Modulhandbuch

für den

Masterstudiengang

Sustainable and Innovative Natural Resource Management (SINReM)
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Abkürzungen

KA: schriftliche Klausur / written exam
MP: mündliche Prüfung / oral examination
AP: alternative Prüfungsleistung / alternative examination
PVL: Prüfungsvorleistung / prerequisite
MP/KA: mündliche oder schriftliche Prüfungsleistung (abhängig von Teilnehmerzahl) / written or oral examination (dependent on number of students)

SS, SoSe: Sommersemester / sommer semester
WS, WiSe: Wintersemester / winter semester

SX: Lehrveranstaltung in Semester X des Moduls / lecture in module semester x

SWS: Semesterwochenstunden
Module Name: Biotechnology in Mining  

(English):

Responsible: Schlömann, Michael / Prof. Dr.
Lecturer(s): Schlömann, Michael / Prof. Dr.
Institute(s): Institute of Biosciences
Duration: 1 Semester(s)

Competencies: In an interdisciplinary approach the students will obtain an understanding of the general concept of bioleaching for the winning of metals, and specifically of the advantages and problems of various process options. The students will understand the involvement of different types of microbes, the stresses to which the microbes are exposed and how they may react. They will also obtain an understanding of the generation and of the biotechnological treatment options for acidic mine drainage. In a lab course the students will obtain experience with methods and problems related to the cultivation of microorganisms relevant for bioleaching or mine water treatment. They will also gain experience in analytical methods to describe and control corresponding processes. In a seminar the students will gain experience with current literature and with reporting about it to other participants. In addition, the students will exercise to plan a lab-scale bioleaching process.

Contents:

1. Basics: concepts of microbial energy metabolism, chemolithotrophic growth, diversity of electron donors and acceptors, microbial redox reactions.  
2. Processes in conventional metal winning.  
4. Microorganisms relevant for aerobic bioleaching: relevant properties, taxonomy, communities, succession.  
5. Methods for the cultivation and characterization of microbial strains and communities.  
7. Important pathways in energy metabolism and biomass formation: proteins/pathways involved in iron and sulfur oxidation, uptake mechanisms (siderophores), CO₂ fixation, nitrogen metabolism, energetic problems.  
8. Environmental challenges for and responses of bioleaching microorganisms: acidity, oxidative stress, metal toxicity, osmolarity, temperature.  
12. Biological methods for winning metals from the aqueous phase: biological sulfafte reduction and biological iron oxidation as active treatment options, wetlands, biosorption.  
13. Lab course: Techniques for cultivation of acidophilic bacteria,
measurement of parameters to follow growth and leaching activity of relevant microorganisms.

Literature:

Types of Teaching:
- S1 (WS): Lectures (2 SWS)
- S1 (WS): Seminar (1 SWS)
- S1 (WS): Practical Application (1 SWS)
- S1 (WS): Excursion (0.5 SWS)

Pre-requisites: **Mandatory:**
- Bachelor degree in a natural science or in mining- or metallurgy-related engineering.
- Grundlagen der Biochemie und Mikrobiologie und Mikrobiologisch-biochemisches Praktikum oder Microbiology for Resource Scientists: Lecture and Microbiology for Resource Scientists: Lab Course or equivalent

**Recommendations:**
- Basic knowledge in chemistry.

Frequency: yearly in the winter semester

Requirements for Credit Points:
For the award of credit points it is necessary to pass the module exam. The module exam contains:
- KA [90 min]
- PVL: Presentation in the seminar
- PVL: Planning of a lab-scale bioleaching process.
- PVL: Planning of a lab-scale bioleaching process.

Voraussetzung für die Vergabe von Leistungspunkten ist das Bestehen der Modulprüfung. Die Modulprüfung umfasst:
- KA [90 min]
- PVL: Seminarvortrag
- PVL: Planung eines Biolaugungs-Prozesses im Labormaßstab.
- PVL müssen vor Prüfungsantritt erfüllt sein bzw. nachgewiesen werden.

Credit Points: 5

Grade: The grade is generated from the examination result(s) with the following weights (w):
- KA [w: 1]

Workload: The workload is 150h. It is the result of 67.5h attendance and 82.5h self-studies.
Module Name: Literature Study and Business Plan

Responsible: Stephan, Johannes / Prof. Dr.

Lecturer(s): Haseneder, Roland / Dr. rer. nat.
Schlömann, Michael / Prof. Dr.
Bertau, Martin / Prof. Dr.
Joseph, Yvonne / Prof. Dr. rer. nat.
Stelter, Michael / Prof. Dr.-Ing.
Frisch, Gero / Prof. Dr.

Institute(s):
- Institute of Thermal, Environmental and Natural Products Process Engineering
- Institute of Biosciences
- Institute of Chemical Technology
- Institute of Electronic and Sensor Materials
- Institute for Nonferrous Metallurgy and Purest Materials
- Institute of Inorganic Chemistry
- Professor of International Resource Policy and Economic Development

Duration: 1 Semester(s)

Competencies: On completion of the course the student shall be able to:

- Consult specialist literature and interpret it critically according to scientific standards.
- Plan, monitor and steer scientific research.
- Collect, process, critically analyse and interpret data. Identify new and remaining bottlenecks and research questions based on knowledge, insights and experience.
- Deploy own knowledge in a creative, purposeful and innovative way in research, design and production processes.
- Argue in a scientifically correct way in a multidisciplinary context.
- Exhale openness to innovative scientific developments and their applications in a broad scientific, economic and social context.
- Adopt an active attitude towards permanent knowledge development, lifelong learning and steer the own learning process independently.
- Clearly communicate research results in English.
- Conceptualize, plan and execute independently result-oriented new concepts at the level of a starting professional.
- Understand the complexity of a problem/system using quantitative methods.
- Extract useful information from superfluous, incomplete or contradictory data.
- Consider specifications and technical, economic and social preconditions and transform them into a sustainable and qualitative system, product, service or process idea.
- Integrate aspects related to sustainable resource management into research, production, quality assessment, management and/or policy.
- Entrepreneurial mindset to develop new ideas within a multidisciplinary context.

After passing the course, the student should be able to describe and
understand the essence of:

- Problem solving – how to analyse a complex problem
- Basic project design
- Innovation and entrepreneurship essentials
- Project planning and project management basics
- An overview of scientific methods
- Problem characteristics and the choice of methods
- Group dynamics and group thinking
- IQ and emotional intelligence
- Basic presentation techniques and rhetoric

**Contents:**
The students will prepare a written thesis. It will be compilation of self-researched literature on a given specific scientific or technical question and should include possible business models to generate systems, products, services or processes. The results from the thesis will be presented in a seminar lecture and discussed afterwards. The students should attend most of the other presentations and participate actively in the corresponding discussions.

**Literature:**
Depend on selected topic

**Types of Teaching:**
S1 (WS): incl. consultations with the supervisor / Seminar (3 SWS)

**Pre-requisites:**

**Frequency:**
yearly in the winter semester

**Requirements for Credit Points:**
For the award of credit points it is necessary to pass the module exam. The module exam contains:
- AP*: Written thesis
- AP*: Active participation in the seminar
- AP*: presentation

* In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.

Voraussetzung für die Vergabe von Leistungspunkten ist das Bestehen der Modulprüfung. Die Modulprüfung umfasst:
- AP*: Seminararbeit
- AP*: Aktive Teilnahme am Seminar
- AP*: Präsentation

* Bei Modulen mit mehreren Prüfungsleistungen muss diese Prüfungsleistung bestanden bzw. mit mindestens "ausreichend" (4,0) bewertet sein.

**Credit Points:**
5

**Grade:**
The Grade is generated from the examination result(s) with the following weights (w):
- AP*: Written thesis [w: 3]
- AP*: Active participation in the seminar [w: 1]
- AP*: presentation [w: 2]

* In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.

**Workload:**
The workload is 150h. It is the result of 45h attendance and 105h self-studies.
### Module Name:
**Master Thesis in Sustainable and Innovative Natural Resource Management**

### Responsible:
Frisch, Gero / Prof. Dr.

### Lecturer(s):
Beteiligte Hochschullehrer (involved lecturers)

### Institute(s):
Institute of Inorganic Chemistry

### Duration:
1 Semester(s)

### Competencies:
The students should get the ability to solve scientific tasks in the field of advanced resource management. They should be able to prepare a scientific presentation of its work and defend it in front of an audience. Economic aspects also have to be considered in the work. The thesis can be written in any institute at the university which provided a obligate lecture and/or in a company which was involved in the training. The master thesis is a kind of examination which completes the entire course. The work is the proof, that the students are able to solve scientific problems by their own.

### Contents:
Concept of the work schedule; analysis of literature; familiarize with methods, testing equipment, numerical methods; realization and analysis of tests in situ and in the laboratory; realization of calculations and numerical simulations; summary, scientific analysis and generalization of the results (period of four months). Preparation of a scientific work and paper in a colloquium (30 min oral presentation with discussion)

### Literature:
Guideline for the preparation of scientific works at TU Bergakademie Freiberg from 27.06.2005, DIN 1422, part 4 (08/1985); Hints for taskspecific literature will be given.

### Types of Teaching:
S1: Consultations, on demand: instruction in laboratory work and software, colloquium / Thesis (24 Wo) / Thesis

### Pre-requisites:
**Mandatory:** Abschluss von Modulen des ersten und zweiten Semesters im Umfang von mindestens 50 Leistungspunkten (modules with the total of 50 credit points of the first and second term have to be passed)

### Frequency:
constantly

### Requirements for Credit Points:
For the award of credit points it is necessary to pass the module exam. The module exam contains:
- **AP**: Written thesis
- **MP**: Oral defense on the topic of the written thesis [30 to 35 min]

* In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.

### Credit Points:
30

### Grade:
The Grade is generated from the examination result(s) with the following weights (w):
- **AP**: Written thesis [w: 3]
- **MP**: Oral defense on the topic of the written thesis [30 to 35 min] [w: 1]
* In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.

| Workload:          | The workload is 900h. It is the result of 0h attendance and 900h self-studies. |
**Module Name:** Microbiology for Resource Scientists: Lab Course

**Responsible:** Schlömann, Michael / Prof. Dr.

**Lecturer(s):** Kaschabek, Stefan / Dr.

**Institute(s):** Institute of Biosciences

**Duration:** 1 Semester(s)

**Competencies:** The students will have obtained experience in basic microbiological methods. They are able to prepare sterile media, to cultivate microorganisms and to enrich as well as isolate pure cultures. They are able to follow the growth of cultures and to analyse substrate conversion and product formation during cultivation.

**Contents:** Working sterile; preparation of minimal and complex media; pouring of plates; enrichment, isolation and identification of microorganisms. Experiments on various metabolic properties of microorganisms (e.g. leaching of sulfides). Turbidity measurement, HPLC analyses, colorimetric determination of ions in solution.

**Literature:** Strete: Mikrobiologisches Grundpraktikum
Steinbüchel & Oppermann-Sanio: Mikrobiologisches Praktikum

**Types of Teaching:** S1 (WS): Practical Application (5 SWS)

**Pre-requisites:**
- Mandatory: Microbiology for Resource Scientists: Lecture, 2018-07-03
- oder (or)"Grundlagen der Biochemie und Mikrobiologie" oder (or) equivalent

**Recommendations:** Knowledge in general, inorganic and organic chemistry.

**Frequency:** yearly in the winter semester

**Requirements for Credit Points:** For the award of credit points it is necessary to pass the module exam. The module exam contains:
- PVL: Online test on the description of the experiments
- AP: Lab reports

PVL have to be satisfied before the examination.

Voraussetzung für die Vergabe von Leistungspunkten ist das Bestehen der Modulprüfung. Die Modulprüfung umfasst:
- PVL: Online-Test zu den Versuchsbeschreibungen (Skripten)
- AP: Praktikumsprotokolle

PVL müssen vor Prüfungsantritt erfüllt sein bzw. nachgewiesen werden.

**Credit Points:** 3

**Grade:** The Grade is generated from the examination result(s) with the following weights (w):
- AP: Lab reports [w: 1]

**Workload:** The workload is 90h. It is the result of 75h attendance and 15h self-studies.
**Module Name:** Microbiology for Resource Scientists: Lecture

**Responsible:** Schlömann, Michael / Prof. Dr.

**Lecturer(s):** Schlömann, Michael / Prof. Dr.

**Institute(s):** Institute of Biosciences

**Duration:** 1 Semester(s)

**Competencies:** Students will have obtained a basic understanding of the functioning of a microbial cell. Specifically they will have obtained an understanding of the diversity of microbial energy metabolism, of the effects of microbial activities on the environment and how that can be used for the winning of metals and oil and for mine-water treatment. Students understand how microorganisms are classified into certain taxa, and they will have some insight into molecular tools for the classification and for the prediction of properties of the microorganisms.

**Contents:**
- Eukaryotic versus prokaryotic cell; important biomolecules (carbohydrates, lipids, proteins, nucleic acids);
- Basics of fundamental cell processes (replication, transcription, translation);
- Structure of the microbial cell, microbial taxonomy and phylogeny;
- Growth of microorganisms;
- Principles of energy metabolism; microbial activities in the carbon cycle: energy metabolism on the example of aerobic degradation of carbohydrates; simple fermentations; aerobic degradation of alkanes; CO₂ fixation in photosynthetic and lithotrophic microorganisms; activities in the nitrogen cycle (nitrification, denitrification, N₂ fixation); microbial iron oxidation and reduction; microbial oxidation and reduction of sulfur compounds.

**Literature:**
- Madigan, Martinko, Stahl, Clark: Brock - Microbiology
- Reineke & Schlömann: Umweltmikrobiologie

**Types of Teaching:**
- S1 (WS): All main topics are also covered in the German lecture "Grundlagen der Biochemie und Mikrobiologie" which is available online and will be subtitled in English. (E-learning platform: OPAL) / Lectures (2 SWS)

**Pre-requisites:**

**Recommendations:**
- Background in general, inorganic and organic chemistry; high school knowledge in biology

**Frequency:** yearly in the winter semester

**Requirements for Credit Points:**
- For the award of credit points it is necessary to pass the module exam. The module exam contains:
  - KA [90 min]

**Credit Points:**
- 3

**Grade:**
- The Grade is generated from the examination result(s) with the following weights (w):
  - KA [w: 1]

**Workload:**
- The workload is 90h. It is the result of 30h attendance and 60h self-studies.
**Module Name:** Problems and Innovations in the Process Chain of Mineral Resources (English)

**Responsible:** Bertau, Martin / Prof. Dr.

**Lecturer(s):** Haseneder, Roland / Dr. rer. nat.  
Höck, Michael / Prof. Dr.  
Schlömann, Michael / Prof. Dr.  
Bertau, Martin / Prof. Dr.  
Joseph, Yvonne / Prof. Dr. rer. nat.  
Stelter, Michael / Prof. Dr.-Ing.  
Frisch, Gero / Prof. Dr.

**Institute(s):**  
Institute of Thermal, Environmental and Natural Products Process Engineering  
Professor of Industrial Management, Production Management and Logistics  
Institute of Biosciences  
Institute of Chemical Technology  
Institute of Electronic and Sensor Materials  
Institute for Nonferrous Metallurgy and Purest Materials  
Institute of Inorganic Chemistry

**Duration:** 1 Semester(s)

**Competencies:** On completion of the course the student shall be able to explain real world problems in the process chain of special resources. They have an understanding about how different sectors have to interact to form a working unit in research. Innovative solutions on current issues in industries shall be highlighted and still occurring problems discussed to create an idea of entrepreneurship for various fields of the here outlined process chain.

**Contents:**  
1. Introduction of lecturers, companies, and students by short talks. Later social events will force the team building.  
2. 5 Lectures on the process chain (Preprocessing technologies, (Bio-)Leaching, Separation processes, Hydrometallurgy, Process analysis) in combination with seminars to form working groups on individual topics.  
3. Excursions and field trips, company talks and lectures.

**Literature:** Not applicable

**Types of Teaching:**  
S1 (WS): Lectures - Bloc course / Lectures (1 SWS)  
S1 (WS): with short report of the team - Bloc course / Seminar (2 SWS)  
S1 (WS): Excursion - Bloc course / Excursion  
S1 (WS): Thesis - Bloc course / project (1 SWS)

**Pre-requisites:** Yearly in the winter semester

**Requirements for Credit Points:** For the award of credit points it is necessary to pass the module exam. The module exam contains:  
AP: Short written report of the team

**Voraussetzung für die Vergabe von Leistungspunkten ist das Bestehen der Modulprüfung. Die Modulprüfung umfasst:**  
AP: Schriftliche Gruppenarbeit

**Credit Points:** 4

**Grade:** The Grade is generated from the examination result(s) with the following weights (w):

AP: Short written report of the team [w: 1]
| **Workload:** | The workload is 120h. It is the result of 60h attendance and 60h self-studies. |
**Module Name:** Resources Chemical Technology  

**Responsible:** Bertau, Martin / Prof. Dr.  

**Institute(s):** Institute of Chemical Technology  

**Duration:** 1 Semester(s)  

**Competencies:** After completing this module, students should be able to  

- understand raw material processing on a technical scale  
- explain the chemical-technological concepts behind modern production techniques  

**Contents:**  

**Fundamentals:** Chemical technology of raw material recovery processes, chemistry of main group and transition metals as well as lanthanides, basic unit operations, basic reaction engineering.  

**Applications:** Realisation of raw material processing on a technical scale, process economy, environmental safeguards.  

**Literature:**  
- Kirk-Othmer et al., Chemical Technology, Wiley, 2013  
- J. Huheey et al., Inorganic Chemistry, Pearson, 2008  

**Types of Teaching:**  
- S1 (WS): Lectures (1 SWS)  
- S1 (WS): Tutorials / Exercises (1 SWS)  
- S1 (WS): Problem-based learning workshops / Seminar (1 SWS)  

**Pre-requisites:**  
**Recommendations:** Fundamental knowledge in chemical technology, chemical engineering and inorganic chemistry  

**Frequency:** yearly in the winter semester  

**Requirements for Credit Points:** For the award of credit points it is necessary to pass the module exam. The module exam contains:  
- KA*: [60 to 120 min]  
- AP*: Course work  

* In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.  

**Credit Points:**  

**Grade:** The Grade is generated from the examination result(s) with the following weights (w):  
- KA*: [w: 2]  
- AP*: Course work [w: 1]  

* In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.  

**Workload:** The workload is 150h. It is the result of 45h attendance and 105h self-studies.
Data: RECH. MA. Nr. 3649 / Examination number: 20109
Version: 20.02.2015 % Start Year: WiSe 2016

<table>
<thead>
<tr>
<th>Module Name:</th>
<th>Resources Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>(English):</td>
<td>Bertau, Martin / Prof. Dr. Frisch, Gero / Prof. Dr.</td>
</tr>
<tr>
<td>Lecturer(s):</td>
<td>Bertau, Martin / Prof. Dr. Frisch, Gero / Prof. Dr.</td>
</tr>
<tr>
<td>Institute(s):</td>
<td>Institute of Chemical Technology</td>
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<tr>
<td></td>
<td>Institute of Inorganic Chemistry</td>
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<tr>
<td>Duration:</td>
<td>2 Semester(s)</td>
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<tr>
<td>Competencies:</td>
<td>After completing this module, students should be able to</td>
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<tr>
<td></td>
<td>- describe the chemical properties of complex raw materials,</td>
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<td></td>
<td>- explain the chemical concepts behind modern enrichment,</td>
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<td></td>
<td>purification and production techniques,</td>
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<td></td>
<td>- suggest a suitable technology for the processing of a particular resource.</td>
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<tr>
<td>Contents:</td>
<td><strong>Fundamentals</strong>: Chemistry of ore deposits, phase diagrams, basic coordination chemistry, modelling of solvation equilibria, kinetic aspects of precipitation and extraction, chemical foundations of metallurgical processes, and applied electrochemistry.</td>
</tr>
<tr>
<td></td>
<td><strong>Applications</strong>: Hydro- und pyrometallurgical processing and recycling technologies, such as smelting, leaching, digestion, flotation, extraction, precipitation, electrowinning and ion exchange; applications of unconventional solvents; economic viability of processing and separation techniques.</td>
</tr>
<tr>
<td>Literature:</td>
<td>J. Huheey et al., Inorganic Chemistry, Pearson, 2008</td>
</tr>
<tr>
<td></td>
<td>M.Bertau et al., Industrial Inorganic Chemistry, Wiley, 2016</td>
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<tr>
<td></td>
<td>Kirk-Othmer et al., Chemical Technology, Wiley, 2013</td>
</tr>
<tr>
<td>Types of Teaching:</td>
<td>S1 (WS): Case Studies - E-Learning / Seminar (2 SWS)</td>
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<td></td>
<td>S2 (SS): Block-course / Lectures (2 SWS)</td>
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<td></td>
<td>S2 (SS): Block-course / Exercises (2 SWS)</td>
</tr>
<tr>
<td></td>
<td>S2 (SS): Block-course with excursions / Practical Application (3 SWS)</td>
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<tr>
<td>The order of the module semesters is flexible.</td>
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<tr>
<td>Pre-requisites:</td>
<td></td>
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<tr>
<td>Frequency:</td>
<td>yearly in the winter semester</td>
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<tr>
<td>Requirements for Credit Points:</td>
<td>For the award of credit points it is necessary to pass the module exam.</td>
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<td></td>
<td>The module exam contains:</td>
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<tr>
<td></td>
<td>KA*: [60 to 120 min]</td>
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<td></td>
<td>AP*: Continuous assessment of the problem-based learning workshops</td>
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<td></td>
<td>AP*: Practicals</td>
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<td></td>
<td>* In modules requiring more than one exam, this exam has to be passed or completed with at least &quot;ausreichend&quot; (4,0), respectively.</td>
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<tr>
<td></td>
<td>Voraussetzung für die Vergabe von Leistungspunkten ist das Bestehen der Modulprüfung. Die Modulprüfung umfasst:</td>
</tr>
<tr>
<td></td>
<td>KA*: [60 bis 120 min]</td>
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<tr>
<td></td>
<td>AP*: Belege zum Workshop problem-basiertes Lernen</td>
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<td></td>
<td>AP*: Übungen</td>
</tr>
</tbody>
</table>
|              | * Bei Modulen mit mehreren Prüfungsleistungen muss diese Prüfungsleistung bestanden bzw. mit mindestens "ausreichend" (4,0) 

15
| Credit Points: | 9 |
| Grade: | The Grade is generated from the examination result(s) with the following weights (w):
| KA* [w: 2] | AP*: Continuous assessment of the problem-based learning workshops [w: 1]
<p>| AP*: Practicals [w: 1] | * In modules requiring more than one exam, this exam has to be passed or completed with at least &quot;ausreichend&quot; (4.0), respectively. |
| Workload: | The workload is 270h. It is the result of 135h attendance and 135h self-studies. |</p>
<table>
<thead>
<tr>
<th>Data:</th>
<th>SSSE. MA. Nr. 3653 / Examination number: 43112</th>
<th>Version: 24.09.2018</th>
<th>Start Year: WiSe 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Name:</td>
<td><strong>Selective Separation of Strategic Elements</strong> (English):</td>
<td></td>
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<tr>
<td>Responsible:</td>
<td>Bräuer, Andreas / Prof. Dr.-Ing.</td>
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</tr>
<tr>
<td>Lecturer(s):</td>
<td>Haseneder, Roland / Dr. rer. nat.</td>
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</tr>
<tr>
<td>Institute(s):</td>
<td>Institute of Thermal, Environmental and Natural Products Process Engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration:</td>
<td>1 Semester(s)</td>
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<tr>
<td>Competencies:</td>
<td>On completion of the course the student shall be able to explain membrane technology and the different applications like extraction and membrane assisted processes regarding the separation of value products. Focus is put on strategic elements. They can use their physicochemical knowledge on membrane separation, development of hybrid operation systems and the influences for practical applications and are familiar with the methods and problems related to separation devices. Due to the seminar the students will be able to discuss the current literature on the topic.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Contents: | • membranes, modules, hybrid processes  
• driving forces, transport resistances  
• structures, materials  
• mass transfer  
• module construction  
• MF, UF, NF, RO  
• standard applications  
• scaling, fouling effects  
• special applications: mine water treatment, leaching solutions, resourcerecovery  
• internship to membrane processes | | |
Anil K. Pabby, Syed S.H. Rizvi, Ana Maria Sastre Requena: Handbook of Membrane Separations, CRC-Press 2008 | | |
| Types of Teaching: | S1 (WS): Lectures (2 SWS)  
S1 (WS): Seminar (1 SWS)  
S1 (WS): Practical Application (1 SWS) | | |
| Pre-requisites: | | | |
| Frequency: | yearly in the winter semester | | |
| Requirements for Credit Points: | For the award of credit points it is necessary to pass the module exam. The module exam contains:  
KA [90 min]  
Voraussetzung für die Vergabe von Leistungspunkten ist das Bestehen der Modulprüfung. Die Modulprüfung umfasst:  
KA [90 min] | | |
| Credit Points: | 5 | | |
| Grade: | The Grade is generated from the examination result(s) with the following weights (w):  
KA [w: 1] | | |
<table>
<thead>
<tr>
<th>Workload:</th>
<th>The workload is 150h. It is the result of 60h attendance and 90h self-studies.</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Name:</td>
<td><strong>Sensors and Actuators</strong></td>
<td>(English):</td>
<td></td>
</tr>
<tr>
<td>Responsible:</td>
<td>Joseph, Yvonne / Prof. Dr. rer. nat.</td>
<td>Lecturer(s):</td>
<td>Joseph, Yvonne / Prof. Dr. rer. nat.</td>
</tr>
<tr>
<td>Institute(s):</td>
<td>Institute of Electronic and Sensor Materials</td>
<td>Duration:</td>
<td>1 Semester(s)</td>
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<tr>
<td>Competencies:</td>
<td>Apply techniques for qualitative and quantitative exploration and physicochemical characterization of resources present in the environment, including spatial and temporal variability. Apply techniques to assess environmental impacts of products and processes. Insights in the different (technological) options for optimizing resource flows in the different parts of the value chain and be able to compare them, taking technical and economic aspects as well as social and environmental impact into account. Consult specialist literature and interpret it critically according to scientific standards. Understand the complexity of a problem/system using quantitative methods. Consider specifications and technical, economic and social preconditions and transform them into a sustainable and qualitative system, product, service or process. Entrepreneurial mindset to develop new ideas within a multidisciplinary context.</td>
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<tr>
<td>Contents:</td>
<td>Physical (e.g. temperature, force, acceleration, etc.) chemical (gas sensors, ion sensors) and biological sensors and actuators will be discussed. First, the physical principles are presented and then applications will be given. The focus is on the relationship between the parameters of the finished device and the properties of the used materials to enable their applications. Specific examples of sensors and actuators are discussed in their measurement environment.</td>
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<tr>
<td>Types of Teaching:</td>
<td>S1 (WS): Lectures (2 SWS)</td>
<td>S1 (WS): Seminar (1 SWS)</td>
<td></td>
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<tr>
<td>Pre-requisites:</td>
<td>yearly in the winter semester</td>
<td></td>
<td></td>
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<tr>
<td>Requirements for Credit Points:</td>
<td>For the award of credit points it is necessary to pass the module exam. The module exam contains: MP/KA (KA if 10 students or more) [MP minimum 30 min / KA 120 min] Voraussetzung für die Vergabe von Leistungspunkten ist das Bestehen der Modulprüfung. Die Modulprüfung umfasst: MP/KA (KA bei 10 und mehr Teilnehmern) [MP mindestens 30 min / KA 120 min]</td>
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<tr>
<td>Credit Points:</td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>Grade:</td>
<td>The Grade is generated from the examination result(s) with the following weights (w): MP/KA [w: 1]</td>
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<tr>
<td>Workload:</td>
<td>The workload is 120h. It is the result of 45h attendance and 75h self-studies.</td>
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</table>
Module Name: Simulation of Sustainable Metallurgical Process

Responsible: Stelter, Michael / Prof. Dr.-Ing.
Reuter, Markus / Prof. Dr.

Competencies:

1. Simulation of reactor types
   - modelling and simulation of hydro- and pyrometallurgical reactors for primary and secondary resources and determination of mass and energy balances as well as minerals processing
   - determination of ecological and economic footprint of reactors

2. Modelling of processing flowsheets
   - develop processing flowsheets for non-ferrous metal containing resources
   - modelling and simulation of hydro- and pyrometallurgical processing plants for primary and secondary non-ferrous resources as well as minerals processing
   - determination of mass and energy balances of the complete flowsheet and determine optimal processing routes
   - determination of ecological and economic footprint of complete flowsheets

3. Methods and tools
   - use of simulation tools such as HSC Sim 9.0, FACTSAGE etc. and environmental software tools such as GaBi to evaluate different processing options
   - create process designs and communicate results to a client and/or stakeholders e.g. NGOs

Contents:

Reactors types in process metallurgy and minerals processing (e.g. TSL, Kaldo, flash smelting, QSL, flotation cells etc.) will be compared using simulation cases, evaluated and optimised for metal and minor metal recovery. The environmental footprint as also the economic performance of each reactor type will be compared with each other to establish best options for reactor flotation types as a function of feed types. The student will understand minerals processing and metallurgical reactor technology better and also be in a better position to create more sustainable industry and society.

Process design cases will be performed by the students to optimally process different feed types. By using a wider range of reactor types the student will be able to simulate complete flowsheets, provide mass and energy balances at the same time also determine the environmental footprint as well as economic analysis. This course will also examine the impact of product design on the recycling of various end-of-life products such as mobile phones etc. Thus, not only will natural resources be processed in the simulated systems but also materials from the “urban mine”. Therefore, this course will also use this rigorous simulation basis to critically discuss environmental legislation as well as communicate...
These results to all stakeholders.

The course takes place as a 2 week block course in September.

<table>
<thead>
<tr>
<th>Literature:</th>
<th></th>
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</thead>
</table>

| Types of Teaching: | S1 (SS): Block course / Lectures (1 SWS) |
|                   | S1 (SS): Block course / Seminar (2 SWS) |
|                   | S1 (SS): Block course / Practical Application (2 SWS) |

<table>
<thead>
<tr>
<th>Pre-requisites:</th>
<th>Recommendations:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic thermodynamic, thermodynamic and kinetic knowledge in process metallurgy</td>
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</tbody>
</table>

| Frequency: | yearly in the summer semester |

| Requirements for Credit Points: | For the award of credit points it is necessary to pass the module exam. The module exam contains: AP: Report of simulation The student should solve a case/example and hand in the computer file as a document. |

Voraussetzung für die Vergabe von Leistungspunkten ist das Bestehen der Modulprüfung. Die Modulprüfung umfasst: AP: Simulationsbeleg Der Student soll einen Fall/Beispiel lösen und die Computerdatei als Dokument einreichen. |

| Credit Points: | 6 |
| Grade: | The Grade is generated from the examination result(s) with the following weights (w):
|        | AP: Report of simulation [w: 1] |
| Workload: | The workload is 180h. It is the result of 75h attendance and 105h self-studies. |
# Training in Industry

**Module Name:** Training in Industry

**Responsible:** Bertau, Martin / Prof. Dr.

**Lecturer(s):** Beteiligte Hochschullehrer (involved lecturers)

**Institute(s):** Institute of Chemical Technology

**Duration:** 1 Semester(s)

**Competencies:** The student is able to:

- reflect critically on the experience gained.
- integrate and participate in the day-to-day-activities of the workplace.
- give a scientific account of the experience gained in the form of an oral presentation and a scientific report.
- analyse the workplace and the activities it undertakes within it’s economical, managerial or strategic context.

**Contents:** The student shall during 5 weeks (minimum) participate in a full-time internship, with an appointed supervisor within the host organization. The work/tasks during the internship must be clearly related to SINREM, and train the student in independent work and cooperation with others. Innovation and entrepreneurship in raw material and resource science are of major interest.

The student will be engaged in every-day working activities at a level corresponding to the final degree. During the training the student has to report to a mentor which is a teacher of the courses of the program (should be elected in advance, two reports are needed). Further a oral presentation will be given at the end of the training in front of the group of respective teacher. Upon completion of the internship, the student will write a report. In the report students will pay attention not only to the practical work they performed but also to methodology, results, managerial, economical and strategic aspects of the internship and workplace.

Course introduction takes place at the university, while supervision is undertaken at the internship location.

**Literature:** not available

**Types of Teaching:**

- S1: Practical Application as block course (7 SWS) / Practical Application (7 SWS)

**Pre-requisites:**

**Recommendations:**

Completed first year of studies in the Master program for sustainable development

**Frequency:** constantly

**Requirements for Credit Points:**

For the award of credit points it is necessary to pass the module exam. The module exam contains:

- PVL: Continuous written reports
- AP*: Final Report
- AP*: Presentation

PVL have to be satisfied before the examination.

* In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively.

Voraussetzung für die Vergabe von Leistungspunkten ist das Bestehen
der Modulprüfung. Die Modulprüfung umfasst:
PVL: Kontinuierliche schriftliche Berichte
AP*: Abschlussbericht
AP*: Präsentation
PVL müssen vor Prüfungsantritt erfüllt sein bzw. nachgewiesen werden.
* Bei Modulen mit mehreren Prüfungsleistungen muss diese
Prüfungsleistung bestanden bzw. mit mindestens "ausreichend" (4,0)
bewertet sein.

<table>
<thead>
<tr>
<th>Credit Points:</th>
<th>10</th>
</tr>
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</table>
| Grade:         | The Grade is generated from the examination result(s) with the following weights (w):
|                | AP*: Final Report [w: 1]  
|                | AP*: Presentation [w: 1]   |
|                | * In modules requiring more than one exam, this exam has to be passed or completed with at least "ausreichend" (4,0), respectively. |
| Workload:      | The workload is 300h. It is the result of 105h attendance and 195h self-studies. |

Freiberg, den 15. April 2019

gez.
Prof. Dr. Klaus-Dieter Barbknecht
Rektor