components  
- solve simple problems in the field of technical thermodynamics  
- solve simple problems in the field of hydro and wind power applications  
- understand and explain the construction and functional mechanisms of hydro - , wind - ,solar thermal - and photovoltaic power plants of different kinds |
- understand and explain the balance terms "cumulated energy input, energy harvest factor, energy pay-back time" and use them for approximative calculations
- distinguish the different kinds of potentials in the use of regenerative sources with different technologies and give approximative quantities for them
- show the technical possibilities for long-distance energy imports from regenerative sources and point out the necessary effort and cost
- describe possible storage technologies together with their problems
- understand and describe structure and functional mechanisms in cogeneration and absorption cooling technologies

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>The course gives an overview on technologies using renewable sources and the concepts of distributed power technologies:</td>
</tr>
<tr>
<td>- development and status of energy consumption and resources;</td>
</tr>
<tr>
<td>- limitations and consequences</td>
</tr>
<tr>
<td>- physical basics of mechanical - electrical energy conversion</td>
</tr>
<tr>
<td>- types of electric machines: DC separately excited, parallel and series wound; asynchronous; synchronous, special forms like AC machines, linear drives, electronically commutated machines</td>
</tr>
<tr>
<td>- structure and function of the electric power grid and its component</td>
</tr>
<tr>
<td>- selectric power generation by means of thermal power plants and their thermodynamical fundamentals: entropy, Carnot -, (Joule) Brayton - and (Clausius) Rankine cyclenuclear power plants, nuclear fusion technology</td>
</tr>
<tr>
<td>- electric power generation from renewable sources: hydro and wind power, photovoltaics, further technologies in the field of renewables</td>
</tr>
<tr>
<td>- primary energy input</td>
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<tr>
<td>- energy pay-back time and energy harvest factor</td>
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<td>- consumption of materials, resources and area</td>
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<td>- ecological impact</td>
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<td>- economy and cost</td>
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<tr>
<td>- the necessities for storage technologies and the problems associated</td>
</tr>
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<td>- cogeneration concepts and absorption cooling</td>
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<tbody>
<tr>
<td>Lecture Energy Science and Technology II (2 hours per week)</td>
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<tr>
<td>Exercises Energy Science and Technology II (1 hour per week)</td>
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<th>Workload</th>
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<td>Presence Time: 75 h</td>
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Self-studying: 45 h  
Total: 120 h  

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<tr>
<th><strong>Assessment</strong></th>
<th>The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.</th>
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<tr>
<td><strong>Grading procedure</strong></td>
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### Energy Science and Technology III

**Modules referring to Energy Technology - Modules**

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<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Josef Kallo</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Josef Kallo</td>
</tr>
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</table>

**Allocation of study programmes**
- Master Energy Science and Technology, compulsory module, 1.-3. semester
- Master Chemistry, Study Programm Chemistry, elective or specialization (Energy Technology), 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Energy Technology), 1.-3. semester

**Recommended prerequisites**
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**
- Students are able to
  - present a detailed understanding of Fuel Cell technology and rechargeable Battery technology – alkaline and acid systems, electrochemical double layer capacitors

**Syllabus**
- The course gives an overview on:
  - The role of fuel cells and batteries as key technologies in the modern energy world
  - Fundamentals of fuel cell technology, fuel cell systems: key components and operational characteristics, performance testing, degradation principles of fuel
cells, application of fuel cells (automotive, bus, stationary CHP and back up power, leisure market)

- fundamentals of rechargeable batteries and electrochemical double layer capacitors, characterization of batteries (charge, discharge, degradation), battery systems, battery management, thermal management, maintenance, safety aspects of batteries

<table>
<thead>
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<th>Literature</th>
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| Teaching and learning methods | Lecture Energy Science and Technology III (3 hours per week)  
Exercises Energy Science and Technology III (1 hour per week) |
| Workload | Presence Time: 45 h  
Self-studying: 75 h  
Total: 120 h |
| Assessment | The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration. |
| Grading procedure | The grade of the module will be the grade of the exam. |
| Basis for | no data |
Solid State Chemistry and Applications in Energy Materials
Modules referring to Energy Technology - Modules

Code
8803274182

ECTS credits
3

Attendance time
2

Language of instruction
English

Duration
1 Semester

Cycle
each Summer Semester

Coordinator
Prof. Dr. Maximilian Fichtner

Instructor(s)
Prof. Dr. Maximilian Fichtner

Allocation of study programmes
Master Chemistry, Study Program Chemistry, elective or specialization (Energy Technology) or specialization (Inorganic Chemistry), 1.-3. Semester

Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester

Master Chemistry and Management, elective / Modul Group 1 (Inorganic Chemistry) or specialization / Modul Group 2 (Inorganic Chemistry or Energy Technology), 1.-3. semester

Recommended prerequisites
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject, especially basics related to solid state chemistry

Learning objectives
Students who have successfully completed this module achieve the following learning objectives:

Learn about the classification of solids and the different synthesis methods of solids from the gas-, liquid-, or solid phase. Get an overview of the different structure types of solids and their relevance in the energy sector. Learn how to describe and investigate phenomena of solid surfaces and the bulk. Selected and typical examples will be discussed from the actual research and development and strategies will be presented for further development of energy related materials. The students will also learn the fundamentals in designing and function of battery materials and materials for hydrogen storage.
Syllabus

This module covers the following subject-specific topics:
Introduction into the topic of energy storage and typical problems in the development of energy materials. Systematics and basics of the synthesis and structure description of solids with examples from practical energy materials. Discussion of physical/chemical phenomena of solids and related testing methods. Discussion of selected problems and practical examples from different applications, mainly battery materials and materials for chemical energy storage such as H storage materials.

Literature

E. Riedel, Moderne Anorganische Chemie, de Gruyter (2007)

Teaching and learning methods

Lecture (2 hours per week)

Workload

Presence time: 30 h
Self study: 60 h
Total: 90 h

Assessment

The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.

Grading procedure

The grade of the module will be the grade of the exam.

Basis for

No data
## Interface Chemistry I - Surface Chemistry

Modules referring to Energy Technology - Modules

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<tr>
<td>Attendance time</td>
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</tr>
<tr>
<td>Language of instruction</td>
<td>English</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Juergen Behm</td>
</tr>
</tbody>
</table>

**Instructor(s)**

- Bachelor Chemistry, elective (Fourth Subject Energy technology), 5. Semester
- Master Chemistry, Study Program Chemistry, elective or specialization (PhysicalChemistry or Energy Technology), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 (PhysicalChemistry) or specialization / Module Group 2 (Physical Chemistry or EnergyTechnology), 1.-3. semester

**Allocation of study programmes**

- Bachelor Chemistry, elective (Fourth Subject Energy technology), 5. Semester
- Master Chemistry, Study Program Chemistry, elective or specialization (PhysicalChemistry or Energy Technology), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 (PhysicalChemistry) or specialization / Module Group 2 (Physical Chemistry or EnergyTechnology), 1.-3. semester

**Recommended prerequisites**

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**

- The students who have finished this module successfully,
  - dispose of basic knowledge of the interdisciplinary field of Energy technology, in the interface between chemistry and electrical engineering
  - have an image of surfaces as well as of catalyzed processes running off in surfaces and reactions
<table>
<thead>
<tr>
<th>Syllabus</th>
<th>In this module the following contents are given:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Qualities and characterisation of surfaces</td>
</tr>
<tr>
<td></td>
<td>- Expiry of surface processes, e.g., adsorption / desorption and surface reactions</td>
</tr>
<tr>
<td></td>
<td>- Catalytic processes</td>
</tr>
<tr>
<td>Literature</td>
<td>Will be told in the lecture</td>
</tr>
<tr>
<td>Teaching and learning methods</td>
<td>Lecture and Seminar (2+1 hours per week, 4 CP)</td>
</tr>
<tr>
<td>Workload</td>
<td>Presence: 45 h</td>
</tr>
<tr>
<td></td>
<td>Private study: 75 h</td>
</tr>
<tr>
<td></td>
<td>Total: 120 h</td>
</tr>
<tr>
<td>Assessment</td>
<td>The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.</td>
</tr>
<tr>
<td>Grading procedure</td>
<td>The grade of the module will be the grade of the exam.</td>
</tr>
<tr>
<td>Basis for</td>
<td>no data</td>
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</table>
# Surface Chemistry II - Electorchemistry

**Modules referring to Energy Technology - Modules**

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<td>Attendance time</td>
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<td>Language of instruction</td>
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<td>Duration</td>
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<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**

- Bachelor Chemistry, elective (Fourth Subject Energy Technology), 6. Semester
- Master Chemistry, Study Program Chemistry, elective or specialization (Physical Chemistry or Energy Technology), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 (Physical Chemistry) or specialization / Module Group 2 (Physical Chemistry or Energy Technology), 1.-3. semester

**Recommended prerequisites**

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**

The students who have finished this module successfully,
- own a sound knowledge to electro-chemical processes
- dispose of the skill to apply the knowledge to electro-chemical problem formulations

**Syllabus**

In this module the following contents are given:
- Structure and reactions on the electro-chemical phase border
- Electric catalysis
- experimental methods

### Literature
- Schmickler, Santos: Interfacial Electrochemistry
- Hamann, Vielstich: Elektrochemie

### Teaching and learning methods
Lecture and Seminar (2+1 hours per week, 4 CP)

### Workload
- Presence: 45 h
- Private study: 75 h
- Total: 120 h

### Assessment
The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration.

### Grading procedure
The grade of the module will be the grade of the exam.

### Basis for
No data
Hydrogen as Energy Carrier
Modules referring to Energy Technology - Modules

Code 8803271326

ECTS credits 3

Attendance time 2

Language of instruction English

Duration 1 Semester

Cycle each Summer Semester

Coordinator PD Dr. Christian Mohrdieck

Instructor(s) PD Dr. Christian Mohrdieck

Allocation of study programmes Master Chemistry, Study Programm Chemistry, elective or specialization (Energy Technology), 1.-3. semester

Master Chemistry and Management, specialization / Module Group 2 (Energy Technology), 1.-3. semester

Master Energy Science and Technology, elective, 1.-3. semester

Master Advanced Materials, elective, 1.-3. semester

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives Students who have successfully completed this module
- are familiar with the scientific, technical and economic aspects of hydrogen as a promising and environmentally friendly energy source
- have an idea of technical applications

Syllabus This module provides the following content:
- Overview hydrogen in research and applications
- Production methods, logistics and infrastructure for hydrogen
- Hydrogen storage methods (non-compressed gaseous)
- Storage methods (compressed hydrogen gas)
- Hydrogen (re)fueling technology
- Process, stationary and alternative applications
- Application of hydrogen in transportation, fuel cell vehicles
- Hydrogen - Fuel Cell - Efficiency - Entropy
- Visit of hydrogen and fuel cell laboratory, witnessing a leakage test
- Visit of a hydrogen refueling station and fuel cell vehicle test drive
- Different pathways of hydrogen production and use. Comparison with other energy sources based on the complete energy chain efficiency and emissions
- Tool for the visualization of energy chain efficiency results
- Safety, regulations, codes and standards
- Future perspectives of hydrogen as an energy carrier

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Zuttel, Andreas; Borgschulte, Andreas; Schlapbach, Louis (eds.): Hydrogen as a future energy carrier (Wiley-VCH, Weinheim, 1. Auflage 2008)</td>
</tr>
<tr>
<td>- International seminar proceedings, 3rd (Springer Netherlands, 2003)</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Lecture (2 hours per week)</td>
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<table>
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<tr>
<th>Workload</th>
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<table>
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<table>
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<th>Basis for</th>
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<td>Research in field of Energy and Energy conversion</td>
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Lithium Ion Batteries
Modules referring to Energy Technology - Modules

Code 8803271323

ECTS credits 3

Attendance time 2

Language of instruction English

Duration 1 Semester

Cycle each Winter Semester

Coordinator Head of the ZSW or Head of the HIU

Instructor(s) Dr. Margret Wohlfahrt-Mehrens

Allocation of study programmes Master Chemisty, Study Programm Chemistry, elective or specialization (Energy Technology), 1.-3. semester
Master Chemistry and Management, specialization / Module Group 2 (Energy Technology), 1.-3. semester
Master Energy Science and Technology, elective, 1.-3. semester
Master Advanced Materials, elective, 1.-3. semester

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): none
Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject

Learning objectives Students who have successfully completed this module,
- are familiar with the basics of lithium-ion batteries
- know the correlations between binary and ternary phase diagrams and electrochemistry
- have distinctive knowledge of structure and property relationships in compounds

Syllabus This module provides the following content:
- Electrochemical energy storage systems
- Introduction to Lithium batteries
- Basic principles I
- Cathode materials I

Master of Science Chemistry Date printed: 18. Juli 2018 page 44 of 230
- Cathode materials II
- Nanomaterials
- Measurement techniques
- Anode materials I
- Anode materials II
- Electrolytes
- Electrode/Electrolyte interface (SEI)
- Battery management I
- Battery management II
- Alternative Systems, Lab visit ZSW

### Literature
- M. Whittingham, Intercalation compounds, in fast ion transport, Dordrecht (1993)

### Teaching and learning methods
Lecture (2 hours per week)

### Workload
Presence: 30 h
Private study: 60 h
Total: 90 h

### Assessment
The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

### Grading procedure
The grade of the module will be the grade of the exam.

### Basis for
research in the field of Batteries
### Multiscale-Modeling in Energy Research

Modules referring to Energy Technology - Modules

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<td>Winter Semester every two Years</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
</tbody>
</table>

#### Allocation of study programmes
- Master Chemistry, Study Program Chemistr, elective or specialization (Physical Chemistry or Energy Technology)
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 (Physical Chemistry) or specialization / Module Group 2 (Physical Chemistry or Energy Technology), 1.-3. semester

#### Recommended prerequisites
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

#### Learning objectives
Students who have successfully completed this module,
- have a basic understanding of various theoretical methods that can be used for atomistic simulations of energy-related systems.
- learn how to apply and combine different modelling methods to study and understand the structures, properties, and processes relevant for energy-related systems.

#### Syllabus
This module provides the following content:
- description of the fundamentals of electrochemistry.
- focus on the multiscale modelling ranging from atomistic to continuum scales.

- Different methods of modelling and simulation for different time and length scales such as density-functional theory, molecular dynamics, Monte Carlo simulations, hybrid quantum mechanics/molecular mechanics, and coarse graining.

- description of the theoretical background and mathematical formulation of these methods. Through examples will be shown how these methods can be used for the simulation of energy-related systems.

- Seminar: Besides the lectures, there will be seminar presentations and discussions on various topics related to the multiscale modelling.

**Literature**


3. Combined Quantum Mechanical and Molecular Mechanical Methods, Edited by Jiali Gao and Mark A. Thompson, American Chemical Society (1999).


**Teaching and learning methods**

Lecture and seminar (2+1 hours per week)

**Workload**

Presence: 45 h

Private study: 75 h

Total: 120 h

**Assessment**

The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.

**Grading procedure**

The grade of the module will be the grade of the exam.

**Basis for**

no data
# Project Work in Energy Technology

Modules referring to Energy Technology - Modules

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<td>Cycle</td>
<td>each Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Instrcutors of the Physical Chemistry</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Instructors of the Physical Chemistry and related institutes or working groups</td>
</tr>
</tbody>
</table>
| Allocation of study programmes | Master Chemistry, Study Program Chemistry, elective, 1.-3. semester  
Master Chemistry, Study Program Materials, elective, 1.-3. semester  
Master Chemistry and Management, elective, 1.-3. semester |
| Recommended prerequisites | Formal prerequisites (according to Study order and examination regulations): none  
Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject |
| Learning objectives     | The students who have finished this module successfully,  
- earn the skill and competence to work independently on a project in theory and practise in energy technology, write it down, discuss it academically in a short treatise, and present it clearly. |
| Syllabus                | In this module the following contents are given:  
Practical research project on a topical subject of energy technology from the working groups |
| Literature              | - it is made available  
- independent literature search |
<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
<th>Project work (lab course) Energy Technology (12 hours per week, 9 CP) with written elaboration and presentation in the working group or institute</th>
</tr>
</thead>
</table>
| Workload                      | Presence: 180 h  
Private study: 90 h  
Total: 270 h                                                                                                                          |
| Assessment                    | Written elaboration of the project.                                                                                                                                                  |
| Grading procedure             | None, because unmarked study achievement                                                                                                                                              |
| Basis for                     | no data                                                                                                                                                                                 |
# Materials of Energy Management

Modules referring to Energy Technology - Modules

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<td>Language of instruction</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Hans-Jörg Fecht</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Hans-Jörg Fecht, Dr.-Ing. Kai Brühne</td>
</tr>
</tbody>
</table>

### Allocation of study programmes
- Master Electrical Engineering, elective, engineer's sciences, 1.-3. semester
- Master Advanced Materials, compulsory module, 1.-3. semester
- Master Chemistry, Study Program Chemistry, elective or specialization (Energy Technology), 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Energy Technology), 1.-3. semester

### Recommended prerequisites
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject and additionally basic mathematical knowledge

### Learning objectives
The students who have finished this module successfully, are able to describe the properties from materials in the thermal balance (for example, structural qualities, electric and thermal qualities) describe and analyse. They are able to do transport phenomena in materials (load transport, Warm transport, particle transport) calculate and value. The students, if draughts of the thermodynamics can apply, state changes judge, Phase diagrammes construct as well as phase crossings 1st kind and 2nd kind make a distinction. In the training period the students learn at well-chosen examples, to validate important statements of the lecture by experiments. Therefore the students are able to do draughts and uses, develop and plan issues of the sensoric, energy change and evaluate storage to in the area of the nanotechnology.
Syllabus

In this module the following contents are given:

Materials with qualities optimised straight have a cross section function and play a crucial role in the technology, and with it for the economic progress under ecological edge terms. While in the lecture „materials of the electrical engineering“ were treated basically of the isotherm case, the thermal balance is in the foreground here increasingly. Outgoing from structural and thermo-dynamic, chemical one

Hence, bases are treated state changes, phase diagrammes, phase crossings (the first and second kind), as well as the kinetics by such phase crossings.

The stability of a material, microstructurally as well as concerning the reliability of a construction element, depends furthermore not only on the temperature, but also substantially on the temperature-steered processes, as for example diffusion and phase changes which change qualities, for example, firmness, conductivity, etc. with the time. The mechanisms of these processes are discussed and made clear at examples.

The treatment of the influence of other environmental parametres and parametres of influence, like a mechanical demand, a magnetic field, an optical radiotherapy or a chemical interaction is made clear furthermore.

The discussion of these bases allows then furthermore to develop strategies for new draughts of the Sensorik, energy change and energy storage to in the area of the nanotechnology.

The lecture main focuses are therefore:

- Introduction
- Crystal structures
- Declension in the crystal
- Energetics, Phononen
- Energetics, electrons
- Transport qualities
- Matter transport and diffusion
- Thermodynamics (reversible, irreversible processes)
- State changes
- Phase diagrammes
- Phase crossings (structurally, magnetically, electronically...)
- Kinetics and germ education (production of clusters and thin layers)
- Uses in the Sensorik
- Uses in the energy storage
- View in the problems of the nanotechnology for the energy technology

Literature

- Physikalische Chemie, Atkins, VCH-Wiley 1988
- Werkstoffe der Energietechnik, DGM 1999
- H. Schaumburg, Sensoren, Teubner 1992
- Physik der Nanostrukuren, Forschungszentrum Jülich 1998

<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
<th>Lecture and Seminar (2+1 hours per week, 4 CP)</th>
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<tbody>
<tr>
<td>Workload</td>
<td>Presence: 45 h</td>
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<tr>
<td></td>
<td>Private study: 75 h</td>
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<td></td>
<td>Total: 120 h</td>
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<tr>
<td>Assessment</td>
<td>The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. Prerequisite for exam registration is passing the pre-course (to be defined by the examiner).</td>
</tr>
<tr>
<td>Grading procedure</td>
<td>The grade of the module will be the grade of the exam.</td>
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<tr>
<td>Basis for</td>
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# Energy Technology - Specialization

Modules referring to Energy Technology - Specialisation

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<td><strong>Attendance time</strong></td>
<td>keine Angaben</td>
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<tr>
<td><strong>Language of instruction</strong></td>
<td>English</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>2 Semester</td>
</tr>
<tr>
<td><strong>Cycle</strong></td>
<td>each Semester</td>
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<tr>
<td><strong>Coordinator</strong></td>
<td>Instructors of the Physical Chemistry</td>
</tr>
<tr>
<td><strong>Instructor(s)</strong></td>
<td>Instructors of the Physical Chemistry</td>
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</tbody>
</table>
| **Allocation of study programmes** | Master Chemistry, Study Program Chemistry, specialization, 1.-3. semester  
Master Chemistry and Management, specialization / Module Group 2, 1.-3. semester |
| **Recommended prerequisites** | Formal prerequisites (according to Study order and examination regulations): none  
Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject |
<p>| <strong>Learning objectives</strong> | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| <strong>Syllabus</strong> | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| <strong>Literature</strong> | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| <strong>Teaching and learning methods</strong> | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |</p>
<table>
<thead>
<tr>
<th><strong>Workload</strong></th>
<th>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment</strong></td>
<td>The exam form is depending on the elective module. The single module descriptions of the electoral duty area regulate further details.</td>
</tr>
<tr>
<td><strong>Grading procedure</strong></td>
<td>The result of exams in the deepening area is not relevant for the final mark (cf. study order and examination regulations)</td>
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<tr>
<td><strong>Basis for</strong></td>
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**Macromolecular Chemistry - Specialisation**  
Modules referring to Macromolecular Chemistry - Specialisation

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<td>Cycle</td>
<td>each Semester</td>
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<tr>
<td>Coordinator</td>
<td>Instructors of the Macromolecular Chemistry</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Instructors of the Macromolecular Chemistry</td>
</tr>
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</table>
| Allocation of study programmes | Master Chemistry, Study Program Chemistry, specialization, 1.-3. semester  
Master Chemistry and Management, specialization / Module Group 2, 1.-3. semester |
| Recommended prerequisites | Formal prerequisites (according to Study order and examination regulations): none  
**Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject |
<p>| Learning objectives | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| Syllabus       | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| Literature     | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| Teaching and learning methods | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |</p>
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### Biomaterials

**Modules referring to Macromolecular Chemistry - Modules**

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<td>Cycle</td>
<td>each Winter Semester</td>
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<tr>
<td>Coordinator</td>
<td>Prof. Dr. Mika Lindén</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Anita Ignatius, Prof. Dr. Mika Lindén, Prof. Dr. Boris Mizaikoff, Prof. Dr. Ulrich Ziener</td>
</tr>
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</table>

**Allocation of study programmes**

- Master Biochemistry, elective, 1.-3. semester
- Master Chemistry, study program Chemistry, elective or specialization (Inorganic Chemistry or Macromolecular Chemistry), 1.-3. semester
- Master Chemistry, study program Materials, elective, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 (Inorganic Chemistry) or or specialization / Modul Group 2 (Inorganic Chemistry or Macromolecular Chemistry), 1.-3. semester

**Recommended prerequisites**

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**

- Students who have successfully completed this module
  - attain the understanding of biomaterials as materials that interfere with biological systems to measure, treat, support or replace a tissue, organ or physiological function.
  - are familiar with the various application areas of biomaterials.
  - possess knowledge for the preparation and characterization of biomaterials.
  - are able to explain and interpret the structural composition of biomaterials.

**Syllabus**

- This module covers the following subject-specific topics:
• Protein aggregates, amyloid and nanotechnology
• Polymer-based and protein-based biomaterials
• Polymer therapeutics
• Directed transport of agents

Literature

Literature will be announced in the lecture.

Teaching and learning methods

Lecture (2 hours per week)

Workload

Attendance: 30 h
Private study: 60 h
Sum: 90 h

Assessment

The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

Grading procedure

The grade of the module will be the grade of the exam.

Basis for

not specified
## Biopolymers

Modules referring to Macromolecular Chemistry - Modules

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<td>English</td>
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<tr>
<td>Duration</td>
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<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Ulrich Ziener</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Tanja Weil</td>
</tr>
</tbody>
</table>

### Allocation of study programmes
- Master Chemistry, Study Program Chemistry, elective (Macromolecular Chemistry) or specialization (Organic Chemistry or Macromolecular Chemistry)
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Organic Chemistry or Macromolecular Chemistry), 1.-3. semester
- Master Biology, specialization, 1.-3. semester
- Master Biochemistry, elective, 1.-3. semester

### Recommended prerequisites
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

### Learning objectives
The students who have finished this module successfully,
- have knowledge about the structure and function of nucleic acids, proteins and other biological macromolecules
- know analytic methods that are used for characterization of this substance class

### Syllabus
In this module the following contents are given:
- structure and function of biopolymers, especially nucleic acids and proteins and some other natural products
- physical and chemical characterization methods
- structural regulation and chemical changes of biopolymers with regard to special applications

<table>
<thead>
<tr>
<th>Literature</th>
<th>it is announced in the lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and learning methods</td>
<td>Lecture (2 hours per week)</td>
</tr>
<tr>
<td>Workload</td>
<td>Presence: 30 h</td>
</tr>
<tr>
<td></td>
<td>Private study: 60 h</td>
</tr>
<tr>
<td></td>
<td>Total: 90 h</td>
</tr>
<tr>
<td>Assessment</td>
<td>The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration</td>
</tr>
<tr>
<td>Grading procedure</td>
<td>The grade of the module will be the grade of the exam.</td>
</tr>
<tr>
<td>Basis for</td>
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Colloid Chemistry
Modules referring to Macromolecular Chemistry - Modules

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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Ulrich Ziener</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Ulrich Ziener</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**
- Master Chemistry, Study Program Chemistry, elective or specialization (Macromolecular Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Macromolecular Chemistry), 1.-3. semester
- Master Advanced Materials, elective, 1.-3. semester

**Recommended prerequisites**
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**
- Students who have successfully completed this module
  - know the essential details of the synthesis and characterization of (polymeric) colloids

**Syllabus**
- This module provides the following content:
  - history of colloid chemistry
  - stabilization of colloids
  - surface-active agents
  - applications of surface-active agents
<table>
<thead>
<tr>
<th>Literature</th>
<th>- Dörfler: Grenzflächen- und Kolloidchemie, Wiley-VCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and learning methods</td>
<td>Lecture (2 hours per week)</td>
</tr>
</tbody>
</table>
| Workload         | Presence: 30 h  
                  | Private study: 60 h  
                  | Total: 90 h |
| Assessment       | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |
| Grading procedure| The grade of the module will be the grade of the exam. |
| Basis for        | Research in the field of chemistry, polymers and Colloids |
Functional Materials
Modules referring to Macromolecular Chemistry - Modules

Code 8803271306

ECTS credits 3

Attendance time 2

Language of instruction English

Duration 1 Semester

Cycle each Summer Semester

Coordinator Prof. Dr. Ulrich Ziener

Instructor(s) Prof. Dr. Ulrich Ziener, Dr. Elena Mena-Osteritz, Prof. Dr. Sven Rau, Prof. Dr. Mika Lindén

Allocation of study programmes
Master Chemistry, Study Program Chemistr, elective or specialization (Inorganic Chemistry or Macromolecular Chemistry), 1.-3. semester

Master Chemistry, Study Program Materials, elective, 1.-3. semester

Master Chemistry and Management, elective / Modul Group 1 (Inorganic Chemistry) or specialization / Modul Group 2 (Inorganic or Macromolecular Chemistry), 1.-3. semester

Recommended prerequisites
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives The students who have finished this module successfully,
- can deal with the development, synthesis and characterisation of Nano particles and Nano materials
- have a clear image of it, to put this on the nanoscopic length scale
- are trusted with the miniaturization of makroskopischer components (top down principle) or about the chemical synthesis (bottom-up principle) of the material
- know principles of the Funktionalisierung of makroskopischer material systems by the use of biological principles, physical laws and chemical qualities
- own the skill to use the different research disciplines - physics, chemistry, material and engineer sciences, biology and informatics - together and specialised covering for the development of functional materials

<table>
<thead>
<tr>
<th>Syllabus</th>
<th>In this module the following contents are given:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Construction and the movement processes of the condensed matter</td>
</tr>
<tr>
<td></td>
<td>- atomic dimensions</td>
</tr>
<tr>
<td></td>
<td>- Stones of metals, semiconductors and organic materials</td>
</tr>
<tr>
<td></td>
<td>- makroskopische behaviour of these materials (structural own shaft relations)</td>
</tr>
</tbody>
</table>

| Literature                                                               | it is announced in the lecture                   |

| Teaching and learning methods                                           | Lecture (2 hours per week)                       |

| Workload                                                                 | Presence: 30 h                                  |
|                                                                        | Private study: 60 h                             |
|                                                                        | Total: 90 h                                     |

| Assessment                                                               | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |

| Grading procedure                                                       | The grade of the module will be the grade of the exam. |

| Basis for                                                                | No data                                         |
### Ground Course I Macromolecular Chemistry

**Modules referring to Macromolecular Chemistry - Modules**

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<td>keine Angaben</td>
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<td>Language of instruction</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Ulrich Ziener</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Ulrich Ziener</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**

- Master Chemistry, Study Program Chemistry, compulsory module (Macromolecular Chemistry), 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Macromolecular Chemistry), 1.-3. semester

The obligation to the participation exists exclusively in the case, that this course was not already completed in the bachelor’s course of studies.

**Recommended prerequisites**

- Formal prerequisites (according to Study order and examination regulations): none
- Prerequisites regarding to the contents: none

**Learning objectives**

The students who have finished this module successfully,

- dispose of sound knowledge in the synthesis and use of polymers
- own practical skills to the use of the knowledge on problem formulations

**Syllabus**

In this module the following contents are given:

- Structural principles
- Synthesis: Aspects, kinetics and use from: chain growth polymerisations (radical broad Polymerisation, anion broad Polymerisation, cationic Polymerisation, Insertion polymerisation)
- step growth polymerisation (polyaddition, polycondensation)
- Copolymerisation
- Polymerisation techniques
- Living and controlled Polymerisations
- Group transfer polymerisation
- Metathesis

**Literature**

**Teaching and learning methods**
- Lecture with seminar (2+1 hours per week)

**Workload**
- Presence: 45 h
- Self study: 45 h
- Total: 90 h

**Assessment**
- not specified

**Grading procedure**
- not specified

**Basis for**
- If Macromolecular Chemistry is chosen as the "Fourth Subject", it is obligatory to pass the Basic Lecture I in Macromolecular Chemistry (to complete the respective module group), except the exam is already passed in the Bachelor's course of studies.
# Projekt Work in Macromolecular Chemistry

**Modules referring to Macromolecular Chemistry - Modules**

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<td>Language of instruction</td>
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<tr>
<td>Duration</td>
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</tr>
<tr>
<td>Cycle</td>
<td>each Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Ulrich Ziener</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Lecturers of the macromolecular chemistry</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**
- Master Chemistry, Study Program Chemistry, elective, 1.-3. semester
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, electoral duty module, 1.-3. semester

**Recommended prerequisites**
- Formal prerequisites (according to Study order and examination regulations): none
- Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

**Learning objectives**
The students who have finished this module successfully,
- earn the skill and competence to work independently on a project in theory and practice in macromolecular chemistry, write it down, discuss it academically in a short treatise, and present it clearly.

**Syllabus**
In this module the following contents are given:
- Practical research project on a topical subject of the macromolecular chemistry from the working groups

**Literature**
- it is made available
- independent literature search
<table>
<thead>
<tr>
<th><strong>Teaching and learning methods</strong></th>
<th>Project work (lab course) Macromolecular chemistry (12 hours per week) with written elaboration and presentation in the working group or institute</th>
</tr>
</thead>
</table>
| **Workload**                    | Presence: 180 h  
|                                 | Private study: 90 h  
|                                 | Total: 270 h |
| **Assessment**                  | Written elaboration of the project. |
| **Grading procedure**           | None, because unmarked study achievement |
| **Basis for**                   | No data |
### Polymeric Materials

Modules referring to Macromolecular Chemistry - Modules

<table>
<thead>
<tr>
<th>Code</th>
<th>ECTS credits</th>
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<td>3</td>
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<td>English</td>
<td>1 Semester</td>
<td>each Winter Semester</td>
<td>Prof. Dr. Ulrich Ziener</td>
<td>Prof. Dr. Ulrich Ziener</td>
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</table>

#### Allocation of study programmes

- Master Chemistry, Study Program Chemistr, compulsory module (Macromolecular Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Macromolecular Chemistry), 1.-3. semester
- Master Advanced Materials, elective, 1.-3. semester

#### Recommended prerequisites

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

#### Learning objectives

Students who have successfully completed this module,
- are able to understand and describe modern applications of organic and macromolecular materials

#### Syllabus

This module provides the following content:
- Block copolymers for the synthesis of nanoparticles
- Conductive polymers
- Liquid crystalline polymers
- Nanostructuring
- Porous polymeric materials
- Thermoreversible gels
<table>
<thead>
<tr>
<th>Literature</th>
<th>Scientific articles in professional journals</th>
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</thead>
<tbody>
<tr>
<td>Teaching and learning methods</td>
<td>Lecture (2 hours per week)</td>
</tr>
</tbody>
</table>
| Workload        | Presence: 30 h  
                      | Private study: 60 h  
                      | Total: 90 h |
| Assessment      | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |
| Grading procedure | The grade of the module will be the grade of the exam. |
| Basis for       | If Macromolecular Chemistry is chosen as the "Fourth Subject", it is obligatory to pass Polymeric Materials (to complete the respective module group). |
**Precision Macromolecules**  
Modules referring to Macromolecular Chemistry - Modules

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<td>Cycle</td>
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<tr>
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<td>Instructor(s)</td>
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<tr>
<td>Allocation of study programmes</td>
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<td>Syllabus</td>
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<tr>
<td>Workload</td>
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**Assessment**

The credit points will be awarded once the written or oral exam has been passed (depending on the number of participants). The type of examination will be announced in time - at least 4 weeks prior to the date of the exam. No prerequisites are necessary for exam registration.
**Grading procedure**  The grade of the module will be the grade of the exam.

**Basis for**  No English version available yet.
## Soft Matter Nanoscience
Modules referring to Macromolecular Chemistry - Modules

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<tr>
<td><strong>Duration</strong></td>
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<td><strong>Cycle</strong></td>
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<td><strong>Coordinator</strong></td>
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<tr>
<td><strong>Learning objectives</strong></td>
<td>No English version available yet.</td>
</tr>
<tr>
<td><strong>Syllabus</strong></td>
<td>No English version available yet.</td>
</tr>
<tr>
<td><strong>Literature</strong></td>
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<tr>
<td><strong>Teaching and learning methods</strong></td>
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<td><strong>Workload</strong></td>
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<td><strong>Assessment</strong></td>
<td>The credit points will be awarded once the written or oral exam has been passed (depending on the number of participants). The type of examination will be announced in time - at least 4 weeks prior to the date of the exam. No prerequisites are necessary for exam registration.</td>
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<tr>
<td><strong>Grading procedure</strong></td>
<td>The grade of the module will be the grade of the exam.</td>
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<tr>
<td><strong>Basis for</strong></td>
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# Macromolecular Chemistry - Specialization

Modules referring to Theoretical Chemistry - Specialisation

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<tr>
<td>Cycle</td>
<td>each Semester</td>
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<tr>
<td>Coordinator</td>
<td>Instructors of the Theoretical Chemistry</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Instructors of the Theoretical Chemistry</td>
</tr>
</tbody>
</table>
| Allocation of study programmes | Master Chemistry, Study Program Chemistry, elective or specialization, 1.-3. semester  
|                       | Master Chemistry and Management, specialization / Module Group 2, 1.-3. semester |
| Recommended prerequisites | Formal prerequisites (according to Study order and examination regulations): none  
<p>|                       | Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject and basic knowledge in mathematics |
| Learning objectives   | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| Syllabus              | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| Literature            | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| Teaching and learning methods | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |</p>
<table>
<thead>
<tr>
<th><strong>Workload</strong></th>
<th>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</th>
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</thead>
<tbody>
<tr>
<td><strong>Assessment</strong></td>
<td>The exam form is depending on the elective module. The single module descriptions of the electoral duty area regulate further details.</td>
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<tr>
<td><strong>Grading procedure</strong></td>
<td>The result of exams in the deepening area is not relevant for the final mark (cf. study order and examination regulations)</td>
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<tr>
<td><strong>Basis for</strong></td>
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</table>
Introduction in Quantum Chemistry
Modules referring to Theoretical Chemistry - Modules

Code 8803271330

ECTS credits 3

Attendance time 2

Language of instruction English

Duration 1 Semester

Cycle each Winter Semester

Coordinator Prof. Dr. Axel Groß

Instructor(s) Prof. Dr. Axel Groß

Allocation of study programmes Master Chemistry, Study program Chemistry, compulsory module (Theoretical Chemistry), 1.-3. semester

Master Chemistry and Management, specialization / Module Group 2 (Theoretical Chemistry), 1.-3. semester

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject and basic knowledge in mathematics

Learning objectives Students who have successfully completed this module,
- have an overview and basic understanding of modern methods of quantum chemistry
- are capable of the accuracy of different methods, but can also assess their numerical effort
- have the skill, to choose the appropriate method for the theoretical treatment of chemical systems

Syllabus This module provides the following content:
- Hartree Fock Theory
- Configuration Interaction (CI)
- Methods of correlation: perturbation theory, coupled-pair theories, multireference approaches
- alternative methods for the treatment of the correlation of electrons: Monte Carlo methods, explicit methods, density functional theory
<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>- W. Kutzelnigg, Einführung in die Theoretische Chemie, Wiley 2002</td>
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</table>

<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture (2 hours per week)</td>
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</table>

<table>
<thead>
<tr>
<th>Workload</th>
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<tbody>
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<table>
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<tr>
<th>Grading procedure</th>
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<tbody>
<tr>
<td>The grade of the module will be the grade of the exam.</td>
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<table>
<thead>
<tr>
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<tbody>
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**Advanced Methods of Quantum Chemistry**

*Modules referring to Theoretical Chemistry - Modules*

**Code**  
8803271331

**ECTS credits**  
3

**Attendance time**  
2

**Language of instruction**  
English

**Duration**  
1 Semester

**Cycle**  
each Summer Semester

**Coordinator**  
Prof. Dr. Axel Groß

**Instructor(s)**  
Prof. Dr. Axel Groß

<table>
<thead>
<tr>
<th>Allocation of study programmes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master Chemistry, Study Program Chemistry, elective or specialization (Theoretical Chemistry), 1.-3. semester</td>
</tr>
<tr>
<td>Master Chemistry and Management, specialization / Module Group 2 (Theoretical Chemistry), 1.-3. semester</td>
</tr>
</tbody>
</table>

**Recommended prerequisites**  
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject and basic knowledge in mathematics

**Learning objectives**  
The students who have finished this module successfully,
- dispose of detailed and advanced knowledge in the quantum chemistry
- know the newest developments with the theoretical and numerical methods of the quantum chemistry

**Syllabus**  
In this module the following contents are given:
- Postal Hartree Fock methods
- Special methods of the treatment of the electron correlation
- Dispersion effects
- Numerical methods and algorithms for the solution of electron structure problems
| Literature | - W. Kutzelnigg, Einführung in die Theoretische Chemie, Wiley 2002  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and learning methods</td>
<td>Lecture (2 hours per week)</td>
</tr>
</tbody>
</table>
| Workload | Presence: 30 h  
Private study: 60 h  
Total: 90 h |
| Assessment | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |
| Grading procedure | The grade of the module will be the grade of the exam. |
| Basis for | no data |
# Group Theory

Modules referring to Theoretical Chemistry - Modules

<table>
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<tbody>
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<td>Attendance time</td>
<td>2</td>
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<tr>
<td>Language of instruction</td>
<td>English</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Gerhard Taubmann</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Gerhard Taubmann</td>
</tr>
<tr>
<td>Allocation of study programmes</td>
<td>Master Chemistry, Study Program Chemistry, elective or specialization (Theoretical Chemistry), 1.-3. semester</td>
</tr>
<tr>
<td></td>
<td>Master Chemistry and Management, specialization / Module Group 2 (Theoretical Chemistry), 1.-3. semester</td>
</tr>
<tr>
<td>Recommended prerequisites</td>
<td>Formal prerequisites (according to Study order and examination regulations): none</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites regarding to the contents:</strong> Bachelor's competences in the field related to the subject and basic knowledge in mathematics</td>
</tr>
<tr>
<td>Learning objectives</td>
<td>The students who have finished this module successfully,</td>
</tr>
<tr>
<td></td>
<td>- own the skill to recognise the symmetry of molecules and to predict her qualities arising from it</td>
</tr>
<tr>
<td></td>
<td>- get on on the use of the group theory as well as their use on point groups is applied</td>
</tr>
<tr>
<td></td>
<td>- are able to determine qualities of molecules on the basis of character boards.</td>
</tr>
<tr>
<td></td>
<td>- own the skill to the prediction of selection rules in the oscillation spectroscopy</td>
</tr>
<tr>
<td>Syllabus</td>
<td>In this module the following contents are given:</td>
</tr>
<tr>
<td></td>
<td>- Group axioms and abstract group theory</td>
</tr>
</tbody>
</table>
- Point groups
- Symmetry in molecules
- Matrices of the symmetric operations
- Representations characters
- Orthogonalithy theorem and uses
- Reduction of reducible representations
- Quantum-mechanical integrals
- Electronic structure
- Oscillations and oscillation spectra
- Selection rules

**Literature**
- W. Kutzelnigg, Einführung in die Theoretische Chemie, Wiley 2002

**Teaching and learning methods**

Lecture (2 hours per week)

**Workload**

Presence: 30 h  
Private study: 60 h  
Total: 90 h

**Assessment**

The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

**Grading procedure**

The grade of the module will be the grade of the exam.

**Basis for**

no data
### Seminar of the Institute of Theoretical Chemistry

Modules referring to Theoretical Chemistry - Modules

<table>
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<tr>
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<tr>
<td>Language of instruction</td>
<td>English</td>
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<tr>
<td>Duration</td>
<td>2 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Axel Groß</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Axel Groß, Prof. Dr. Gerhard Taubmann</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**
- Master Chemistry, Study Program Chemistry, elective or specialization (Theoretical Chemistry), 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Theoretical Chemistry), 1.-3. semester

**Recommended prerequisites**
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject and basic knowledge in mathematics

**Learning objectives**
The students who have finished this module successfully,
- get on on the contact with topical problems from the theoretical chemistry, in particular of the surface chemistry and electrochemistry
- have an overview about the newest developments in the theoretical chemistry
- acquire competence to typical presentation technologies

**Syllabus**
In this module the following contents are given:
Topical subjects and problems from the theoretical chemistry

**Literature**
- W. Kutzelnigg, Einführung in die Theoretische Chemie, Wiley 2002
- if necessary topical technical literature suitably on the topical subject (is made available)

<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
<th>Seminar (2 hours per week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workload</td>
<td>Presence: 30 h</td>
</tr>
<tr>
<td></td>
<td>Private study: 60 h</td>
</tr>
<tr>
<td></td>
<td>Total: 90 h</td>
</tr>
<tr>
<td>Grading procedure</td>
<td>The grade of the module will be the grade of the exam.</td>
</tr>
<tr>
<td>Basis for</td>
<td>no data</td>
</tr>
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</table>
Project Work in Theoretical Chemistry

Modules referring to Theoretical Chemistry - Modules

**Code**  
8803271335

**ECTS credits**  
9

**Attendance time**  
12

**Language of instruction**  
German or English

**Duration**  
1 Semester

**Cycle**  
each Semester

**Coordinator**  
Prof. Dr. Axel Groß

**Instructor(s)**  
Lecturers of the theoretical chemistry

**Allocation of study programmes**  
Master Chemistry, Study Program Chemistry, elective (Theoretical Chemistry), 1.-3. semester

Master Chemistry, Study Program Materials, elective, 1.-3. semester

Master Chemistry and Management, elective (Theoretical Chemistry), 1.-3. semester

**Recommended prerequisites**  
Formal prerequisites (according to Study order and examination regulations): none

**Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject and basic knowledge in mathematics

**Learning objectives**  
The students who have finished this module successfully,

- earn the skill and competence to work independently on a project in theory and practise in the theoretical chemistry, write it down, discuss it academically in a short treatise, and present it clearly.

**Syllabus**  
In this module the following contents are given:

Practical research project on a topical subject of the theoretical chemistry from the working groups

**Literature**  
- it is made available
- independent literature search

<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
<th>Project work (lab course) Theoretical chemistry (12 hours per week) with written elaboration and presentation in the working group or institute</th>
</tr>
</thead>
</table>
| Workload                      | Presence: 180 h  
Private study: 90 h  
Total: 270 h |
| Assessment                    | Written elaboration of the project. |
| Grading procedure             | None, because unmarked study achievement |
| Basis for                     | No data |
# Exercises in Quantum Chemistry

**Modules referring to Theoretical Chemistry - Modules**

<table>
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<tbody>
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<td><strong>Attendance time</strong></td>
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<tr>
<td><strong>Language of instruction</strong></td>
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<tr>
<td><strong>Duration</strong></td>
<td>1 Semester</td>
</tr>
<tr>
<td><strong>Cycle</strong></td>
<td>each Semester</td>
</tr>
<tr>
<td><strong>Coordinator</strong></td>
<td>Prof. Dr. Axel Groß</td>
</tr>
<tr>
<td><strong>Instructor(s)</strong></td>
<td>Prof. Dr. Axel Groß</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**
- Master Chemistry, Study Program Chemistry, elective or specialization (Theoretical Chemistry), 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Theoretical Chemistry), 1.-3. semester

**Recommended prerequisites**
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject and basic knowledge in mathematics

**Learning objectives**
The students who have finished this module successfully,
- get on on the contact with numerical methods of the quantum chemistry
- are able to calculate independently chemical qualities of molecules, solid states and surfaces with the suitable software package

**Syllabus**
In this module the following contents are given:
- Use of quantum-chemical software packages
- Periodical programmes based on the thick functional theory
- Calculation of the structural and theoretical qualities of molecules, solid states and surfaces
| **Literature** | - W. Kutzelnigg, Einführung in die Theoretische Chemie, Wiley 2002  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Seminar (2 hours per week)</td>
</tr>
</tbody>
</table>
| **Workload** | Presence: 30 h  
  Private study: 60 h  
  Total: 90 h |
| **Assessment** | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |
| **Grading procedure** | The grade of the module will be the grade of the exam. |
| **Basis for** | no data |
# Programming Practical Course Quantum Chemistry I

Modules referring to Theoretical Chemistry - Modules

<table>
<thead>
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<th>Code</th>
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<tbody>
<tr>
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<tr>
<td>Language of instruction</td>
<td>German</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Jun. Prof. Dr. Martin Korth</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Jun. Prof. Dr. Martin Korth</td>
</tr>
</tbody>
</table>

## Allocation of study programmes
- Master Chemistry, Study Program Chemistry, electoral duty or deepening module (Theoretical Chemistry), 1.-3. semester
- Master Chemistry and Management, deepening module (Theoretical Chemistry), 1.-3. semester

## Recommended prerequisites
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject and basic knowledge in mathematics

## Learning objectives
The students who have finished this module successfully,
- are able to implement theoretical attempts as a computer program
- understand therefore the use of the software as tools for the research
- dispose of a detailed insight into the functionality of quantum-chemical arithmetic procedures

## Syllabus
In this module the following contents are given:
- short introduction to Bash and Fortran
- short theory Hartree Fock procedure
- own program works for the production of an easy Hartree Fock programme
- Example calculations with this programme

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Study materials for the introduction to Bash and Fortran are given.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Course (2 hours per week)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence: 30 h</td>
</tr>
<tr>
<td>Private study: 60 h</td>
</tr>
<tr>
<td>Total: 90 h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful and independent implementing of a functioning computer program</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grading procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment of the course participation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basis for</th>
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</thead>
<tbody>
<tr>
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</table>
# Programming Practical Course Quantum Chemistry II

**Modules referring to Theoretical Chemistry - Modules**

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<thead>
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</tr>
<tr>
<td>Language of instruction</td>
<td>German</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Jun. Prof. Dr. Martin Korth</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Jun. Prof. Dr. Martin Korth</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**
- Master Chemistry, Study Program Chemistry, electoral duty or deepening module (Theoretical Chemistry), 1.-3. semester
- Master Chemistry and Management, deepening module (Theoretical Chemistry), 1.-3. semester

**Recommended prerequisites**
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject, especially the lectures Introduction to the quantum chemistry and Advanced methods of the quantum chemistry, as well as the first program practical course quantum chemistry

**Learning objectives**
The students learn, how to develop theoretical attempts by the Implementation as Computer program to tools for the research allow to develop and receive an insight into the functionality of topical developments in this area.

**Syllabus**
Short recapitulation of the first program practical course, own program works on a topical subject of the theoretical chemistry (yearly alternately, e.g., periodical DFT calculations, GPU Programming, Volunteer-Computing etc.), example calculations with own programme.

**Literature**
Study materials are given.
<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
<th>Programing Course with integrated seminar (2 hours per week)</th>
</tr>
</thead>
</table>
| Workload                      | Presence: 30 h  
Private study: 60 h  
Total: 90 h |
| Assessment                    | Study achievement (implementing of a computer program) |
| Grading procedure             | The module mark arises from the assessment of the implemented computer program. |
| Basis for                     | no data |

Master of Science Chemistry  
Date printed: 18. Juli 2018  
page 92 of 230
### Theoretical Solid State Chemistry

**Modules referring to Theoretical Chemistry - Modules**

<table>
<thead>
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<tbody>
<tr>
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<td>Attendance time</td>
<td>2</td>
</tr>
<tr>
<td>Language of instruction</td>
<td>English</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>irregular</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Axel Groß</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Axel Groß</td>
</tr>
</tbody>
</table>

#### Allocation of study programmes
- Master Chemistry, Study Programs Chemistry and Materials, elective module, 1.-3. semester
- Master Chemistry and Management, elective module / module group 2, 1.-3. semester

#### Recommended prerequisites

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject and basic knowledge in mathematics

#### Learning objectives

The students who have finished this module successfully,
- know structural, chemical and physical properties of solid states and her theoretical calculation
- are able to arrange the different connection types and the suitable structural differences of solid states and on the basic electronic structure go back
- own the skill to select the suitable theoretical and numerical methods to work out the suitable qualities

#### Syllabus

In this module the following contents are given:
- Theoretical bases to the description of solid states
- Periodical structures
- Electronic structure of solid states
- Cohesion
- Grid oscillations
- Magnetism
- Transport processes
- Upper effects and interface effects

**Literature**
- W. Kutzelnigg, Einführung in die Theoretische Chemie, Wiley 2002

**Teaching and learning methods**
Lecture (2 hours per week)

**Workload**
Presence: 30 h
Private study: 60 h
Total: 90 h

**Assessment**
The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

**Grading procedure**
The grade of the module will be the grade of the exam.

**Basis for**
No data
Theoretical Surface Chemistry

Modules referring to Theoretical Chemistry - Modules

**Code** 8803271302
**ECTS credits** 3
**Attendance time** 2
**Language of instruction** English
**Duration** 1 Semester
**Cycle** each Winter Semester

**Coordinator** Prof. Dr. Axel Groß
**Instructor(s)** Prof. Dr. Axel Groß

**Allocation of study programmes**
- Master Chemistry, Study Program Chemistry, elective or specialization (Theoretical Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, specialization / Module Group 2 (Theoretical Chemistry), 1.-3. semester

**Recommended prerequisites**
Formal prerequisites (according to Study order and examination regulations): none
Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject and basic knowledge in mathematics

**Learning objectives**
The students who have finished this module successfully,
- know the structural, chemical and catalytic qualities of surfaces
- can interpret the chemical trends in these qualities with the help of draughts based on the basic electronic structure and analyse
- get on on the choice of the suitable theoretical and numerical methods to work out the suitable qualities.

**Syllabus**
In this module the following contents are given:
- Theoretical bases to the description of surfaces
- Electron structure methods and whole energy
- Structure and energetics of pure surfaces
- Adsorption in surfaces
- Surface magnetism
- Gas-surface dynamism
- Kinetic modelling of processes in surfaces
- Electronically non-adiabatic processes
- Liquid party interface

**Literature**
- W. Kutzelnigg, Einführung in die Theoretische Chemie, Wiley 2002

**Teaching and learning methods**
Lecture (2 hours per week)

**Workload**
Presence: 30 h
Private study: 60 h
Total: 90 h

**Assessment**
The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

**Grading procedure**
The grade of the module will be the grade of the exam.

**Basis for**
No data
### Theoretical Physical Chemistry

Modules referring to Theoretical Chemistry - Modules

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<tbody>
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<td>Attendance time</td>
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<td>Language of instruction</td>
<td>German</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>Winter Semester every two Years</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Wolfgang Schmickler</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Wolfgang Schmickler</td>
</tr>
</tbody>
</table>

#### Allocation of study programmes
- Master Chemistry, Study Program Chemistry, Electoral duty or deepening module (Physical Chemistry or Theoretical Chemistry), 1.-3. semester
- Master Chemistry and Management, Electoral duty (Physical Chemistry) or deepening module (Physical Chemistry or Theoretical Chemistry), 1.-3. semester

#### Recommended prerequisites
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject and basic knowledge in mathematics

#### Learning objectives
The students who have finished this module successfully,
- dispose of a sound understanding of the theoretical bases of the catalysis
- can apply mathematical draughts of the theoretical physical chemistry

#### Syllabus
In this module the following contents are given:
- Marcus theory
- theoretical physical-chemical draughts to the catalysis
- Electric catalysis

#### Literature
It is announced in the lecture
<table>
<thead>
<tr>
<th><strong>Teaching and learning methods</strong></th>
<th>Lecture (2 hours per week)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workload</strong></td>
<td>Presence: 30 h</td>
</tr>
<tr>
<td></td>
<td>Private study: 60 h</td>
</tr>
<tr>
<td></td>
<td>Total: 90 h</td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td>Written or oral Exam.</td>
</tr>
<tr>
<td><strong>Grading procedure</strong></td>
<td>The total grade for the module results of the Exam.</td>
</tr>
<tr>
<td><strong>Basis for</strong></td>
<td>no data</td>
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## Inorganic Materials Synthesis/Inorganic Nanomaterials

**Modules referring to Inorganic Chemistry - Modules**

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<th>Code</th>
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<td>Language of instruction</td>
<td>English</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Mika Lindén</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Mika Lindén</td>
</tr>
</tbody>
</table>

### Allocation of study programmes

- Master Chemistry, Study Program Chemistry, elective or specialization (Inorganic Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Modul Group 1 or specialization / Modul Group 2 (Inorganic Chemistry), 1.-3. semester

### Recommended prerequisites

**Formal prerequisites (according to Study order and examination regulations):** none

**Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

### Learning objectives

- Students who have successfully completed this module,
  - will learn important synthesis paradigms and advanced characterization techniques in relation to functional nanomaterials

### Syllabus

- nanoparticle synthesis methods
- film formation techniques
- functional nanosystems
- nanomaterial characterization
| **Literature**                      | - Brinker & Scherer: Sol-Gel Science  
|                                   | - Ozin: Nanochemistry               |
| **Teaching and learning methods**  | Lecture (2 hours per week)          |
| **Workload**                      | Presence: 30 h                      
|                                   | Private study: 60 h                 
|                                   | Total: 90 h                         |
| **Assessment**                    | The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration. |
| **Grading procedure**             | The grade of the module will be the grade of the exam. |
| **Basis for**                     | no data                             |
# Inorganic Photochemistry/Photocatalysis

## Modules referring to Inorganic Chemistry - Modules

<table>
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<tr>
<td>Language of instruction</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Sven Rau</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Sven Rau</td>
</tr>
</tbody>
</table>

## Allocation of study programmes

- Master Chemistry, Study Program Chemistry, elective or specialization (Inorganic Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Modul Group 1 or specialization / Modul Group 2 (Inorganic Chemistry), 1.-3. semester

## Recommended prerequisites

**Formal prerequisites (according to Study order and examination regulations):** none

**Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

## Learning objectives

- The students who have finished this module successfully,
  - have turned inward the bases of the photo catalysis at the example of the biological photosynthesis
  - can explain draughts for the transference of the biological model to artificial catalysts and discuss critically with the help of topical results of the research
  - acquire the ability to form independently basic idea for the development of photo-catalytic processes

## Syllabus

In this module the following contents are given:

- molecular understanding of the biological photosynthesis
- topical examples to the connection between bases of the photochemistry and photo-catalytic uses
- Clarification of photo-catalytic reactions by means of different complementary spectroscopy kinds
- Mechanisms of the photo-catalytic water splitting, carbon dioxide change and related reactions
- Immobilisierung und photoelektrochemische cells
- well-chosen aspects of the heterogeneous photo catalysis

**Literature**
- V. Balzani, A. Credi, M. Venturi, Molecular Devices and Machines, Wiley-VCH ISBN 3-527-30506-8
- topical publications

**Teaching and learning methods**
Lecture (2 hours per week)

**Workload**
- Presence: 30 h
- Private study: 60 h
- Total: 90 h

**Assessment**
The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

**Grading procedure**
The grade of the module will be the grade of the exam.

**Basis for**
No data
## Inorganic Structural Chemistry and Crystallography

Modules referring to Inorganic Chemistry - Modules

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<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Carsten Streb</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Carsten Streb</td>
</tr>
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</table>

### Allocation of study programmes
- Master Chemistry, Study Program Chemistry, elective or specialization (Inorganic Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, elective / Modul Group 1 or specialization / Modul Group 2 (Inorganic Chemistry), 1.-3. semester

### Recommended prerequisites
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

### Learning objectives
The students who have finished this module successfully,
- have a distinctive knowledge in the area of the crystallography
- if skills own in dealing with the Internationally Tables for Crystallography
- have an understanding of complicated crystal structures and chemical connections in the solid state
- are able to recognise structural own shaft relations in the solid state with the help of well-chosen substance classes

### Syllabus
In this module the following contents are given:
- Bases of the crystallography
- inorganic structural types
- Structural own shaft relations in Elektrika, Magnetika, to ion leaders, semiconductors, supraconductors, intermetallic and Zintl phases

**Literature**

- U. Müller, Anorganische Strukturchemie;
- W. Borchardt-Ott, Kristallographie;
- A. R. West, Solid State Chemistry and Its Applications

**Teaching and learning methods**

Lecture (2 hours per week)

**Workload**

Presence: 30 h
Private study: 60 h
Total: 90 h

**Assessment**

The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.

**Grading procedure**

The grade of the module will be the grade of the exam.

**Basis for**

no data
Bioanorganic Chemistry
Modules referring to Inorganic Chemistry - Modules

Code 8803271551

ECTS credits 3

Attendance time 2

Language of instruction English

Duration 1 Semester

Cycle each Summer Semester

Coordinator Prof. Dr. Sven Rau

Instructor(s) Prof. Dr. Sven Rau

Allocation of study programmes

Master Chemistry, Study Program Chemistry, elective or specialization (Inorganic Chemistry), 1.-3. semester

Master Chemistry and Management, elective/Module Group 1 or specialization/Modul Group 2 (Inorganic Chemistry), 1.-3. semester

Master Biochemistry, compulsory module

Recommended prerequisites

Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives

The students who have finished this module successfully,

- dispose of knowledge of the coordination chemistry and electron structure of transitional metals in Metallo-proteins and model connections

- dispose of knowledge of important classes of Metallo-proteins and other biological inorganic connections, functionality and biochemical role

- have the ability to be able to present able to interpret results in the topical literature critically and to be able to present competently

Syllabus

In this module the following contents are given:

- Occurrence, availability and biological function of inorganic elements
- Biological ligands and metal ions: Crash course coordination chemistry
- Structure and function of Metalloproteines, e.g., cobalt and Coenzym B12, oxygen transport and activation, Cytochrom P450, iron sulphur proteins, nitrogen fixation, zinc-containing enzymes (Hydrolases, Alcohol-Dehydrogenases, Carboanhydrases)
- Biochemistry of toxic metal connections, e.g., Hg, Pb, As
- Metals in the medical chemistry (e.g., Pt, Au, Li)
- Biochemistry of the non-metals
- Biomineralisation

**Literature**

- A.Sigel, H.Sigel, Metal Ions in Biological Systems, Buchreihe bei Marcel Dekker

**Teaching and learning methods**

Lecture (2 hours per week)

**Workload**

Presence: 30 h  
Private study: 60 h  
Total: 90 h

**Assessment**

The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

**Grading procedure**

The grade of the module will be the grade of the exam.

**Basis for**

no data
Biomaterials
Modules referring to Inorganic Chemistry - Modules

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<td>Cycle</td>
<td>each Winter Semester</td>
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<tr>
<td>Coordinator</td>
<td>Prof. Dr. Mika Lindén</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Anita Ignatius, Prof. Dr. Mika Lindén, Prof. Dr. Boris Mizaikoff, Prof. Dr. Ulrich Ziener</td>
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<td>Allocation of study programmes</td>
<td>Master Biochemistry, elective, 1.-3. semester</td>
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<tr>
<td></td>
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<td>Master Chemistry, study program Materials, elective, 1.-3. semester</td>
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<td>Master Chemistry and Management, elective / Module Group 1 (Inorganic Chemistry) or or specialization / Modul Group 2 (Inorganic Chemistry or Macromolecular Chemistry), 1.-3. semester</td>
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<td>Recommended prerequisites</td>
<td>Formal prerequisites (according to Study order and examination regulations): none</td>
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<td>Learning objectives</td>
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<tr>
<td></td>
<td>• attain the understanding of biomaterials as materials that interfere with biological systems to measure, treat, support or replace a tissue, organ or physiological function.</td>
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<tr>
<td></td>
<td>• are familiar with the various application areas of biomaterials.</td>
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<tr>
<td></td>
<td>• possess knowledge for the preparation and characterization of biomaterials.</td>
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<tr>
<td></td>
<td>• are able to explain and interpret the structural composition of biomaterials.</td>
</tr>
<tr>
<td>Syllabus</td>
<td>This module covers the following subject-specific topics:</td>
</tr>
</tbody>
</table>
- Protein aggregates, amyloid and nanotechnology
- Polymer-based and protein-based biomaterials
- Polymer therapeutics
- Directed transport of agents

<table>
<thead>
<tr>
<th>Literature</th>
<th>Literature will be announced in the lecture.</th>
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<tr>
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<td>Lecture (2 hours per week)</td>
</tr>
<tr>
<td>Workload</td>
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<tr>
<td></td>
<td>Private study: 60 h</td>
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<td></td>
<td>Sum: 90 h</td>
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<td>Assessment</td>
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<tr>
<td>Grading procedure</td>
<td>The grade of the module will be the grade of the exam.</td>
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<tr>
<td>Basis for</td>
<td>not specified</td>
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### Solid State Chemistry and Applications in Energy Materials

**Modules referring to Inorganic Chemistry - Modules**

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<tr>
<td><strong>Cycle</strong></td>
<td>each Summer Semester</td>
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<tr>
<td><strong>Coordinator</strong></td>
<td>Prof. Dr. Maximilian Fichtner</td>
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<tr>
<td><strong>Instructor(s)</strong></td>
<td>Prof. Dr. Maximilian Fichtner</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**
- Master Chemistry, Study Program Chemistry, elective or specialization (Energy Technology) or specialization (Inorganic Chemistry), 1.-3. Semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Modul Group 1 (Inorganic Chemistry) or specialization / Modul Group 2 (Inorganic Chemistry or Energy Technology), 1.-3. semester

**Recommended prerequisites**
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor’s competences in the field related to the subject, especially basics related to solid state chemistry

**Learning objectives**

Students who have successfully completed this module achieve the following learning objectives:

Learn about the classification of solids and the different synthesis methods of solids from the gas-, liquid-, or solid phase. Get an overview of the different structure types of solids and their relevance in the energy sector. Learn how to describe and investigate phenomena of solid surfaces and the bulk. Selected and typical examples will be discussed from the actual research and development and strategies will be presented for further development of energy related materials. The students will also learn the fundamentals in designing and function of battery materials and materials for hydrogen storage.
**Syllabus**

This module covers the following subject-specific topics:

Introduction into the topic of energy storage and typical problems in the development of energy materials. Systematics and basics of the synthesis and structure description of solids with examples from practical energy materials. Discussion of physical/chemical phenomena of solids and related testing methods. Discussion of selected problems and practical examples from different applications, mainly battery materials and materials for chemical energy storage such as H storage materials.

**Literature**


**Teaching and learning methods**

Lecture (2 hours per week)

**Workload**

- Presence time: 30 h
- Self study: 60 h
- Total: 90 h

**Assessment**

The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.

**Grading procedure**

The grade of the module will be the grade of the exam.

**Basis for**

No data
**Functional Materials**

Modules referring to Inorganic Chemistry - Modules

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<td>Coordinator</td>
<td>Prof. Dr. Ulrich Ziener</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Ulrich Ziener, Dr. Elena Mena-Osteritz, Prof. Dr. Sven Rau, Prof. Dr. Mika Lindén</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**

- Master Chemistry, Study Program Chemistr, elective or specialization (Inorganic Chemistry or Macromolecular Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, elective / Modul Group 1 (Inorganic Chemistry) or specialization / Modul Group 2 (Inorganic or Macromolecular Chemistry), 1.-3. semester

**Recommended prerequisites**

- Formal prerequisites (according to Study order and examination regulations): none
- Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject

**Learning objectives**

The students who have finished this module successfully,

- can deal with the development, synthesis and characterisation of Nano particles and Nano materials
- have a clear image of it, to put this on the nanoscopic length scale
- are trusted with the miniaturization of makroskopischer components (top down principle) or about the chemical synthesis (bottom-up principle) of the material
- know principles of the Funktionalisierung of makroskopischer material systems by the use of biological principles, physical laws and chemical qualities
- own the skill to use the different research disciplines - physics, chemistry, material and engineer sciences, biology and informatics - together and specialised covering for the development of functional materials

<table>
<thead>
<tr>
<th>Syllabus</th>
<th>In this module the following contents are given:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Construction and the movement processes of the condensed matter</td>
</tr>
<tr>
<td></td>
<td>- atomic dimensions</td>
</tr>
<tr>
<td></td>
<td>- Stones of metals, semiconductors and organic materials</td>
</tr>
<tr>
<td></td>
<td>- makroskopische behaviour of these materials (structural own shaft relations)</td>
</tr>
</tbody>
</table>

| Literature        | it is announced in the lecture |

| Teaching and learning methods | Lecture (2 hours per week) |

| Workload           | Presence: 30 h |
|                    | Private study: 60 h |
|                    | Total: 90 h |

| Assessment         | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |

| Grading procedure  | The grade of the module will be the grade of the exam. |

| Basis for          | No data |
# Modern Aspects of Inorganic Chemistry

## Modules referring to Inorganic Chemistry - Modules

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<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
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</table>
| Coordinator | Prof. Dr. Sven Rau  
Prof. Dr. Mika Lindén |
| Instructor(s) | Prof. Dr. Sven Rau  
Prof. Dr. Mika Lindén |
| Allocation of study programmes | Master Chemistry, Study Program Chemistry, Electoral duty or deepening module (Inorganic Chemistry), 1.-3. semester  
Master Chemistry and Management, Electoral duty or deepening module (Inorganic Chemistry), 1.-3. semester |
| Recommended prerequisites | Formal prerequisites (according to Study order and examination regulations): none  
Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject |
| Learning objectives | The students who have finished this module successfully,  
- are enabled for the analysis of topical research projects in the area of the inorganic chemistry  
- get on on the use or getting to know modern analysis procedures on concrete research subjects |
| Syllabus | In this module the following contents are given:  
- topical publications with the help of whose modern analysis procedures and modern synthesis draughts are discussed |
<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
<th>Topical publications and authoritative literature which are announced in lecture</th>
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</thead>
<tbody>
<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Lecture (2 hours per week)</td>
</tr>
</tbody>
</table>
| **Workload** | Presence: 30 h  
  Private study: 60 h  
  Total: 90 h |
| **Assessment** | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |
| **Grading procedure** | The grade of the module will be the grade of the exam. |
| **Basis for** | no data |
Project Work in Inorganic Chemistry
Modules referring to Inorganic Chemistry - Modules

Code 8803271196

ECTS credits 9

Attendance time 12

Language of instruction German or English

Duration 1 Semester

Cycle each Semester

Coordinator Prof. Dr. Sven Rau

Instructor(s) Lecturers of the inorganic chemistry

Allocation of study programmes
Master Chemistry, Study Program Chemistry, elective, 1.-3. semester
Master Chemistry, Study Program Materials, elective, 1.-3. semester
Master Chemistry and Management, elective, 1.-3. semester

Recommended prerequisites
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives
The students who have finished this module successfully,
- earn the skill and competence to work independently on a project in theory and practise in the inorganic chemistry, write it down, discuss it academically in a short treatise, and present it clearly.

Syllabus
In this module the following contents are given:
Practical research project on a topical subject of the inorganic chemistry from the working groups

Literature
- it is made available
- independent literature search
<table>
<thead>
<tr>
<th><strong>Teaching and learning methods</strong></th>
<th>Project work (lab course) inorganic chemistry (12 hours per week) with written elaboration and presentation in the working group or institute</th>
</tr>
</thead>
</table>
| **Workload**                     | Presence: 180 h  
Private study: 90 h  
Total: 270 h                                                                                                                                                      |
| **Assessment**                   | Written elaboration of the project.                                                                                                                                 |
| **Grading procedure**            | None, because unmarked study achievement                                                                                                                                 |
| **Basis for**                    | No data                                                                                                                                                           |
# Inorganic Chemistry - Specialization

**Modules referring to Inorganic Chemistry - Specialisation**

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<tr>
<td>Coordinator</td>
<td>Instructors of the Inorganic Chemistry</td>
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<td>Instructors of the Inorganic Chemistry</td>
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<tr>
<td>Allocation of study programmes</td>
<td>Master Chemistry, Study Program Chemistry, specialization, 1.-3. semester</td>
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<tr>
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<td>Master Chemistry and Management, specialization, 1.-3. semester</td>
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<tr>
<td>Recommended prerequisites</td>
<td>Formal: please refer to your specific Study order and examination regulations.</td>
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<td>Concerning the contents: Bachelor modules in Inorganic chemistry</td>
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<tr>
<td>Learning objectives</td>
<td>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</td>
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<tr>
<td>Syllabus</td>
<td>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</td>
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<tr>
<td>Literature</td>
<td>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</td>
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<tr>
<td>Teaching and learning methods</td>
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<tr>
<td>Workload</td>
<td>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</td>
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<tr>
<td><strong>Assessment</strong></td>
<td>The exam form is depending on the elective module. The single module descriptions of the electoral duty area regulate further details.</td>
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<tr>
<td><strong>Grading procedure</strong></td>
<td>The result of exams in the deepening area is not relevant for the final mark (cf. study order and examination regulations)</td>
</tr>
<tr>
<td><strong>Basis for</strong></td>
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Concepts of Drug Discovery and Design
Modules referring to Organic Chemistry - Modules

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<td>Duration</td>
<td>1 Semester</td>
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<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Dr. Daniel Seeliger</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Dr. Daniel Seeliger</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**
- Master Chemistry, Organic Chemistry (elective or specialization ), 1.-3. semester
- Master Chemistry and Management, Organic Chemistry (elective / Module Group 1 or specialization / Module Group 2), 1.-3. semester
- Master Biochemistry, subject Chemistry

**Recommended prerequisites**

Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

**Learning objectives**

Students, who have successfully completed this module,
- have a basic understanding how modern drug discovery works
- understand the principles of drug action and the thermodynamics of protein/ligand binding
- have a basic understanding of hit finding strategies and chemical optimization of molecule properties

**Syllabus**

In this module, the following content is given:
1) Introduction to Drug Discovery
2) Protein Structure
3) Drug Targets
4) Molecular Recognition
5) Assay Technologies
6) Hit Finding
7) Medicinal Chemistry
8) Pharmacokinetics
9) Metabolism

**Literature**
- Basic biochemistry textbooks
- Medicinal chemistry textbooks
- Basic principles of drug discovery and development, Benjamin Blass, Academic Press

**Teaching and learning methods**
Lecture (2 hours per week)

**Workload**
Presence time: 30 h
Self study: 60 h
Total: 90 h

**Assessment**
The credit points will be awarded once the written exam has been passed. No prerequisites are necessary for exam registration.

**Grading procedure**
The grade of the module will be the grade of the exam.

**Basis for**
no data
**Introduction to the Chemistry of Natural Products**

*Modules referring to Organic Chemistry - Modules*

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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Tanja Weil</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Tanja Weil</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**

- Master Chemistry, Study Program Chemistry, elective or specialization (Organic Chemistry), 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 or specialization / Module Group 2 (Organic Chemistry), 1.-3. Semester
- Master Biochemistry, elective, 1.-3. semester

**Recommended prerequisites**

- Formal prerequisites (according to Study order and examination regulations): none

- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**

The students who have finished this module successfully,

- have knowledge about occurrence, meaning as well as chemical and physical properties the most important substance classes in the field of natural products

- knows synthesis and characterization methods of these natural products

- are familiar with the reactivity and fields of use of selected natural products

**Syllabus**

In this module the following contents are given:

- Natural material chemistry and natural materials: an overview

- Terpenes and molecules that are similar to terpenes
- Steroids
- Lipides, complicated Lipides, membranes
- Carbohydrates
- Amino acids
- Peptides, proteins
- Well-chosen biosynthetic key reactions

<table>
<thead>
<tr>
<th>Literature</th>
<th>It is announced in the lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Lecture (2 hours per week)</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>Presence: 30 h</td>
</tr>
<tr>
<td></td>
<td>Private study: 60 h</td>
</tr>
<tr>
<td></td>
<td>Total: 90 h</td>
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<tr>
<td><strong>Assessment</strong></td>
<td>The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.</td>
</tr>
<tr>
<td><strong>Grading procedure</strong></td>
<td>The grade of the module will be the grade of the exam.</td>
</tr>
<tr>
<td><strong>Basis for</strong></td>
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# Functional Materials

**Modules referring to Organic Chemistry** - Modules

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<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Ulrich Ziener</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Ulrich Ziener, Dr. Elena Mena-Osteritz, Prof. Dr. Sven Rau, Prof. Dr. Mika Lindén</td>
</tr>
</tbody>
</table>

## Allocation of study programmes

- Master Chemistry, Study Program Chemistr, elective or specialization (Inorganic Chemistry or Macromolecular Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, elective / Modul Group 1 (Inorganic Chemistry) or specialization / Modul Group 2 (Inorganic or Macromolecular Chemistry), 1.-3. semester

## Recommended prerequisites

**Formal prerequisites (according to Study order and examination regulations):** none

**Prerequisites regarding to the contents:** Bachelor’s competences in the field related to the subject

## Learning objectives

The students who have finished this module successfully,

- can deal with the development, synthesis and characterisation of Nano particles and Nano materials
- have a clear image of it, to put this on the nanoscopic length scale
- are trusted with the miniaturization of makroskopischer components (top down principle) or about the chemical synthesis (bottom-up principle) of the material
- know principles of the Funktionalisierung of makroskopischer material systems by the use of biological principles, physical laws and chemical qualities
- own the skill to use the different research disciplines - physics, chemistry, material and engineer sciences, biology and informatics - together and specialised covering for the development of functional materials

**Syllabus**

In this module the following contents are given:

- Construction and the movement processes of the condensed matter
- atomic dimensions
- Stones of metals, semiconductors and organic materials
- makroskopische behaviour of these materials (structural own shaft relations)

**Literature**

it is announced in the lecture

**Teaching and learning methods**

Lecture (2 hours per week)

**Workload**

Presence: 30 h  
Private study: 60 h  
Total: 90 h

**Assessment**

The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

**Grading procedure**

The grade of the module will be the grade of the exam.

**Basis for**

No data
**Functional Materials**
Modules referring to Organic Chemistry - Modules

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</tr>
</tbody>
</table>

**Allocation of study programmes**
Master Chemistry, Study Program Chemistr, elective or specialization (Inorganic Chemistry or Macromolecular Chemistry), 1.-3. semester
Master Chemistry, Study Program Materials, elective, 1.-3. semester
Master Chemistry and Management, elective / Modul Group 1 (Inorganic Chemistry) or specialization / Modul Group 2 (Inorganic or Macromolecular Chemistry), 1.-3. semester

**Recommended prerequisites**
Formal prerequisites (according to Study order and examination regulations): none

**Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**
The students who have finished this module successfully,
- can deal with the development, synthesis and characterisation of Nano particles and Nano materials
- have a clear image of it, to put this on the nanoscopic length scale
- are trusted with the miniaturization of makroskopischer components (top down principle) or about the chemical synthesis (bottom-up principle) of the material
- know principles of the Funktionalisierung of makroskopischer material systems by the use of biological principles, physical laws and chemical qualities
- own the skill to use the different research disciplines - physics, chemistry, material and engineer sciences, biology and informatics - together and specialised covering for the development of functional materials

<table>
<thead>
<tr>
<th>Syllabus</th>
<th>In this module the following contents are given:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Construction and the movement processes of the condensed matter</td>
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<tr>
<td></td>
<td>- atomic dimensions</td>
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<tr>
<td></td>
<td>- Stones of metals, semiconductors and organic materials</td>
</tr>
<tr>
<td></td>
<td>- makroskopische behaviour of these materials (structural own shaft relations)</td>
</tr>
</tbody>
</table>

| Literature          | it is announced in the lecture |

| Teaching and learning methods | Lecture (2 hours per week) |

| Workload            | Presence: 30 h |
|                     | Private study: 60 h |
|                     | Total: 90 h |

| Assessment          | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |

| Grading procedure   | The grade of the module will be the grade of the exam. |

| Basis for           | No data |
# Modern Physical Organic Chemistry

Modules referring to Organic Chemistry - Modules

## Code

8803274287

## ECTS credits

3

## Attendance time

2

## Language of instruction

English

## Duration

1 Semester

## Cycle

each Summer Semester

## Coordinator

Prof. Dr. Max von Delius

## Instructor(s)

Prof. Dr. Max von Delius

## Allocation of study programmes

Master Chemistry, Study Program Chemistry, Organic Chemistry (elective or specialization), 1.-3. Semester

Master Chemistry, Study Program Materials, Materials II - Soft Matter (elective / Module Group 1 or specialization / Module Group 2), 1.-3. Semester

Master Chemistry and Management, Organic Chemistry (elective or specialization), 1.-3. semester

## Recommended prerequisites

Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

## Learning objectives

Students will gain deep insights into physical organic chemistry. In contrast to previous lectures in organic chemistry, researchers in this discipline seek to answer the question "how do we find out about this?". So, the focus of this lecture is not to learn new reaction mechanisms (by heart), but to learn about methods and techniques that allow the elucidation of organic reaction mechanisms. As core subject of physical organic chemistry, the thermodynamics and kinetics or organic reactions will be discussed, but also newer aspects, such as systems chemistry, ionic liquids and catalysis will be covered.

## Syllabus

1) Introduction and recap, 2) strain and stability, 3) solutions and non-covalent interactions, 4) (organic) acid-base chemistry, 5) stereochemistry, 6) systems chemistry, 7) reactivity, kinetics and mechanism, 8) catalysis
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<tbody>
<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Lecture (2 hours per week)</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>Presence time: 30 h</td>
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<tr>
<td></td>
<td>Self study: 60 h</td>
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<td></td>
<td>Total: 90 h</td>
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<tr>
<td><strong>Assessment</strong></td>
<td>The credit points will be awarded once the written or the oral exam has been passed (depending on the number of participants). No prerequisites are necessary for exam registration.</td>
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<tr>
<td><strong>Grading procedure</strong></td>
<td>The grade of the module will be the grade of the exam.</td>
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## Non-aromatic Carbo- and Heterocycles

Modules referring to Organic Chemistry - Modules

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<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Gerhard Maas</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Gerhard Maas</td>
</tr>
</tbody>
</table>

### Allocation of study programmes
- Master Chemistry, Study Program Chemistry, duty module (Organic Chemistry), 1.-3. semester
- Master Chemistry and Management, Electoral duty or deepening module (Organic Chemistry), 1.-3. Semester
- Master biochemistry, electoral duty module, 2. semester

### Recommended prerequisites
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

### Learning objectives
The students who have finished this module successfully,
- are trusted with synthesis, qualities and use of important classes of Carbo cycles and Hetero cycles

### Syllabus
In this module the following contents are given:
- **Carbo cycles:** Cyclo alkanes, Cyclo alkenes, Cyclo alkines, Catenanes, condensed and bridged ring systems
- **Hetero cycles:** From 3 to 6-part rings, mainly with nitrogen or oxygen as a Hetero atoms, crown ethers and cryptands
<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
<th>It is announced in the lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Lecture (2 hours per week)</td>
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</table>
|**Workload** | Presence: 30 h  
Private study: 60 h  
Total: 90 h |
|**Assessment** | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |
|**Grading procedure** | The grade of the module will be the grade of the exam. |
|**Basis for** | no data |
Organic Materials / Organic Materials
Modules referring to Organic Chemistry - Modules

Code 8803271303

ECTS credits 3

Attendance time 2

Language of instruction English

Duration 1 Semester

Cycle each Winter Semester

Coordinator Prof. Dr. Peter Bäuerle

Instructor(s) Dr. E. Mena-Osteritz, Prof. Dr. Peter Bäuerle

Allocation of study programmes
- Master Chemistry, Study Program Chemistry, elective or specialization (Organic Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 or specialization / Module Group 2 (Organic Chemistry), 1.-3. semester

Recommended prerequisites
- Formal prerequisites (according to Study order and examination regulations): none
- Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject and basics in physics

Learning objectives
The students who have finished this module successfully,
- are trusted with the chemical and physical properties of organic materials
- dispose of knowledge to the chemical and electronic molecule structure
- have an overview about conjugated Oligo-and polymers whose structural and functional qualities and their synthesis acquire

Syllabus
In this module the following contents are given:
Part A: Conjugated polymers and oligomers, carbon allotropes, dyes
<table>
<thead>
<tr>
<th>Literature</th>
<th>is provided in the lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Lecture (2 hours per week)</td>
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<tr>
<td><strong>Workload</strong></td>
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<td></td>
<td>Private study: 60 h</td>
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<tr>
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<td>Total: 90 h</td>
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<td><strong>Assessment</strong></td>
<td>The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.</td>
</tr>
<tr>
<td><strong>Grading procedure</strong></td>
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</tr>
<tr>
<td><strong>Basis for</strong></td>
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Project Work in Organic Chemistry
Modules referring to Organic Chemistry - Modules

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<td>Cycle</td>
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<tr>
<td>Coordinator</td>
<td>Instructors of the Organic Chemistry</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Instructors of the Organic Chemistry</td>
</tr>
</tbody>
</table>
| Allocation of study programmes | Master Chemistry, Study Program Chemistry, elective, 1.-3. semester  
Master Chemistry, Study Program Materials, elective, 1.-3. semester  
Master Chemistry and Management, elective, 1.-3. semester |
| Recommended prerequisites | Formal prerequisites (according to Study order and examination regulations): none  
Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject |
| Learning objectives | The students who have finished this module successfully,  
- earn the skill and competence to work independently on a project in theory and practise in the organic chemistry, write it down, discuss it academically in a short treatise, and present it clearly. |
| Syllabus       | In this module the following contents are given:  
Practical research project on a topical subject of the organic chemistry from the working groups |
| Literature     | - it is made available  
- independent literature search |
<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
<th>Project work (lab course) Organic chemistry (12 hours per week) with written elaboration and presentation in the working group or institute</th>
</tr>
</thead>
</table>
| Workload                      | Presence: 180 h  
Private study: 90 h  
Total: 270 h |
| Assessment                    | Written elaboration of the project. |
| Grading procedure             | None, because unmarked study achievement |
| Basis for                     | No data |
Polymeric Materials
Modules referring to Organic Chemistry - Modules

Code 8803271305

ECTS credits 3

Attendance time 2

Language of instruction English

Duration 1 Semester

Cycle each Winter Semester

Coordinator Prof. Dr. Ulrich Ziener

Instructor(s) Prof. Dr. Ulrich Ziener

Allocation of study programmes Master Chemistry, Study Program Chemistr, compulsory module (Macromolecular Chemistry), 1.-3. semester

Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester

Master Chemistry and Management, specialization / Module Group 2 (Macromolecular Chemistry), 1.-3. semester

Master Advanced Materials, elective, 1.-3. semester

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject

Learning objectives Students who have successfully completed this module,
- are able to understand and describe modern applications of organic and macromolecular materials

Syllabus This module provides the following content:
- Block copolymers for the synthesis of nanoparticles
- Conductive polymers
- Liquid crystalline polymers
- Nanostructuring
- Porous polymeric materials
- Thermoreversible gels
<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
<th>Scientific articles in professional journals</th>
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</thead>
<tbody>
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<td><strong>Workload</strong></td>
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<td>Private study: 60 h</td>
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<td>Total: 90 h</td>
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<td><strong>Assessment</strong></td>
<td>The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration</td>
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<td><strong>Basis for</strong></td>
<td>If Macromolecular Chemistry is chosen as the &quot;Fourth Subject&quot;, it is obligatory to pass Polymeric Materials (to complete the respective module group).</td>
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Stereoccontrolled Synthesis
Modules referring to Organic Chemistry - Modules

Code 8803271198
ECTS credits 3
Attendance time 2
Language of instruction German
Duration 1 Semester
Cycle each Winter Semester
Coordinator Prof. Dr. Gerhard Maas
Instructor(s) Prof. Dr. Gerhard Maas

Allocation of study programmes
Master Chemistry, Study Program Chemistry, duty module (Organic Chemistry), 1.-3. semester
Master Chemistry and Management, Electoral duty or deepening module (Organic Chemistry), 1.-3. semester

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): none
Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject

Learning objectives The students who have finished this module successfully,
- have knowledge of important reaction types of the modern asymmetrical synthesis

Syllabus In this module the following contents are given:
1. Strategies to the synthesis of enantiomerreiner connections
2. Methods of the Racematspaltung, characterisation enantio- of merenreiner connections
3. Examples of enantioselektiver syntheses
3.1. Reductions of Carbonylverbindungen
3.2. Hydrogenation of Olefinen
3.3. Allylamin-Enamin-Isomerisierung
3.4. Oxidations (Epoxidierung, 1.2-Dihydroxylierung, 1.2-Aminohydroxylierung)
3.5. Asymmetrical Diels Alder reactions

4. Uses of the called reactions with the chemical ones
Synthesis of natural materials and other biologically active substance molecules

<table>
<thead>
<tr>
<th>Literature</th>
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</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
| Workload | Presence: 30 h  
Private study: 60 h  
Total: 90 h |
| Assessment | The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration |
| Grading procedure | The grade of the module will be the grade of the exam. |
| Basis for | no data |
# Structural Analysis by NMR-Methods

Modules referring to Organic Chemistry - Modules

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<td>German</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Hans-Ullrich Siehl</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Hans-Ullrich Siehl</td>
</tr>
</tbody>
</table>

### Allocation of study programmes
- Master Chemistry, Study Program Chemistry, Electoral duty or deepening module (Organic Chemistry), 1.-3. semester
- Master Chemistry and Management, Electoral duty or deepening module (Organic Chemistry), 1.-3. semester

### Recommended prerequisites
- Formal prerequisites (according to Study order and examination regulations): none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

### Learning objectives
The students who have finished this module successfully,
- dispose of knowledge and skills to the use more fashionably of linear and two-dimensional multi pulse procedures in the high-resolution NMR spectroscopy to the structural regulation in solution

### Syllabus
In this module the following contents are given:
- NMR device technology
- Vector representation of chemical Shift
- Spin coupling
- NMR experiments in the rotary co-ordinate system
- Multi-pulse sequences 1D: Spin echo, APT, SPT, INEPT, DEPT, NOE-Diff. and variations
- Pulse sequences 2D: COSY, HETCOR variations, HSQC, HMBC, NOESY etc. and variations
- Uses and exercises to the NMR variations

**Literature**
It is announced in the lecture

**Teaching and learning methods**
Lecture and Seminar (2+1 hours per week)

**Workload**
Presence: 45 h
Private study: 75 h
Total: 120 h

**Assessment**
The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.

**Grading procedure**
The grade of the module will be the grade of the exam.

**Basis for**
no data
Supramolecular Chemistry
Modules referring to Organic Chemistry - Modules

Code 8843274231

ECTS credits 3

Attendance time 2

Language of instruction English

Duration 1 Semester

Cycle each Winter Semester

Coordinator Prof. Dr. Max von Delius

Instructor(s) Prof. Dr. Max von Delius

Allocation of study programmes Master Chemistry, Study Program Chemistry, Organic Chemistry (elective or specialization), Macromolecular Chemistry (specialization) 1.-3. Semester


Master Chemistry and Management, Organic Chemistry (elective / Module Group 1 or specialization / Module Group 2), Macromolecular Chemistry (specialization / Module Group 2), 1.-3. semester

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Knowledge of the fundamentals of organic, inorganic and physical chemistry

Learning objectives Chapter 1 of this lecture gives an overview on the history of the field and introduces key terminology, concepts and (spectroscopic) techniques. Chapters 2 and 3 focus on the core processes behind supramolecular chemistry: non-covalent interactions between host and guest molecules (and ions) and the dynamic assembly of large superstructures from small building blocks (bottom-up approach of soft nanomaterials). Chapter 4 covers molecular machines, a fascinating topic of intense current research and chapter 5 discusses the applications of supramolecular chemistry in other research areas (e.g. catalysis) and everyday products (e.g. in the air freshener Febreze).

Syllabus In this module the following contents are given:
1) Concepts and Techniques
2) Host-Guest Chemistry
3) Self-Assembly
4) Molecular Machines
5) Applications of Supramolecular Chemistry

| Literature                                                                 |
|                                                                          |

<table>
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<tbody>
<tr>
<td>Lecture (2 hours per week)</td>
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<table>
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<tr>
<th>Workload</th>
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<tbody>
<tr>
<td>Presence: 30 H</td>
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<td>Self Study: 60 H</td>
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<thead>
<tr>
<th>Grading procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>The grade of the module will be the grade of the exam.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basis for</th>
</tr>
</thead>
<tbody>
<tr>
<td>No data</td>
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</table>
Special Reaction Mechanisms
Modules referring to Organic Chemistry - Modules

Code 8803271199

ECTS credits 3

Attendance time 2

Language of instruction German

Duration 1 Semester

Cycle each Summer Semester

Coordinator Prof. Dr. Gerhard Maas

Instructor(s) Prof. Dr. Gerhard Maas

Allocation of study programmes
Master Chemistry, Study Program Chemistry, Electoral duty or deepening module (Organic Chemistry), 1.-3. semester
Master Chemistry and Management, Electoral duty or deepening module (Organic Chemistry), 1.-3. semester

Recommended prerequisites
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives
The students who have finished this module successfully,
- dispose of knowledge to the reaction mechanisms of pericyclic reactions
- know important photo reactions of organic molecules

Syllabus
In this module the following contents are given:
- Theoretical draughts to the mechanism of electrocyclic reactions
- sigmatrope reactions and Cyclo additions with stereochemistry
- quick Valenzisomerisations
- Draughts to the understanding of the reaction velocity and the regio selectivity of Cyclo additions
- physical-organic methods of the investigation of reaction mechanisms discussed.
- Photochemistry: Overview to photo-physical processes
- important ones photo-chemically induced reactions ([(2+2)]-Cyclo additions of pi systems, Cyclo addition of Alkenes to benzene derivatives, photo reactions of Carbonyl substances, Di pi Methane rearrangements)

<table>
<thead>
<tr>
<th>Literature</th>
<th>It is announced in the lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and learning methods</td>
<td>Lecture (2 hours per week)</td>
</tr>
</tbody>
</table>
| Workload | Presence: 30 h  
Private study: 60 h  
Total: 90 h |
| Assessment | The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration. |
| Grading procedure | The grade of the module will be the grade of the exam. |
| Basis for | no data |
### Organic Chemistry - Specialization

**Modules referring to Organic Chemistry - Specialisation**

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<td>Attendance time</td>
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<td>Language of instruction</td>
<td>English</td>
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<tr>
<td>Duration</td>
<td>2 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Instructors of the Organic Chemistry</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Instructors of the Organic Chemistry</td>
</tr>
<tr>
<td>Allocation of study programmes</td>
<td>Master Chemistry, Study Program Chemistry, specialization, 1.-3. semester Master Chemistry and Management, specialization, 1.-3. semester</td>
</tr>
<tr>
<td>Recommended prerequisites</td>
<td>Formal: please refer to your specific Study order and examination regulations. Concerning the contents: Bachelor modules in Organic chemistry</td>
</tr>
<tr>
<td>Learning objectives</td>
<td>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</td>
</tr>
<tr>
<td>Syllabus</td>
<td>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</td>
</tr>
<tr>
<td>Literature</td>
<td>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</td>
</tr>
<tr>
<td>Teaching and learning methods</td>
<td>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</td>
</tr>
<tr>
<td>Workload</td>
<td>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td>The exam form is depending on the elective module. The single module descriptions of the electoral duty area regulate further details.</td>
</tr>
<tr>
<td><strong>Grading procedure</strong></td>
<td>The result of exams in the deepening area is not relevant for the final mark (cf. study order and examination regulations)</td>
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<td><strong>Basis for</strong></td>
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</table>
## Introduction to Electrochemistry

### Code
8803271652

### ECTS credits
4

### Attendance time
3

### Language of instruction
German

### Duration
1 Semester

### Cycle
each Winter Semester

### Coordinator
Prof. Dr. Timo Jacob

### Instructor(s)
Prof. Dr. Timo Jacob

### Allocation of study programmes
- Master Chemistry, Study Program Chemistry, Electoral duty or deepening module (Physical Chemistry or Energy Technology), 1.-3. semester
- Master Chemistry, Study Program Materials, electoral duty module, 1.-3. semester
- Master Chemistry and Management, Electoral duty (Physical Chemistry) or deepening module (Physical Chemistry or Energy Technology), 1.-3. semester

### Recommended prerequisites
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

### Learning objectives
The students who have finished this module successfully,
- dispose of basic knowledge in the area of the electrochemistry
- if the most important electro-chemical relations can apply to problem formulations
- own an overview about electro-chemical energy change and energy storage

### Syllabus
In this module the following contents are given:
- Qualities and characterisation of the festival-liquidly interface
- Expiry of potential-controlled processes and reactions in the festival-liquidly interface

<table>
<thead>
<tr>
<th>Literature</th>
<th>Lecture scripts are made available in the lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and learning methods</td>
<td>Lecture (2 hours per week)</td>
</tr>
<tr>
<td>Workload</td>
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<tr>
<td></td>
<td>Private study: 60 h</td>
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<tr>
<td></td>
<td>Total: 90 h</td>
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<tr>
<td>Assessment</td>
<td>The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration</td>
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<tr>
<td>Grading procedure</td>
<td>The grade of the module will be the grade of the exam.</td>
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<tr>
<td>Basis for</td>
<td>no data</td>
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</table>
Electrochemistry
Modules referring to Physical Chemistry - Modules

Code 8803274329

ECTS credits 4

Attendance time 3

Language of instruction English

Duration 1 Semester

Cycle each Winter Semester

Coordinator Prof. Dr. Timo Jacob

Instructor(s) Prof. Dr. Timo Jacob

Allocation of study programmes
Master Chemistry, Study Program Chemistry, Elective (Physical Chemistry or Energy Technology) oder Specialization (Physical Chemistry or Energy Technology), 1.-3. semester
Master Chemistry, Study Program Materials, Elective, 1.-3. semester
Master Chemistry and Management, Elective/Module Group 1 (Physical Chemistry) or Specialization/Module Group 2 (Physical Chemistry or Energy Technology), 1.-3. semester
Master Chemical Engineering, Elective, 1.-3. semester
Master Energy Science and Technology, Elective, 1.-3. semester

Recommended prerequisites
Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives
Students, who have successfully completed this module,
- dispose of knowledge in area of the electrochemistry and its related areas of application
- can apply electrochemical relations to problem formulations
- have an overview as well as detailed knowledge about systems and processes in the area of the electrochemical energy change / storage

Syllabus
In this module, the following contents are given:
(1) Repetition and deepening of electrochemical basics:
- Electrolytic conductivity
- Electrode reactions and electrode potentials
- Cell tension and potential courses in the cell
- Electrode potentials with current flow and overvoltage of electrodes
- Introduction to the electrochemistry of the solid states
(2) Applications from electrochemical processes in
- Batteries
- Fuel cells
- Electrochemical production procedures
- Electrolysis
- Photo (electro) chemical systems
- Sensors
- Corrosion
- Electroplating

**Literature**
- Hamann, Vielstich: *Elektrochemie*
- Bard, Faulkner: *Electrochemical Methods*
- Oldman, Myland, bond: *Electrochemical Science and Technology*

**Teaching and learning methods**
Lecture (2 hours) and Seminar (1 hour)

**Workload**
Presence: 45 h
Self study: 75 h
Total: 120 h

**Assessment**
The credit points will be awarded once the written or oral exam has been passed (depending on the number of participants). The type of examination will be announced in time - at least 4 weeks prior to the date of the exam. No prerequisites are necessary for exam registration.

**Grading procedure**
The grade of the module will be the grade of the exam.

**Basis for**
No data.
# Interface Chemistry I - Surface Chemistry

**Modules referring to Physical Chemistry - Modules**

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<td>Language of instruction</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
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<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Juergen Behm</td>
</tr>
</tbody>
</table>

**Instructor(s)**
- Bachelor Chemistry, elective (Fourth Subject Energy technology), 5. Semester
- Master Chemistry, Study Program Chemistry, elective or specialization (PhysicalChemistry or Energy Technology), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 (PhysicalChemistry) or specialization / Module Group 2 (Physical Chemistry or EnergyTechnology), 1.-3. semester

**Allocation of study programmes**
- Bachelor Chemistry, elective (Fourth Subject Energy technology), 5. Semester
- Master Chemistry, Study Program Chemistry, elective or specialization (PhysicalChemistry or Energy Technology), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 (PhysicalChemistry) or specialization / Module Group 2 (Physical Chemistry or EnergyTechnology), 1.-3. semester

**Recommended prerequisites**
- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor’s competences in the field related to the subject

**Learning objectives**
The students who have finished this module successfully,

- dispose of basic knowledge of the interdisciplinary field of Energy technology, in the interface between chemistry and electrical engineering
- have an image of surfaces as well as of catalyzed processes running off in surfaces and reactions

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Date printed: 18. Juli 2018

Page 151 of 230
<table>
<thead>
<tr>
<th><strong>Syllabus</strong></th>
<th>In this module the following contents are given:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Qualities and characterisation of surfaces</td>
</tr>
<tr>
<td></td>
<td>- Expiry of surface processes, e.g., adsorption / desorption and surface reactions</td>
</tr>
<tr>
<td></td>
<td>- Catalytic processes</td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Will be told in the lecture</td>
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<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Lecture and Seminar (2+1 hours per week, 4 CP)</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>Presence: 45 h</td>
</tr>
<tr>
<td></td>
<td>Private study: 75 h</td>
</tr>
<tr>
<td></td>
<td>Total: 120 h</td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td>The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.</td>
</tr>
<tr>
<td><strong>Grading procedure</strong></td>
<td>The grade of the module will be the grade of the exam.</td>
</tr>
<tr>
<td><strong>Basis for</strong></td>
<td>no data</td>
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</table>
### Surface Chemistry II - Electrochemistry

**Modules referring to Physical Chemistry - Modules**

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<td>Attendance time</td>
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<tr>
<td>Language of instruction</td>
<td>English</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**

- Bachelor Chemistry, elective (Fourth Subject Energy Technology), 6. Semester
- Master Chemistry, Study Program Chemistry, elective or specialization (Physical Chemistry or Energy Technology), 1.-3. semester
- Master Chemistry, Study Program Materials, compulsory module, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 (Physical Chemistry) or specialization / Module Group 2 (Physical Chemistry or Energy Technology), 1.-3. semester

**Recommended prerequisites**

- **Formal prerequisites (according to Study order and examination regulations):** none

- **Prerequisites regarding to the contents:** Bachelor’s competences in the field related to the subject

**Learning objectives**

The students who have finished this module successfully,
- own a sound knowledge to electro-chemical processes
- dispose of the skill to apply the knowledge to electro-chemical problem formulations

**Syllabus**

In this module the following contents are given:
- Structure and reactions on the electro-chemical phase border
- Electric catalysis
### Literature
- Schmickler, Santos: Interfacial Electrochemistry
- Hamann, Vielstich: Elektrochemie

### Teaching and learning methods
Lecture and Seminar (2+1 hours per week, 4 CP)

### Workload
- Presence: 45 h
- Private study: 75 h
- Total: 120 h

### Assessment
The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

### Grading procedure
The grade of the module will be the grade of the exam.

### Basis for
No data
Laser Spectroscopy
Modules referring to Physical Chemistry - Modules

Code 8803271204

ECTS credits 4

Attendance time 3

Language of instruction English

Duration 1 Semester

Cycle each Winter Semester

Coordinator Prof. Dr. T. M. Bernhardt

Instructor(s) Prof. Dr. T. M. Bernhardt

Allocation of study programmes
- Master Chemistry, Study Program Chemistry, elective or specialization (Physical Chemistry), 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 or specialization / Module Group 2 (Physical Chemistry), 1.-3. semester

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject

Learning objectives
The students who have finished this module successfully,
- dispose of the understanding of the physical bases of the laser
- have an overview to well-chosen modern laser uses in the chemistry
- own the skill to prepare a talk on the subject Laser spectroscopy independently and to report

Syllabus In this module the following contents are given:
- Derivation of the Planck’s radiation sentence
- Nitrogen laser
- Laser rate equations - laser threshold
- Colouring laser
- Line forms, homogeneous - inhomogenous widening
- Coherence
- Laser fashions
- Light matter interaction
- Transitional dipole moment
- Born-Oppenheimer approximation
- Franck's Condon principle
- Laser spectroscopy of big molecules (basic ideas)
- Selection rules for big molecules
- Jablonski diagramme
- Femtochemie - coherence, potential surfaces, wave packages
- Non-beaming (not adiabatische) processes and photochemistry
- Laser spectroscopy in molecular rays
- Production of fs-laser pulses
- LIDAR
- Two-photon microscopy

| Literature          | - Telle, Urena, Donovan: "Laser Chemistry: Spectroscopy, Dynamics and Applications"
|                    | - Eugene Hecht: "Optik"

| Teaching and learning methods | Lecture and Seminar (2+1 hours per week) |

| Workload | Presence: 45 h |
|          | Private study: 75 h |
|          | Total: 120 h |

| Assessment | Written or oral Exam |

| Grading procedure | The total grade for the module results of the Exam. |

| Basis for | no data |
Multiscale-Modeling in Energy Research

Modules referring to Physical Chemistry - Modules

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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>Winter Semester every two Years</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Timo Jacob</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**
- Master Chemistry, Study Program Chemistr, elective or specialization (Physical Chemistry or Energy Technology)
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 (Physical Chemistry) or specialization / Module Group 2 (Physical Chemistry or Energy Technology), 1.-3. semester

**Recommended prerequisites**

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**

- Students who have successfully completed this module,
  - have a basic understanding of various theoretical methods that can be used for atomistic simulations of energy-related systems.
  - learn how to apply and combine different modelling methods to study and understand the structures, properties, and processes relevant for energy-related systems.

**Syllabus**

- This module provides the following content:
  - description of the fundamentals of electrochemistry.
- focus on the multiscale modelling ranging from atomistic to continuum scales.

- Different methods of modelling and simulation for different time and length scales such as density-functional theory, molecular dynamics, Monte Carlo simulations, hybrid quantum mechanics/molecular mechanics, and coarse graining

- description of the theoretical background and mathematical formulation of these methods. Through examples will be shown how these methods can be used for the simulation of energy-related systems.

- Seminar: Besides the lectures, there will be seminar presentations and discussions on various topics related to the multiscale modelling.

### Literature


3. Combined Quantum Mechanical and Molecular Mechanical Methods, Edited by Jiali Gao and Mark A. Thompson, American Chemical Society (1999).


### Teaching and learning methods

Lecture and seminar (2+1 hours per week)

### Workload

Presence: 45 h

Private study: 75 h

Total: 120 h

### Assessment

The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.

### Grading procedure

The grade of the module will be the grade of the exam.

### Basis for

no data
Surface Analytic
Modules referring to Physical Chemistry - Modules

Code 8803271202

ECTS credits 4

Attendance time 3

Language of instruction English

Duration 1 Semester

Cycle each Summer Semester

Coordinator Prof. Dr. Juergen Behm

Instructor(s) Prof. Dr. Juergen Behm, PD Dr. Joachim Bansmann

Allocation of study programmes
- Master Chemistry, Study Programs Chemistr, elective or specialization (Physical Chemistry), 1.-3. semester
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 or specialization / Module Group 2 (Physical Chemistry), 1.-3. semester

Recommended prerequisites
- Formal prerequisites (according to Study order and examination regulations): none
- Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives
The students who have finished this module successfully,
- dispose of knowledge of surface structures and their effects on the chemical reactivity of the matter
- know analytic procedures to the qualitative and quantitative regulation of surface structures

Syllabus
In this module the following contents are given:
- Surface structures
- Qualities of the surfaces and their effects on the chemical reactivity of the substrate
- Analytic methods of the surface characterisation

<table>
<thead>
<tr>
<th>Literature</th>
<th>It is announced in the lecture</th>
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</thead>
<tbody>
<tr>
<td><strong>Teaching and learning methods</strong></td>
<td>Lecture and Seminar (2+1 hours per week)</td>
</tr>
</tbody>
</table>
| **Workload** | Presence: 45 h  
Private study: 75 h  
Total: 120 h |
| **Assessment** | The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration. |
| **Grading procedure** | The grade of the module will be the grade of the exam. |
| **Basis for** | No data |
## Project Work in Physical Chemistry

Modules referring to Physical Chemistry - Modules

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<tbody>
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<td>German or English</td>
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<td>Duration</td>
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</tr>
<tr>
<td>Cycle</td>
<td>each Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Instructors of the Physical Chemistry</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Instructors of the Physical Chemistry</td>
</tr>
</tbody>
</table>
| Allocation of study programmes | Master Chemistry, Study Program Chemistry, elective, 1.-3. semester  
Master Chemistry, Study Program Materials, elective, 1.-3. semester  
Master Chemistry and Management, elective, 1.-3. semester |
| Recommended prerequisites | Formal prerequisites (according to Study order and examination regulations): none  
Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject |
| Learning objectives | The students who have finished this module successfully,  
- earn the skill and competence to work independently on a project in theory and practise in the physical chemistry, write it down, discuss it academically in a short treatise, and present it clearly. |
| Syllabus      | In this module the following contents are given:  
Practical research project on a topical subject of the physical chemistry from the working groups |
| Literature    | - it is made available  
- independent literature search |
<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
<th>Project work (lab course) Physical chemistry (12 hours per week) with written elaboration and presentation in the working group or institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workload</td>
<td>Presence: 180 h Private study: 90 h Total: 270 h</td>
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<tr>
<td>Assessment</td>
<td>Written elaboration of the project.</td>
</tr>
<tr>
<td>Grading procedure</td>
<td>None, because unmarked study achievement</td>
</tr>
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<td>Basis for</td>
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## Physical Chemistry Properties of Clusters from Atoms and Molecules

Modules referring to Physical Chemistry - Modules

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<tbody>
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<td>Language of instruction</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. T. M. Bernhardt</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. T. M. Bernhardt</td>
</tr>
</tbody>
</table>

### Allocation of study programmes
- Master Chemistry, Study Program Chemistr, elective or specialization (Physical Chemistry)
- Master Chemistry, Study Program Materials, elective, 1.-3. semester
- Master Chemistry and Management, elective / Module Group 1 or specialization / Module Group 2 (Physical Chemistry), 1.-3. semester

### Recommended prerequisites
- Formal prerequisites (according to Study order and examination regulations): none
- Prerequisites regarding to the contents: Bachelor’s competences in the field related to the subject

### Learning objectives
- The students who have finished this module successfully,
- dispose of knowledge to qualities dependent on dimensions of materials consisting of few atoms or molecules
- can prepare a talk on the subject and report

### Syllabus
- In this module the following contents are given:
  - Draughts: Scaleable area, not skalierbarer Bereich
  - Methods: Cluster springs, molecular rays / condensation, Massenspektrometer
- Lennard Jones cluster: Noble gas cluster, structural principles
- Molecule cluster: Carbon cluster, Solvatation, dynamism in clusters
- Semiconductor and half metal cluster: Silicon cluster, antimony cluster
- Metal cluster: physical properties, chemical qualities

| Literature | - R. L. Johnston: "Atomic and Molecular Clusters"
- Bergmann, Schäfer: "Lehrbuch der Experimentalphysik, Band 5"

| Teaching and learning methods | Lecture and Seminar (2+1 hours per week) |

| Workload | Presence: 45 h  
Private study: 75 h  
Total: 120 h |

| Assessment | The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration. |

| Grading procedure | The grade of the module will be the grade of the exam. |

| Basis for | no data |
### Solar Energy Conversion: Fundamentals

Modules referring to Physical Chemistry - Modules

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<tr>
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<tr>
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<td>2</td>
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<tr>
<td>Language of instruction</td>
<td>English</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Radim Beranek</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Radim Beranek</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**

- Master Chemistry, Study program Chemistry, Physical Chemistry (elective or specialization), 1.-3. semester
- Master Chemistry and Management, Physical Chemistry (elective / Module Group 1 or specialization / Module Group 2), 1.-3. semester
- Master Energy Science and Technology, elective, 1.-3. semester

**Recommended prerequisites**

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**

- Students, who participate in the course, will
  - learn the fundamental principles of quantum solar energy conversion
  - be able to understand and discuss key concepts in photocatalysis, solar water splitting, and solar cells

**Syllabus**

- The following topics are part of the course:
  - solar energy conversion schemes
  - fundamentals of photophysics and photochemistry of photoactive materials
  - methods for characterization of photoactive materials
- fundamental concepts of photo(electro)catalysis and solar cells


| Teaching and learning methods | Lecture (2 hours per week) |

| Workload | Presence time: 30 h  
|          | Self study: 60 h  
|          | Total: 90 h |

| Assessment | The grade of the module will be the grade of the written exam (120 min). No prerequisites are necessary for exam registration. |

| Grading procedure | The grade of the module will be the grade of the exam. |

| Basis for | No data |
Solar Energy Conversion: Selected Topics
Modules referring to Physical Chemistry - Modules

Code 8803274150

ECTS credits 3

Attendance time 2

Language of instruction English

Duration 1 Semester

Cycle each Summer Semester

Coordinator Prof. Dr. Radim Beranek

Instructor(s) Prof. Dr. Radim Beranek

Allocation of study programmes
- Master Chemistry, Study program Chemistry, Physical Chemistry (elective or specialization), 1.-3. semester
- Master Chemistry and Management, Physical Chemistry (elective / Module Group 1 or specialization / Module Group 2), 1.-3. Semester
- Master Energy Science and Technology, Elective, 1.-3. semester

Recommended prerequisites
- Formal prerequisites (according to Study order and examination regulations): none
- Prerequisites regarding to the contents: Bachelor's competences in the field related to the subject

Learning objectives
- Students, who participate in the course, will
  - learn the fundamental principles of solar energy conversion
  - be able to understand and discuss selected topical concepts of solar energy conversion (photocatalysis, solar water splitting, solar cells)

Syllabus
- The following topics are part of the course:
  - fundamentals of photophysics and photochemistry of semiconductors
  - methods for characterization of photoactive materials
  - current challenges in development of photo(electro)catalysts and solar cells
<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
</table>

| Teaching and learning methods | Lecture (2 hours per week) |

<table>
<thead>
<tr>
<th>Workload</th>
<th>Presence time: 30 h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self study: 60 h</td>
</tr>
<tr>
<td></td>
<td>Total: 90 h</td>
</tr>
</tbody>
</table>

| Assessment                   | The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration. |

| Grading procedure            | The grade of the module will be the grade of the exam. |

| Basis for                    | No data |

---
# Theoretical Physical Chemistry

Modules referring to Physical Chemistry - Modules

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<tr>
<th>Code</th>
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<td>Attendance time</td>
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<td>Language of instruction</td>
<td>German</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>Winter Semester every two Years</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Wolfgang Schmickler</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Wolfgang Schmickler</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**

- Master Chemistry, Study Program Chemistry, Electoral duty or deepening module (Physical Chemistry or Theoretical Chemistry), 1.-3. semester
- Master Chemistry and Management, Electoral duty (Physical Chemistry) or deepening module (Physical Chemistry or Theoretical Chemistry), 1.-3. semester

**Recommended prerequisites**

- Formal prerequisites (according to Study order and examination regulations): none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject and basic knowledge in mathematics

**Learning objectives**

The students who have finished this module successfully,
- dispose of a sound understanding of the theoretical bases of the catalysis
- can apply mathematical draughts of the theoretical physical chemistry

**Syllabus**

In this module the following contents are given:
- Marcus theory
- theoretical physical-chemical draughts to the catalysis
- Electric catalysis

**Literature**

It is announced in the lecture
<table>
<thead>
<tr>
<th><strong>Teaching and learning methods</strong></th>
<th>Lecture (2 hours per week)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workload</strong></td>
<td>Presence: 30 h</td>
</tr>
<tr>
<td></td>
<td>Private study: 60 h</td>
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<td></td>
<td>Total: 90 h</td>
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<tr>
<td><strong>Assessment</strong></td>
<td>Written or oral Exam.</td>
</tr>
<tr>
<td><strong>Grading procedure</strong></td>
<td>The total grade for the module results of the Exam.</td>
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<tr>
<td><strong>Basis for</strong></td>
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## Physical Chemistry - Specialisation

Modules referring to Physical Chemistry - Specialisation

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<td>keine Angaben</td>
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<td>Language of instruction</td>
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<td>Duration</td>
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</tr>
<tr>
<td>Cycle</td>
<td>each Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Instructors of the Physical Chemistry</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Instructors of the Physical Chemistry</td>
</tr>
</tbody>
</table>
| Allocation of study programmes | Master Chemistry, Study Program Chemistry, specialization, 1.-3. semester  
| | Master Chemistry and Management, specialization, 1.-3. semester |
| Recommended prerequisites |  
| Formal prerequisites (according to Study order and examination regulations): | none  
<p>| Prerequisites regarding to the contents: | Bachelor's competences in the field related to the subject |
| Learning objectives | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| Syllabus | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| Literature | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |
| Teaching and learning methods | Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details. |</p>
<table>
<thead>
<tr>
<th><strong>Workload</strong></th>
<th>Depending on elective lecture. The single module descriptions of the electoral duty area regulate further details.</th>
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<tbody>
<tr>
<td><strong>Assessment</strong></td>
<td>The exam form is depending on the elective module. The single module descriptions of the electoral duty area regulate further details.</td>
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<tr>
<td><strong>Grading procedure</strong></td>
<td>The result of exams in the deepening area is not relevant for the final mark (cf. study order and examination regulations)</td>
</tr>
<tr>
<td><strong>Basis for</strong></td>
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## Technical Chemistry

Modules referring to Multidisciplinary Subsidary Subject

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<td>Attendance time</td>
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<tr>
<td>Language of instruction</td>
<td>German / English</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>The Chairman of the Examination Board</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Instructors of the dedicated courses that can be used to complete this module</td>
</tr>
<tr>
<td>Allocation of study programmes</td>
<td>Master Chemistry, Study programs Chemistry and Materials, electoral duty module, 1.-3. semester</td>
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<tr>
<td>Recommended prerequisites</td>
<td><strong>Formal prerequisites (according to Study order and examination regulations):</strong> none</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites regarding to the contents:</strong> Bachelor's competences in the field related to the subject</td>
</tr>
<tr>
<td>Learning objectives</td>
<td>Depending on the dedicated lecture; for detailed information the respective module description must be the source in every single case</td>
</tr>
<tr>
<td>Syllabus</td>
<td>Depending on the dedicated lecture; for detailed information the respective module description must be the source in every single case</td>
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<tr>
<td>Literature</td>
<td>Depending on the dedicated lecture; for detailed information the respective module description must be the source in every single case</td>
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<tr>
<td>Teaching and learning methods</td>
<td>Depending on the dedicated lecture; for detailed information the respective module description must be the source in every single case</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>Depending on the dedicated lecture; for detailed information the respective module description must be the source in every single case</td>
</tr>
<tr>
<td>----------------------</td>
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<tr>
<td><strong>Assessment</strong></td>
<td>The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration.</td>
</tr>
<tr>
<td><strong>Grading procedure</strong></td>
<td>The grade of the module will be the grade of the exam.</td>
</tr>
<tr>
<td><strong>Basis for</strong></td>
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**Economic Topics**

Modules referring to Multidisciplinary Subsidary Subject

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<tr>
<td>Language of instruction</td>
<td>German or English</td>
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<td>Duration</td>
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<tr>
<td>Cycle</td>
<td>each Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>The Chairman of the Examination Board</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Dr. Reitzle; Dr. Gollwitzer; Apl. Prof. Dr. Münch</td>
</tr>
</tbody>
</table>

**Allocation of study programmes**

- Master Chemistry, Study Programs Chemistry and Materials, Electoral duty or deepening module, 1.-3. semester
- Master Energy Science and Technology, electoral duty module, 1.-3. semester

**Recommended prerequisites**

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** Bachelor's competences in the field related to the subject

**Learning objectives**

The students who have finished this module successfully,

1) Patent right: Bases of the patent being

2a) power consumption and trade (in German in the WiSe): Outgoing from the energy consumption becomes the value added chain of the energy supply specifies introduced and discussed. Considering the technical and ecological edge terms particularly the economic and energy-economic questions stand in the focus of the event.

2b) Scientific, economical and environmental aspects of energy economy (in English in the SoSe): This lecture provides in overview of the energy system in Germany with a strong Focus on energy economical aspects. Our energy needs ares closely linked to the available energy technologies. The lecture wants discuss the scientific, economical and ecological dependency of energy need and commission and how a path into a sustainable energy future wants Be achieved.

3) Technology and innovation management in the industrial company: The students are trusted with the methods of the project planning, project control
and project reporting in the technical occupational sphere. They recognise typed behaviour patterns of project employees and can have an effect on this in the Sine of the project success.

4) Medical products: The students get familiar with new knowledge from the applied medicament development, medicament production and medicament check. For this purpose lecturers report from the professional practise with use-related knowledge and hand on experience in the treated areas.

**Syllabus**

In this module the following contents are given:


2a) power consumption and trade: 1. Structure of the energy consumption, 2nd environmental impact, 3. Rational energy use stream, traffic, warmth, 4th stream transport and distribution, 5th liberalisation of the energy markets, 6th overview energy trade.


3) Technology and innovation management in the industrial company: 1. Bases, 2nd meaning of technology in the industrial company for the national economy, 3rd technology strategy as a part of the enterprise strategy, 4th organisation of core technology fields, 5th project work in technology fields, 6th employee's guidance in technology areas, 7th challenges in the project guidance.

4) Medical products: The subjects vary yearly in dependence of the reporting lecturers. The topical subject list can be taken from the homepage of the institute of pharmacology and toxicology.

**Literature**

all courses: Literature is made available in the lecture

**Teaching and learning methods**

Two of three Lectures have to be chosen (each 1-2 hours per week)

**Workload**

Presence: 60 h
Private study: 120 h
Total: 180 h

**Assessment**

Depends on the chosen subject: Written or oral Exam or study achievement

**Grading procedure**

In case of exam: The total grade for the module results of the Exam.

**Basis for**

No data
## Biochemistry I

Modules referring to Subsidiary Subject Biology

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<td>Duration</td>
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</tr>
<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Dr. Frank Rosenau</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Lecturers of the Institute of Biochemistry and Physiological Chemistry</td>
</tr>
</tbody>
</table>

### Allocation of study programmes

Bachelor Biochemistry, compulsory module

Master Chemistry, both study programs, compulsory elective module, non-chemical minor subject, 1.-3. semester

### Recommended prerequisites

Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: none

### Learning objectives

The students
- know the most important biochemical material classes know and can describe their ways of assimilation and dissimilation.
- can explain the meaning of proteins for the organism.
- know the meaning of hormones for the organism and can describe them.
- can explain the forwarding and the use of the genetic information on the molecular level
- know the essential principles of the immune biology and can describe them.
- are able to make conclusions about pathological changes with the help of the normal biochemical circumstances.
- learn basic practical technologies of the biochemistry with the help of well-chosen examples.

### Syllabus

In this module, the following content is given:

- Biochemistry and metabolism of the amino acids and proteins
- Biochemistry and metabolism of the carbohydrates
- Biochemistry and metabolism of the lipids
- Biochemistry and metabolism of the nucleic acids
- Bioenergetics and enzymes, enzyme kinetics
- Vitamins
- Hormones
- Integrative representation of the metabolism as well as its regularisation under different conditions
- Immune biochemistry
- Growth factors
- Topobiology of the cell
- Molecular genetics
- Pathobiochemical aspects of the called points

**Literature**
- Löffler/Petrides, Biochemie, Springer Verlag
- Lehninger, Biochemie, Springer Verlag
- Stryer, Biochemie, Spektrum Verlag

**Teaching and learning methods**
Lecture and seminar (3+1 hours per week)

**Workload**
Presence: 60 h
Self study: 120 h
Total: 180 h

**Assessment**
No english version available yet.

**Grading procedure**
No english version available yet.

**Basis for**
no data
# Biochemistry II

Modules referring to Subsidiary Subject Biology

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<td>Language of instruction</td>
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<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Summer Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Dr. Frank Rosenau</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Lecturers of the Institute of Biochemistry and Physiological Chemistry</td>
</tr>
</tbody>
</table>

## Allocation of study programmes

- Bachelor Biochemistry, compulsory module
- Master Chemistry, both study programs, compulsory elective module, non-chemical minor subject, 1.-3. semester

## Recommended prerequisites

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** none

## Learning objectives

The students
- know the most important biochemical material classes know and can describe their ways of assimilation and dissimilation.
- can explain the meaning of proteins for the organism.
- know the meaning of hormones for the organism and can describe them.
- can explain the forwarding and the use of the genetic information on the molecular level
- know the essential principles of the immune biology and can describe them.
- are able to make conclusions about pathological changes with the help of the normal biochemical circumstances.
- learn basic practical technologies of the biochemistry with the help of well-chosen examples.

## Syllabus

In this module, the following content is given:

- Biochemistry and metabolism of the amino acids and proteins
- Biochemistry and metabolism of the carbohydrates
- Biochemistry and metabolism of the lipids
- Biochemistry and metabolism of the nucleic acids
- Bioenergetics and enzymes, enzyme kinetics
- Vitamins
- Hormones
- Integrative representation of the metabolism as well as its regularisation under different conditions
- Immune biochemistry
- Growth factors
- Topobiology of the cell
- Molecular genetics
- Pathobiochemical aspects of the called points

**Literature**
- Löffler/Petrides, Biochemie, Springer Verlag
- Lehninger, Biochemie, Springer Verlag
- Stryer, Biochemie, Spektrum Verlag

**Teaching and learning methods**
Lecture and seminar (3+1 hours per week)

**Workload**
- Presence: 60 h
- Self study: 120 h
- Total: 180 h

**Assessment**
No english version available yet.

**Grading procedure**
No english version available yet.

**Basis for**
no data
Biological Chemistry
Modules referring to Subsidiary Subject Biology

Code 8803272555
ECTS credits 6
Attendance time 5
Language of instruction German
Duration 2 Semester
Cycle each Summer Semester
Coordinator Dr. Frank Rosenau
Instructor(s) Dr. Frank Rosenau

Allocation of study programmes Master Chemistry, Study Programs Chemistry and Materials, non-chemical minor subject, electoral duty module, 1.-3. semester

Recommended prerequisites Formally: Please refer to your specific study order and examination regulations. Contentually: Basics in Organic Chemistry

Learning objectives The students who have finished this module successfully,
- have knowledge of the biological / biochemical expiries in the cell which are manipulated with chemical tools
- can name chemical options to influence transport processes in living cells.
- control methods to isolate specific bandage molecules (Nukleinsäuren, peptide, proteins).
- can compare and apply the kinds of so-called "Biologicals".
- control the bases of the construction and the application of variation libraries in the development of active substances.
- know methods of assorting samples of libraries ("Screening") according to the active substance candidates.
- know basic draughts of the production and for the application of biomaterials.
- can understand and compare strategies to the bioinspired material synthesis.
- know biotechnological methods of the optimisation of proteins by introduction of non-natural amino acids.

- can develop experimental strategies for the optimisation of nucleic acid and protein active substances.

- control the bases of the directed evolution as universal tools by the development of biological active substances and materials.

- are able to work independently academically on carrying out data bank searches and able to judge works on the basis of literature critically and on arranging own results in the context of the science.

---

**Syllabus**

In this module the following contents are given:

**Lecture „biological chemistry“:***

The cellular processes which can be influenced by chemical tools

Substance absorption, "drug delivery"

Bandage molecules, antibody derivatives, Aptameres, peptides, other proteins

Ligands and receptor interactions

Chemical modification of nucleid acids and proteins

Directed evolution: Technology, possibilities

Biomaterials, synthesis, application, advantages and disadvantages

Screening technologies

Biotechnology of the active compontens and materials synthesis

Peptides as active substances

Phagen display

SELEX process for the isolation of aptameres

„reflection“-SELEX and Phage display for the isolation of bandage molecules

---

**Lab course „biological chemistry“:***

Synthesis of switchable biomaterials followed by the characterisation of the materials

Isolation of nucleic acid and Peptide-based bandage molecules with affinity to Proteine hydrogels

Decoration of biomaterials with active substances as tools to the active substance emission ("drug delivery")

Biotechnological production of polymers to the production of new materials for the family cell research

---

**Literature** is given in the lecture
<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
<th>Lecture (2 hours per week)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lab Course (3 hours per week)</td>
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<table>
<thead>
<tr>
<th>Workload</th>
<th>Presence: 75 h</th>
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<tr>
<td></td>
<td>Self study: 105 h</td>
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<tr>
<td></td>
<td>Total: 180 h</td>
</tr>
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</table>

| Assessment                   | The award of the credit points in the module is based on the oral exam and the laboratory. Prerequisites for the laboratory is passing the exam. |

| Grading procedure            | The grade of the module will be the average of the exam grade and the grade of the laboratory weighted by the credit points. |

| Basis for                    | No data. |
Basics of Biology for Non-Biologists
Modules referring to Subsidiary Subject Biology

Code 8803270572

ECTS credits 6

Attendance time 3

Language of instruction German

Duration 1 Semester

Cycle each Winter Semester

Coordinator Prof. Dr. Bernhard Eikmanns

Instructor(s) Prof. Dr. Manfred Ayasse, apl. Prof. Dr. Stefan Binder, Prof. Dr. Bernhard Eikmanns, Dr. Jürgen Hoppe, Prof. Dr. Harald Wolf

Allocation of study programmes
• Computer Science, B.Sc, PO2010
• Computer Science, B.Sc, PO2013
• Mathematics, B.Sc, PO2006
• Mathematics, B.Sc, PO2013
• Psychology, B.Sc, PO2011
• Chemistry, M.Sc, PO2013
• Computer Science, M.Sc, PO2010
• Computer Science, M.Sc, PO2013
• Mathematics, M.Sc, PO2013

Recommended prerequisites Formally: Refer to the subject-specific examination regulations of the respective study course, in the version effective when taking up the study program.
Contentually: None.

Learning objectives Students who have successfully completed this module
• possess substantiated factual knowledge in the areas of cell biology and (choice-dependent) general botany or general zoology concerning anatomy, metabolism, reproduction and evolution of organisms.
• are familiar with the theoretical fundamentals of two disciplines in biology named above.
• achieved comprehension for the mutual determination of form and function in an organism.

Syllabus This module covers the following subject-specific contents:
• Cell biology: Substance-based elements of the cell; organelles and compartmentalization; localization and meaning of metabolic processes and other cellular processes; cell contacts and interactions; prokaryotes and eukaryotes; unicellularity and multicellularity; evolution of the cell. In addition: cellular aspects of microbiology and important methods of cell biology research.

• Botany: The lecture communicates basic knowledge in plant cell biology, plant anatomy, plant reproduction and an introduction to the feature of plant metabolism and the involved anatomical adaptations. Theoretical knowledge in plant anatomy from the lecture is supplemented and advanced by microscopic observations in the exercises.

• Zoology: Overview about body shapes, anatomies and structures and functional aspects by selected animal phyla from protists up to the vertebrates. Methods of animal preparation.

Literature

Cell biology:

• Stryer: Biochemie. Spektrum Akademischer Verlag, Heidelberg.
• Hirsch-Kauffmann, Schweiger: Biologie für Mediziner, Pharmazeuten und Chemiker, Thieme Verlag, Stuttgart (neueste Auflage)
• Munk: Taschenlehrbuch Biologie – Mikrobiologie, Thieme-Verlag Stuttgart 2008.

Botany:

• Nultsch, W.: Allgemeine Botanik, Thieme Verlag (neueste Auflage).

Zoology:

• Wehner, R.; Gehring, W.: Zoologie, Thieme Verlag (neueste Auflage).
• Campbell: Biologie, Spektrum Verlag, Heidelberg (neueste Auflage).

Teaching and learning methods

Compulsory:

• Cell Biology [Zellbiologie] (lecture), 1 credit hour [SWS], 2 credit points [LP]

Elective (one of the lectures):

• General Botanics [Allgemeine Botanik] (lecture), 2 credit hours [SWS], 4 credit points [LP]
• General Zoology [Allgemeine Zoologie] (lecture), 2 credit hours [SWS], 4 credit points [LP]

Workload

Attendance: 45 h
Private study: 135 h
Sum: 180 h

Assessment

The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration

Grading procedure

The grade of the module will be the grade of the exam.

Basis for

Further modules in biology
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</table>
Ecology for Non-Biologists
Modules referring to Subsidiary Subject Biology

Code 8803270571

ECTS credits 6

Attendance time 4

Language of instruction German

Duration 1 Semester

Cycle each Summer Semester

Coordinator Prof. Dr. Marian Kazda

Instructor(s) Prof. Dr. Marian Kazda, PD Dr. Jutta Schmid

Allocation of study programmes
• Computer Science, B.Sc, PO2010
• Computer Science, B.Sc, PO2013
• Mathematics, B.Sc, PO2006
• Mathematics, B.Sc, PO2013
• Chemie, M.Sc, PO2013
• Computer Science, M.Sc, PO2008
• Computer Science, M.Sc, PO2010
• Computer Science, M.Sc, PO2013
• Mathematics, M.Sc, PO2013

Recommended prerequisites Formally: Refer to the subject-specific examination regulations of the respective study course, in the version effective when taking up the study program.

Contentually: Module Basics in Biology for Computer Science and Mathematics [Grundlagen der Biologie für Informatik und Mathematik].

Learning objectives Students who have successfully completed this module
• know the basic principles of ecology and the effect of biotic and abiotic factors on organisms.
• possess profound factual knowledge concerning the adaptations of animals and plants to various factors and annidation in various ecosystems.

Syllabus This module covers the following subject-specific contents:
Lecture Introduction to Ecology:
• Fundamentals for the comprehension of abiotic and biotic factors that significantly determine the distribution and diversity of organisms and the structure of ecosystems. Major topics are: a broad introduction to the Earth’s climate zones and the elementary mechanisms that control organismic interactions (competition, predation, parasitism, mutualism).

Lecture Ecology and Ecophysiology of Plants:

• Ecophysiological essentials of plants.
• Processes and adaptations from leaf- and root level to the individual plant to the ecosystem.
• Carbon-, water- and nutrient balance of plants.

Literature
• Jones, H.G.: Plants and microclimate. Cambridge Univ. Press, 1992
• Kuttler W. (Hrsg.): Handbuch zur Ökologie. Analytika Verlag, ab 1993
• Larcher W.: Ökophysiologie der Pflanzen. UTB-Verlag, ab der 5. Auff. 1994

Teaching and learning methods
• Introduction to Ecology [Einführung in die Ökologie] (lecture), 2 credit hours [SWS], 3 credit points [LP]
• Ecology and Ecophysiology of Plants [Ökologie und Ökophysiologie der Pflanzen] (lecture), 2 credit hours [SWS], 3 credit points [LP]

Workload
Attendance: 60 h
Private study: 120 h
Sum: 180 h

Assessment
Two examination alternatives: Either two written module part exams about the two lecture parts, or an oral exam about the entire lecture.

Grading procedure
The grade is determined from the results of the written module part exams, weighed by credit points, or it is determined from the result of the oral module exam.

Basis for
Further modules in biology
# Introduction to Computer Science and Programming I and II

Modules referring to Subsidiary Subject Computer Science

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<td>Coordinator</td>
<td>Prof. Dr. Frank Slomka</td>
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<tr>
<td>Instructor(s)</td>
<td>Axel Fürstberger, Dr. Klaus Murmann</td>
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</table>

## Allocation of study programmes

- Biology MSc, start of studies: winter semester, compulsory elective module, 1\textsuperscript{st} and 2\textsuperscript{nd} study semester;
- Mathematics BSc, start of studies: winter semester, compulsory module, 1\textsuperscript{st} and 2\textsuperscript{nd} study semester;
- Mathematics BSc, start of studies: summer semester, compulsory module, 2\textsuperscript{nd} and 3\textsuperscript{rd} study semester;
- Mathematical Economics BSc, start of studies: winter semester, compulsory module, 1\textsuperscript{st} and 2\textsuperscript{nd} study semester;
- Mathematical Economics BSc, start of studies: summer semester, compulsory module, 2\textsuperscript{nd} and 3\textsuperscript{rd} study semester;
- Physics BSc, 1\textsuperscript{st} – 3\textsuperscript{rd} semester;
- Econo-Physics BSc, 1\textsuperscript{st} – 3\textsuperscript{rd} semester;
- Electrical Engineering BSc, start of studies: winter semester, compulsory module, 3\textsuperscript{rd} and 4\textsuperscript{th} study semester;
- Mathematical Biometry, start of studies: winter semester, compulsory module, 1\textsuperscript{st} and 2\textsuperscript{nd} study semester

## Recommended prerequisites

Formally: Refer to the subject-specific examination regulations of the respective study course, in the version effective when taking up the study program.

Contentually: None.

## Learning objectives

Students who have successfully completed this module

- know the fundamentals of formal languages and their definition.
may practically handle computers, operating systems, service programs and tools.
possess insight and intuition regarding the construction of algorithms by concrete examples.
may evaluate algorithms by investigations of complexity.
have the ability to systematically develop simple algorithms in a modern programming language and to transfer it into an executable program, know and understand data structures of higher complexity like trees or associative arrays concerning their definition (recursion) and application (recursive algorithms).
may understand the principles of modern modeling techniques and apply them on the level of simple aspects.
know classic as well as modern programming paradigms (e.g. recursion, abstract data types, inheritance, polymorphism, exception handling) and may apply them.

Syllabus
This module covers the following subject-specific topics:

• Introduction to the utilized operating system, dealing with useful commands and service programs plus practical handling of data files and processes
• Formal languages: definition and structuring
• Regular expressions, finite-state machines
• Algorithms and complexity
• Principles of system development and structuring
• Types of programming languages
• Standard data types, simply structured data types plus control structures of the selected programming language
• Development of simple algorithms for standard problems (e.g. searching, sorting)
• Structuring of software in large scale
• Complex data structures (e.g. lists, trees) and algorithms on top
• Modern concepts of programming languages like inheritance or polymorphism
• Aspects of reliability (e.g. exception handling)

Literature
• Knuth, D.: The Art of Computer Programming, Fundamental Algorithms; Addison-Wesley
• Wirth, N.: Algorithmen und Datenstrukturen; Teubner Verlag
• Lang, H.W.: Algorithmen und Datenstrukturen in Java; Oldenbourg
• Sedgewick, R.: Algorithmen in Java; Pearson Studium 2003

Teaching and learning methods
• General Computer Science I (GI 1) [Allgemeine Informatik I (AI 1)] (lecture), 2 credit hours [SWS], 4 credit points [LP], winter semester
• Exercises for General Computer Science I (GI 1) [Übungen zu Allgemeine Informatik I (AI 1)] (exercise), 1 credit hour [SWS], 2 credit points [LP], winter semester
• General Computer Science 2 (GI 1) [Allgemeine Informatik 2 (AI 2)] (lecture), 2 credit hours [SWS], 4 credit points [LP], summer semester
• Exercises for GI 2 [Übungen zu AI 2] (exercise), 1 credit hour [SWS], 2 credit points [LP], summer semester

Workload
Attendance: 90 h
Private study: 270 h
Sum: 360 h
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Introduction to Programming
Modules referring to Subsidiary Subject Computer Science

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Basis for

No english version available yet.
Basics Philosophy A with 10 ECTS
Modules referring to Subsidiary Subject Philosophy

Code 8803273024

ECTS credits 10

Attendance time keine Angaben

Language of instruction Normally German

Duration 1 Semester

Cycle each Semester

Coordinator Humboldt Study Center of the University of Ulm

Instructor(s) Several lecturers of the Humboldt Study Center

Allocation of study programmes All courses of studies with a subsidiary compulsory elective subject, semester at student's will

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): none

Prerequisites regarding to the contents: none

Learning objectives depends on the chosen course:

Basic knowledge of epistemology and scientific theory (especially model and theory concept); basics of the general and applied ethics (specifically technology ethics); concept of evolution; basic knowledge of the philosophical eras; knowledge of exemplary historical action models; ability of the critical assessment of philosophical explanations.

Competences in contemplation and argumentation, transformation, research, linguistic competence, social competence, competence in moderation.

Syllabus Presentation and discussion of central positions or texts of the occidental philosophy, of the epistemology and scientific theory and of the general and applied ethics; as well as subject-dependent knowledge; Weighing up of different philosophic positions.

Literature Will be announced by the respective lecturer at the beginning of the course.
### Teaching and learning methods
Typically Lectures and Seminars with a total volume of 10 CP (presentation and 20-sided seminar paper)

Courses out of the following areas can be attended:

- history of philosophy
- theoretical philosophy
- practical philosophy
- interdisciplinary seminars
- cultural anthropology
- old languages

### Workload
Presence Time: 100 h  
Self Study: 200 h  
Total: 300 h

### Assessment
The grade of the module will be the grade of the oral exam. No prerequisites are necessary for exam registration.

### Grading procedure
The grade of the module will be the grade of the exam.

### Basis for
-
## Basics Philosophy A with 4 ECTS

Modules referring to Subsidiary Subject Philosophy

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<td>Basic knowledge of epistemology and scientific theory (especially model and theory concept); basics of the general and applied ethics (specifically technology ethics); concept of evolution; basic knowledge of the philosophical eras; knowledge of exemplary historical action models; ability of the critical assessment of philosophical explanations.</td>
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<td>Competences in contemplation and argumentation, transformation, research, linguistic competence, social competence, competence in moderation.</td>
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<td>Syllabus</td>
<td>Presentation and discussion of central positions or texts of the occidental philosophy, of the epistemology and scientific theory and of the general and applied ethics; as well as subject-dependent knowledge; Weighing up of different philosophic positions.</td>
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<td>Literature</td>
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### Teaching and learning methods

Typically lectures and seminars with a total volume of 4 CP (presentation or written or oral exam)

Courses out of the following areas can be attended:

- history of philosophy
- theoretical philosophy
- practical philosophy
- interdisciplinary seminars
- cultural anthropology
- old languages

### Workload

Presence Time: 45 h  
Self Study: 75 h  
Total: 120 h

### Assessment

The grade of the module will be the grade of the oral exam. No prerequisites are necessary for exam registration.

### Grading procedure

The grade of the module will be the grade of the exam.

### Basis for

-
# Basics Philosophy A with 6 ECTS

Modules referring to Subsidiary Subject Philosophy

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<td>Allocation of study programmes</td>
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**Recommended prerequisites**

- **Formal prerequisites (according to Study order and examination regulations):** none
- **Prerequisites regarding to the contents:** none

**Learning objectives**

depends on the chosen course:

- Basic knowledge of epistemology and scientific theory (especially model and theory concept); basics of the general and applied ethics (specifically technology ethics); concept of evolution; basic knowledge of the philosophical eras; knowledge of exemplary historical action models; ability of the critical assessment of philosophical explanations.

- Competences in contemplation and argumentation, transformation, research, linguistic competence, social competence, competence in moderation.

**Syllabus**

Presentation and discussion of central positions or texts of the occidental philosophy, of the epistemology and scientific theory and of the general and applied ethics; as well as subject-dependent knowledge; weighing up of different philosophic positions.

**Literature**

Will be announced by the respective lecturer at the beginning of the course.
Teaching and learning methods

Typically Lectures and Seminars with a total volume of 6 CP (presentation and 10- to 12-sided seminar paper)

Courses out of the following areas can be attended:

- history of philosophy
- theoretical philosophy
- practical philosophy
- interdisciplinary seminars
- cultural anthropology
- old languages

Workload

Presence Time: 60 h
Self Study: 120 h
Total: 180 h

Assessment

The grade of the module will be the grade of the oral exam. No prerequisites are necessary for exam registration.

Grading procedure

The grade of the module will be the grade of the exam.

Basis for

-
## Basics Philosophy B with 4 ECTS

Modules referring to Subsidiary Subject Philosophy

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<td>Allocation of study programmes</td>
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</table>
| Recommended prerequisites | Formal prerequisites (according to Study order and examination regulations): none  
Prerequisites regarding to the contents: none |
| Learning objectives       | depends on the chosen course: Basic knowledge of epistemology and scientific theory (especially model and theory concept); basics of the general and applied ethics (specifically technology ethics); concept of evolution; basic knowledge of the philosophical eras; knowledge of exemplary historical action models; ability of the critical assessment of philosophical explanations.  
Competences in contemplation and argumentation, transformation, research, linguistic competence, social competence, competence in moderation. |
| Syllabus                  | Presentation and discussion of central positions or texts of the occidental philosophy, of the epistemology and scientific theory and of the general and applied ethics; as well as subject-dependent knowledge; Weighing up of different philosophic positions. |
| Literature                | Will be announced by the respective lecturer at the beginning of the course. |
### Teaching and learning methods

Typically Lectures and Seminars with a total volume of 4 CP (presentation or written or oral exam)

Courses out of the following areas can be attended:

- history of philosophy
- theoretical philosophy
- practical philosophy
- interdisciplinary seminars
- cultural anthropology
- old languages

### Workload

<table>
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<th>Presence Time: 45 h</th>
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### Assessment

The grade of the module will be the grade of the oral exam. No prerequisites are necessary for exam registration.

### Grading procedure

The grade of the module will be the grade of the exam.

### Basis for

-
### Introduction to Physics of Condensed Matter

**Modules referring to Subsidiary Subject Physics**

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Basis for

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<td><strong>Basis for</strong></td>
<td>not specified</td>
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## Introduction to Business Administration

Modules referring to Subsidiary Subject Management and Economics

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<tr>
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<td>Attendance time</td>
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<tr>
<td>Language of instruction</td>
<td>German</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>irregular</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Kai-Uwe Marten</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>All professors and lecturers of Management and Economics</td>
</tr>
<tr>
<td>Allocation of study programmes</td>
<td>Biology MSc, start of studies: winter semester, compulsory elective module, 1st or 3rd semester</td>
</tr>
<tr>
<td>Recommended prerequisites</td>
<td>Formally: Refer to the subject-specific examination regulations of the respective study course, in the version effective when taking up the study program. Contentually: None.</td>
</tr>
</tbody>
</table>
| Learning objectives | Students who have successfully completed this module  
  • are familiar with the basic concepts and problems of corporate management.  
  • have learned to apply economic concepts to managerial decisions.  
  • are able to understand intra-company aspects (corporate governance, human resource management, manufacturing) as well as decisions made in interactions with markets (sales, strategy). |
| Syllabus         | This module covers the following subject-specific topics:  
  • Constitutive decisions (legal forms, organizational structure and design, corporate governance, location planning)  
  • Human resource management  
  • Investment (especially net present value rule)  
  • Cost accounting |
Procurement

Production

Sales

Strategic management (competitive analysis, BCG matrix etc.)

**Literature**

- Bea, Franz Xaver; Schweitzer, Marcell: Allgemeine Betriebswirtschaftslehre, 3 volumes, 9th resp. 10th revised edition, Stuttgart 2006-2011
- Schierenbeck, Henner; Wöhle, Claudia: Grundzüge der Betriebswirtschaftslehre, 17th revised edition, Munich 2008
- Steven, Marion: BWL für Ingenieure, 3rd revised edition, Munich 2008
- Wöhe, Günter; Döring, Ulrich: Einführung in die Allgemeine Betriebswirtschaftslehre, 24th revised edition, Munich 2010

**Teaching and learning methods**

Lecture (3 hours per week) and exercises (1 hour per week)

**Workload**

Attendance time: 60 h
Self-study: 120 h
Sum: 180 h

**Assessment**

The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.

**Grading procedure**

The grade of the module will be the grade of the exam.

**Basis for**

-
# Introduction to Economics

Modules referring to Subsidiary Subject Management and Economics

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<td>Attendance time</td>
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<td>Language of instruction</td>
<td>German</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Prof. Dr. Kai-Uwe Marten</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Prof. Dr. Georg Gebhardt, Prof. Dr. Werner Smolny</td>
</tr>
</tbody>
</table>

### Allocation of study programmes

Biology MSc, start of studies: winter semester, compulsory elective module, 1\(^{st}\) or 3\(^{rd}\) semester

### Recommended prerequisites

Formally: Refer to the subject-specific examination regulations of the respective study course, in the version effective when taking up the study program.

Contentually: None.

### Learning objectives

Students who have successfully completed this module are familiar with the fundamental principles of economics such as (1) the use of formal models (optimization, marginal analysis, equilibrium, homo oeconomicus and its behavioral alternatives) (2) Empirical tests of hypotheses (regression analysis, causality, experimental economics). Moreover students are introduced to the most important micro- and macroeconomic applications of these methods (markets, growth, business cycles) together with the associated economic policy questions (development, taxation, monetary and fiscal policy).

### Syllabus

This module covers the following subject-specific topics:

1) Economic indicators
2) Growth
3) Perfect competition
4) Foundations of perfect competition
5) Business cycles
**Literature**
- Wooldridge, Jeffrey M. (2009), Introductory Econometrics, Southwestern, Cengage: 4. Auflage

**Teaching and learning methods**
Lecture (3 hours per week) and exercises (1 hour per week)

**Workload**
- Attendance time: 60 h
- Self-study: 120 h
- Sum: 180 h

**Assessment**
The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.

**Grading procedure**
The grade of the module will be the grade of the exam.

**Basis for**
-
# Fundamentals of Management Accounting and Control

Modules referring to Subsidiary Subject Management and Economics

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<td>Cycle</td>
<td>each academic Year</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Professor Dr. Paul Wentges; Institute of Management Accounting and Control</td>
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<td>Instructor(s)</td>
<td>Professor Dr. Paul Wentges; Institute of Management Accounting and Control</td>
</tr>
<tr>
<td>Recommended prerequisites</td>
<td>none</td>
</tr>
<tr>
<td>Learning objectives</td>
<td>Management Accounting and Control (Controlling) is established in industrial firms, trade and the service industry and it also gains importance in the public sector and non-profit enterprises. The students receive an overview of the relevant concepts and the core tasks of management accounting and control as well as coordination as the central function of control systems. Additionally, they acquire knowledge about the basics, goals, tasks and relevant tools of normative, strategic and operative Controlling.</td>
</tr>
</tbody>
</table>
| Syllabus | 1. Introduction  
(a) Historical development  
(b) Concepts of Controlling  
(c) Demarcation of Controlling  
2. Coordination as the core function of Controlling  
(a) Coordination  
(b) Partial functions of Controlling |
(c) Controlling as the coordination of management sub-systems

(d) Modern theories of the firm

3. Normative Controlling

(a) Mission statement

(b) Vision, mission, norms, values and culture

4. Strategic Controlling

(a) Strategic planning

(b) Strategic control

(c) Strategic information management

(d) Strategic cost management

5. Operative Controlling

(a) Operative planning

(b) Operative control

6. Organization of Controlling

Literature


Teaching and learning methods

Three hours of lectures and one hour of exercises each week

Workload

180 hours; of which 80 hours in class, 100 hours self-study

Assessment

The grade of the module will be the grade of the written exam. No prerequisites are necessary for exam registration.

Grading procedure

The grade of the module will be the grade of the exam.
| Basis for | Major course in Strategic Management and Management Control, major course in Technology and Process Management, compulsory elective business administration |
### Information Society an Globalization II
Modules referring to Subsidiary Subject Management and Economics

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<td>Instructor(s)</td>
<td>No english version available yet.</td>
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<tr>
<td>Allocation of study programmes</td>
<td>No english version available yet.</td>
</tr>
<tr>
<td>Recommended prerequisites</td>
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<td>Learning objectives</td>
<td>No english version available yet.</td>
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<tr>
<td>Syllabus</td>
<td>No english version available yet.</td>
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<td>Literature</td>
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<td>Teaching and learning methods</td>
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<tr>
<td>Workload</td>
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**Assessment**

The grade of the module will be the grade of the oral or written (depending on the number of participants) exam. No prerequisites are necessary for exam registration.

**Grading procedure**

The grade of the module will be the grade of the exam.
Basis for

No english version available yet.
### Macroeconomics

Modules referring to Subsidiary Subject Management and Economics

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<td>each Winter Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Professor Dr. Georg Gebhardt; Institute of Economics, Professor Dr. Werner Smolny; Institute of Economic Policy</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Professor Dr. Georg Gebhardt; Institute of Economics, Professor Dr. Werner Smolny; Institute of Economic Policy</td>
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<td>Allocation of study programmes</td>
<td>Bachelor Wirtschaftswissenschaften (compulsory module)</td>
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<td>Module &quot;Grundlagen der Volkswirtschaftslehre&quot;</td>
</tr>
<tr>
<td>Learning objectives</td>
<td>The students will get some introduction into basic concepts of the macroeconomic analysis. Additional they will get some insights in essential Methods of the macroeconomic analysis. Basic Knowledges in macroeconomic is a requirement for the finance and economic area.</td>
</tr>
<tr>
<td>Syllabus</td>
<td>This lecture should give the students an idea of the basic concept and application of the macroeconomic analysis. Further studies in finance or economics require a basic knowledge of macroeconomics.</td>
</tr>
<tr>
<td>Literature</td>
<td>Announced on the Website of the institute</td>
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<td>lecture (3 SWS) and exercise (1 SWS)</td>
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<tr>
<td><strong>Basis for</strong></td>
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**self study: 100 h**

**Summary: 180 h**
### Process Management II
**Modules referring to Subsidiary Subject Management and Economics**

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<td><strong>Cycle</strong></td>
<td><a href="http://www.uni-ulm.de/index.php?id=43318">long-term range of teaching Master WiWi</a></td>
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<tr>
<td><strong>Coordinator</strong></td>
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<tr>
<td><strong>Instructor(s)</strong></td>
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</tr>
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<td><strong>Allocation of study programmes</strong></td>
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<td><strong>Recommended prerequisites</strong></td>
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<td><strong>Learning objectives</strong></td>
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<tr>
<td><strong>Syllabus</strong></td>
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<td><strong>Assessment</strong></td>
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<tr>
<td><strong>Grading procedure</strong></td>
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Basis for

No english version available yet.
# Technology- and Innovationsmanagement I

Modules referring to Subsidiary Subject Management and Economics

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<tr>
<td>Duration</td>
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</tr>
<tr>
<td>Cycle</td>
<td>irregular</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Professor Dr. Leo Brecht, Institute of Technology and Process Management</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Professor Dr. Leo Brecht, Institute of Technology and Process Management</td>
</tr>
<tr>
<td>Allocation of study programmes</td>
<td>B.Sc. Wima, Wiwi, WiChem, WiPhy</td>
</tr>
<tr>
<td>Recommended prerequisites</td>
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</tr>
<tr>
<td>Learning objectives</td>
<td>Technology is fundamental to every product-based business for reducing costs, differentiating products, providing new opportunities and driving strategic change. Yet many companies fail to understand the value of technology management in providing sustained growth and competitiveness. This lecture sets out to remedy this and answers the questions which continually confront top management: how to decide which technologies to invest in and how to manage and exploit them for maximum commercial value, how much to invest in R&amp;D and how can the additional value be determined; how to shape management roles, corporate structures and culture to fit the technology strategy; and how to gain both employee and shareholder commitment.</td>
</tr>
</tbody>
</table>
| Syllabus        | 1. Why technology matters  
  2. Technology and corporate involvement  
  3. Assessing technology position  
  4. Developing technology strategies  
  5. Planning for the long term  
  6. Buying in technology  
  7. Selling technology  
  8. Structuring technology activities  
  9. Implementation  
  10. Measurement and benchmarking  
  11. Technology and shareholder value |
<table>
<thead>
<tr>
<th>Literature</th>
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<tr>
<td>• Weiterführende Literatur ist im Skript aufgelistet</td>
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<table>
<thead>
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<tbody>
<tr>
<td>Lecture (3 contact hours) and exercise course (1 contact hour)</td>
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</table>

<table>
<thead>
<tr>
<th>Workload</th>
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<tbody>
<tr>
<td>180 hours; 80 contact hours, 100 hours private study</td>
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<table>
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<tr>
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<td>The grade of the module will be the grade of the written exam. Prerequisite for exam registration is passing the pre-course (to be defined by the examiner).</td>
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<table>
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<tr>
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<td>The grade of the module will be the grade of the exam.</td>
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</table>

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### Master's Thesis

**Modules referring to Master Thesis**

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</tr>
<tr>
<td><strong>Cycle</strong></td>
<td>each Semester</td>
</tr>
<tr>
<td><strong>Coordinator</strong></td>
<td>Chairperson of the professional board of examiners</td>
</tr>
<tr>
<td><strong>Instructor(s)</strong></td>
<td>Professors and habilitated members of the field Chemistry, of it divergent lecturers only after approval by the professional board of examiners</td>
</tr>
<tr>
<td><strong>Allocation of study programmes</strong></td>
<td>Master Chemistry, both study programmes, duty module, 4. Semester</td>
</tr>
</tbody>
</table>

**Recommended prerequisites**

Formal prerequisites (according to Study order and examination regulations): please see §20 of the examination regulations Chemistry or §21 of the examination regulations Chemistry and Management

Prerequisites regarding to the contents: Thematically relevant modules and lectures of the master course of studies

The registration of the module must be carried out with the professional board of examiners with the form intended for it!

Download under: http://www.uni-ulm.de/nawi/oc1/pruefungsausschuss-chemie-wirtschaftschemie.html

**Learning objectives**

Independent manufacture of a scientific work to the acquisition of the academic degree M.Sc.

**Syllabus**

Independent treatment of a subject oriented to research from the area of the chemistry or economics

**Literature**

according to demand
<table>
<thead>
<tr>
<th>Teaching and learning methods</th>
<th>Independent scientific work, professional discussions, working group seminars or seminars in the enterprise (28 CP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal presentation of the results of the work (2 CP); the presentation is public (working group, institute, faculty)</td>
<td>The master work can be also made externally in an enterprise. Moreover unity and consent must exist between professional board of examiners and enterprise with regard to the subject as well as the accompanying achievements (enterprise seminars, place and form of the final presentation etc.).</td>
</tr>
<tr>
<td></td>
<td>For the realisation of external training periods and master works a leaflet with important information can be requested from the coordinator!</td>
</tr>
<tr>
<td>Workload</td>
<td>for literature work, experimental works and documentation: 900 H</td>
</tr>
<tr>
<td>Assessment</td>
<td>Written master thesis, verbal presentation of the results of the master thesis.</td>
</tr>
<tr>
<td>Grading procedure</td>
<td>The module mark arises from the arithmetic means of both certificates. The presentation comes with 2 CP of a total of 30 CP into the assessment.</td>
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<td>PhD</td>
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Seminar Master Thesis
Modules referring to Master Thesis

Code 8803271200

ECTS credits 15

Attendance time keine Angaben

Language of instruction German or English

Duration 1 Semester

Cycle each Semester

Coordinator Responsible person of the planned master thesis

Instructor(s) Professors and habilitated members of the field Chemistry, of it divergent lecturers only after approval by the professional board of examiners

Allocation of study programmes Master Chemistry, both study programmes, compulsory module, 3. Semester, before start of master thesis

Recommended prerequisites Formal prerequisites (according to Study order and examination regulations): please mind the FSPO

Prerequisites regarding to the contents: Thematically relevant modules and lectures of the master course of studies

The registration of the module must be done with the professional board of examiners with the form intended for it!

Download under: http://www.uni-ulm.de/nawi/oc1/pruefungsausschuss-chemie-wirtschaftschemie.html

Learning objectives The students who have finished this module successfully,
- attain the ability to show scientific level of knowledge to a specific topic in view of a master work
- are able to compile theory and methodology of the master work in the form of a research plan under instructions

Syllabus Employment with theoretical, methodical and bases experimental-practical if necessary of the subject of the planned master work. In the case of a master work with main focus in economics this module of the training serves in the topic of the planned master work and the literature study, springs study and fact study
is in the foreground as a rule. In the case of a master work with main focus in chemistry at least 25% of the time extent should serve the literature study. If it the responsible person holds for right, besides, a practical training can already occur in the investigation methods necessary for the work; also the orienting experiments which serve the consolidation of the subject can be carried out.

Furthermore a talk is to be prepared on the treated subject. A written elaboration of the talk is to be handed over to the first responsible person of the planned master work. Contents of the talk should be the topic, methodology and a research plan for the master work.

Furthermore, it is obligatory to attend at least 10 scientific colloquia. On the website of the examination board a form is provided that informs about the regulations which speeches and talks are accepted as scientific colloquia. When attending a colloquium a responsible person for the speech will provide his/her signature on the form. The module will not be finished before the completely filled form is yielded to the examination board.

<table>
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<tr>
<th>Literature</th>
<th>according to setting of tasks, primarily independent literature search</th>
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<tbody>
<tr>
<td>Teaching and learning methods</td>
<td>Own study with talk in the working group or institute seminar Attendance in at least 10 scientific colloquia (please see &quot;Syllabus&quot;)</td>
</tr>
<tr>
<td>Workload</td>
<td>15 ECTS Credit Points, distributed between presence and self study periods depending on the arrangement between the person in support and the student. The 15 CP include the attendance in at least 10 scientific colloquia.</td>
</tr>
<tr>
<td>Assessment</td>
<td>Talk in the seminar of the working group / of the institute as well as written elaboration of the talk</td>
</tr>
<tr>
<td>Grading procedure</td>
<td>None, because unmarked achievement</td>
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<td>Basis for</td>
<td>Master Thesis in the course of studies Chemistry</td>
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Seminar Master Thesis
Modules referring to Seminars and Practical Experience

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<td>Language of instruction</td>
<td>German or English</td>
</tr>
<tr>
<td>Duration</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Cycle</td>
<td>each Semester</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Responsible person of the planned master thesis</td>
</tr>
<tr>
<td>Instructor(s)</td>
<td>Professors and habilitated members of the field Chemistry, of it divergent lecturers only after approval by the professional board of examiners</td>
</tr>
<tr>
<td>Allocation of study programmes</td>
<td>Master Chemistry, both study programmes, compulsory module, 3. Semester, before start of master thesis</td>
</tr>
<tr>
<td>Recommended prerequisites</td>
<td>Formal prerequisites (according to Study order and examination regulations): please mind the FSPO</td>
</tr>
<tr>
<td></td>
<td>Prerequisites regarding to the contents: Thematically relevant modules and lectures of the master course of studies</td>
</tr>
<tr>
<td></td>
<td>The registration of the module must be done with the professional board of examiners with the form intended for it!</td>
</tr>
<tr>
<td></td>
<td>Download under: <a href="http://www.uni-ulm.de/nawi/oc1/pruefungsausschuss-chemie-wirtschaftschemie.html">http://www.uni-ulm.de/nawi/oc1/pruefungsausschuss-chemie-wirtschaftschemie.html</a></td>
</tr>
<tr>
<td>Learning objectives</td>
<td>The students who have finished this module successfully,</td>
</tr>
<tr>
<td></td>
<td>- attain the ability to show scientific level of knowledge to a specific topic in view of a master work</td>
</tr>
<tr>
<td></td>
<td>- are able to compile theory and methodology of the master work in the form of a research plan under instructions</td>
</tr>
<tr>
<td>Syllabus</td>
<td>Employment with theoretical, methodical and bases experimental-practical if necessary of the subject of the planned master work. In the case of a master work with main focus in economics this module of the training serves in the topic of the planned master work and the literature study, springs study and fact study</td>
</tr>
</tbody>
</table>
is in the foreground as a rule. In the case of a master work with main focus in chemistry at least 25% of the time extent should serve the literature study. If it the responsible person holds for right, besides, a practical training can already occur in the investigation methods necessary for the work; also the orienting experiments which serve the consolidation of the subject can be carried out.

Furthermore a talk is to be prepared on the treated subject. A written elaboration of the talk is to be handed over to the first responsible person of the planned master work. Contents of the talk should be the topic, methodology and a research plan for the master work.

Furthermore, it is obligatory to attend at least 10 scientific colloquia. On the website of the examination board a form is provided that informs about the regulations which speeches and talks are accepted as scientific colloquia. When attending a colloquium a responsible person for the speech will provide his/her signature on the form. The module will not be finished before the completely filled form is yielded to the examination board.

<table>
<thead>
<tr>
<th>Literature</th>
<th>according to setting of tasks, primarily independent literature search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and learning methods</td>
<td>Own study with talk in the working group or institute seminar</td>
</tr>
<tr>
<td></td>
<td>Attendance in at least 10 scientific colloquia (please see &quot;Syllabus&quot;)</td>
</tr>
<tr>
<td>Workload</td>
<td>15 ECTS Credit Points, distributed between presence and self study periods depending on the arrangement between the person in support and the student. The 15 CP include the attendance in at least 10 scientific colloquia.</td>
</tr>
<tr>
<td>Assessment</td>
<td>Talk in the seminar of the working group / of the institute as well as written elaboration of the talk</td>
</tr>
<tr>
<td>Grading procedure</td>
<td>None, because unmarked achievement</td>
</tr>
<tr>
<td>Basis for</td>
<td>Master Thesis in the course of studies Chemistry</td>
</tr>
</tbody>
</table>
## Additional Key Qualifications

**Modules referring to Additional Key Qualifications**

<table>
<thead>
<tr>
<th><strong>Code</strong></th>
<th>8803286000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ECTS credits</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>Attendance time</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>Language of instruction</strong></td>
<td>Depends on the chosen course</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1 Semester</td>
</tr>
<tr>
<td><strong>Cycle</strong></td>
<td>each Semester</td>
</tr>
<tr>
<td><strong>Coordinator</strong></td>
<td>Leader of the language center of the University of Ulm</td>
</tr>
<tr>
<td><strong>Instructor(s)</strong></td>
<td>Depends on the chosen course</td>
</tr>
</tbody>
</table>
| **Allocation of study programmes** | Master Chemistry, both study programs, duty module, 1.-3. Semester  
Master Chemistry and Management, duty module, 1.-3. semester |
| **Recommended prerequisites** | Formal prerequisites (according to Study order and examination regulations): none  
Prerequisites regarding to the contents: none |
| **Learning objectives** | The students acquire: Intercultural competence and foreign linguistic knowledge; knowledge and abilities in the areas of Works in the team, communication and presentation learns; reflecting competence, communication competence and argumentation competence. |
| **Syllabus** | Depends on the chosen course |
| **Literature** | is made available in the lecture |
| **Teaching and learning methods** | as a rule: seminar (2 hours per week) |
| **Workload** | Presence study: 30 H  
Self study: 60 H |
Total: 90 H

<table>
<thead>
<tr>
<th></th>
<th>not specified</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Grading procedure</strong></td>
<td>not specified</td>
</tr>
<tr>
<td><strong>Basis for</strong></td>
<td>no data</td>
</tr>
</tbody>
</table>