# Hochschule Nordhausen

## Fachbereich Ingenieurwissenschaften

### Modulhandbuch für den Studiengang

Environmental and Recycling Technology

Erstellungsdatum: 03.12.2024

# Modulübersicht für den Studiengang Environmental and Recycling Technology

| 0. Fachsemester | | | | |
|---|---|---|---|---|
| **ID** | **Modulname** | **Version** | **ECTS** | **Verwendbarkeit** |
| 747 | Introduction in Environmental and Recycling Technology | 1 | 5.0 | PFLICHT |
| 870 | Basics in Electrical Engineering | 2 | 5.0 | PFLICHT |
| 871 | Basics in Thermal Engineering | 2 | 5.0 | PFLICHT |
| 873 | Scientific Practice and Writing | 1 | 5.0 | PFLICHT |
| 908 | German as a Foreign Language I | 2 | 5.0 | PROFIL |
| 912 | Technical English I | 1 | 5.0 | PROFIL |
| 1012 | Basics of Mechanical Engineering | 1 | 5.0 | PFLICHT |
| **1. Fachsemester** | | | | |
| **ID** | **Modulname** | **Version** | **ECTS** | **Verwendbarkeit** |
| 568 | Project Management | 1 | 5.0 | PFLICHT |
| 731 | Proseminar / Soft Skills | 1 | 5.0 | PFLICHT |
| 732 | Lifecycle Assessment | 1 | 5.0 | PFLICHT |
| 733 | Environmental and Sustainability Management | 1 | 5.0 | PFLICHT |
| 734 | Environmental Law | 1 | 5.0 | PFLICHT |
| 910 | German as a Foreign Language II | 2 | 5.0 | PROFIL |
| 914 | Technical English II | 1 | 5.0 | PROFIL |
| **2. Fachsemester** | | | | |
| **ID** | **Modulname** | **Version** | **ECTS** | **Verwendbarkeit** |
| 735 | (ET) Environ. Poll. and Chemistry Asp. | 1 | 5.0 | PROFIL |
| 736 | (ET) Wastewater Engineering | 1 | 5.0 | PROFIL |
| 737 | (ET) Plant Planning for ET | 1 | 5.0 | PROFIL |
| 738 | (ET) Renewable Raw Material | 1 | 5.0 | PROFIL |
| 739 | (RT) Urban Mining / Circular Economy | 1 | 5.0 | PROFIL |
| 740 | (RT) Recycling Technologies of Anthropogenic Material Flows | 1 | 5.0 | PROFIL |
| 742 | (RT) Preparation of Energy Raw Materials and Recovery | 1 | 5.0 | PROFIL |
| 743 | (RT) Plant Planning for RT | 1 | 5.0 | PROFIL |
| 744 | (RT) Future Technologies of Recycling Practice | 1 | 5.0 | PROFIL |
| 864 | (ET) Bioengineering | 1 | 5.0 | PROFIL |
| 1024 | IT-Service Management | 1 | 5.0 | WAHLPFLICHT |
| 8000 | Study success and career progression | 1 | 5.0 | WAHLPFLICHT |
| **3. Fachsemester** | | | | |
| **ID** | **Modulname** | **Version** | **ECTS** | **Verwendbarkeit** |
| 941 | Master Thesis and Colloquium ERT | 1 | 30.0 | PFLICHT |

| Modul-No. | 568 | MA | |
|---|---|---|---|
| **Modul name** | **Project Management** | | |
| Modul coordinator | Rutz, Michael | | |
| Title | Project Management | | |
| Title of examination | Project Management | | |
| Course Type / SWS | 3 SWS Lecture / 1 SWS Exercise | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**
1 Basics
• definition and characteristics of projects • short history of Project Management • Project Life Cycle
2 Initialisation
• project goals • Stakeholder Analysis • rough planning • Project Organisation
3 Planning
• Project Structuring • Time Management • Resource Planning
4 Execution
• role of Project Manager and Project Team • Team Development • Project Management • Communication • Risk Management • Quality Management
5 Project Closing
6 Agile Project Management
• advantages of agile methods • Scrum

**Learning objectives:** Students are able to plan projects and organise their implementation. They have learned the basics of project management for industrial applications. They have an overview of selected methods, tools (software) and information systems for planning and controlling industrial projects. The students are able to plan, organise and document a project with the help of a project example. They are able to present the project idea, the progress and the results.

**Recommended Literature**

Dionisio, Cynthia Snyder (2018): A project manager´s book of tools and techniques. a companion to the PMBOK Gui-de. Hoboken, New Jersey: Wiley.
Lester, Albert (2014): Project Management, planning and control. Managing Engineering, Construction and Manufac-turing Projects to PMI, APM and BSI Standards. 6. Aufl. Oxford: Butterworth-Heinemann.
Project Management Institute, Inc. (2021): A Guide to the Project Management Body of Knowledge (PMBOK Guide) and The Standard for Project Management. 7. Aufl.

**Forms of teaching / Prerequisites for participation**

This module is a classical lecture combined with exercises. There are no formal requirements for participation.

**Usability of module**

This module is mandatory for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

no formal requirements

**ECTS credit points and grading**

Students need to pass the module examination, which encompasses all contents of the lecture. Type of examination: written examination with a duration of 120 min. Alternative types of examination are possible The grade corresponds to the grading of the written examination or the submitted project documentation. When com-pleting the unit successfully, students are granted 5 credit points (ECTS).

**Frequency of offer / Duration of module**

| | |
|---|---|
| SOMMER | The module is lectured in one semester. |

**Work load**

The total workload for this module is 150 hours; this corresponds to 5 ECTS credits. This workload results from the presence at the lectures with with integrated exercises (about 45 hours). As part of the self-study, the lecture material should be reworked (about 55 hours). The preparation and execution of the examination is about 50 hours.

| Modul-No. | 731 | MA | |
|---|---|---|---|
| **Modul name** | **Proseminar / Soft Skills** | | |
| Modul coordinator | Rutz, Michael | | |
| Title | Proseminar / Soft Skills | | |
| Title of examination | Proseminar / Soft Skills | | |
| Course Type / SWS | 1 SWS Lecture / 1 SWS Exercise / 2 SWS Project work | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**
The students will work on a specific project in the field of Environmental and Recycling Technology. For that purpose, different projects will be offered and the students will be allocated to a project team. Each project can be organised in-dividually based on topic, framework, supervisor,... containing timeslots for self-study, group activities and consulta-tions with supervisor.
The realistic up-to-date cooperation projects are taken from companies, institutions or own research topics. Following the rules of scientific practice a project report has to be submitted (20 pages each project) and the results has to be presented.
During the semester additional lectures will focus on Soft skills e. g. concerning how to develop a topic, how to prepare a presentation and how to work in a team.

**Learning objectives:**
The main objective is to work on a project close to realistic conditions (working environment). To learn and apply spe-cific knowledge in the different fields of Environmental and Recycling Technology helps to find an adequate speciali-sation for the 2nd semester. Furthermore scientific working skills should be trained.

**Recommended Literature**


1. Owen, J.: The leadership skills handbook : 100 essential skills you need to be a leader, London New York : Kogan Page, 2021. ISBN: 9781789666694, 1789666686.
2. Cowher, S.; Dickson, L. Effective planning strategies and proposal writing : a workbook for helping professi-onals, Lanham, Maryland : University Press of America, 2010, ISBN: 0761849777, 9780761849773.
3. Šeďová, Klára: Getting Dialogic Teaching into Classrooms : Making Change Possible, Singapore : Springer Singapore 2020, ISBN: 9789811592430.
4. Franck, Norbert: Schlüsselkompetenzen für den Beruf: professionell Schreiben und Reden, Präsentieren und Moderieren; Paderborn : Ferdinand Schöningh ; Stuttgart : UTB GmbH, 2020,ISBN: 9783825253974.


**Forms of teaching / Prerequisites for participation**

The module consists of a lecture and individual project work.

There are no formal requirements for participation.

**Usability of module**

This module is mandatory for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Students need to pass the module examination, which encompasses all contents of the lecture.

**ECTS credit points and grading**

alternative examination performance: paper / weighting 50% + final presentation / weighting 25% + consultation, presentation, motivation during semester / weighting 25 % Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS (European Credit Transfer and Accumulation System).

**Frequency of offer / Duration of module**

| | |
|---|---|
| SOMMER | The module is lectured in one semester. |

| **Work load** |
| --- |
| Course Participation = 20 h<br>Preparation and follow-up (of the lecture) = 20 h<br>Preparation for examination = 110 h<br>The entire workload encompasses 150 hours, which equals 5 ECTS credit points. |

| Modul-No. | 732 | MA | |
|---|---|---|---|
| **Modul name** | **Lifecycle Assessment** | | |
| Modul coordinator | Voswinckel, Sebastian | | |
| Title | Lifecycle Assessment | | |
| Title of examination | Lifecycle Assessment | | |
| Course Type / SWS | 2 SWS Lecture / 2 SWS Lecture/Exercise | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**
In order to approach the subject of energy, substance and environmental assessments, knowledge of the associated relationships (politics, economy, society) is necessary. It is not the raw calculation of balances, but the consideration of the correct description of the problem. In this context the setting of system boundaries is important too. In workshops, each lasting 4 hours, students will learn to recognize problems in teams and to provide solutions with the help of assessment tools (knowledge based and software).

1. Recognizing and evaluating environmental issues in the media – workshop
2. Introduction to material flows - workshop
3. Consideration and definition of boundaries - workshop
4. Energy/Substance/Environment assessments - workshop
5. Human-Environment-Future - Workshop to select the examination topic based on current environmental issues

**Learning objectives:**
Students will be able to recognize environmental connections in texts that do not seem to be related to environmental issues (unit 1).
After the unit 2, students will be able to recognize, classify and evaluate material flows.
Establishing system boundaries is a basic requirement for every life cycle assessment. After the workshop 3, students will know how to set system boundaries correctly.
After the workshop 4, students will be able to create the relevant assessment sheets and read data from sheets that have already been created. Students also got an insight into software for creating these assessments.
After the workshop 5 students have to choose a topic for your scientific work and explained it to the person responsible for the module.

**Recommended Literature**

For preparation the following international/national standards and scientific books are recommended:

- ISO 14001 Environmental management systems — Requirements with guidance for use
- ISO 14040 Environmental management – Life cycle assessment – Principles and Framework
- ISO 14041 Goal and Scope definition and inventory analysis
- ISO 14042: Environmental management — Life cycle assessment — Life cycle impact assessment
- ISO 14043 Environmental management — Life cycle assessment — Life cycle interpretation
- ISO 14044 Environmental management – Life cycle assessment – Requirements and Guidelines
- DIN EN ISO 14040 Umweltmanagement – Ökobilanz – Grundsätze und Rahmenbedingungen
- DIN EN ISO 14044 Umweltmanagement – Ökobilanz – Anforderungen und Anleitungen
- Klöpffer, W.; Grahl, B.: Ökobilanz (LCA): Ein Leitfaden für Ausbildung und Beruf, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2009, Print ISBN:9783527320431 |Online ISBN:9783527627158
- Frischknecht, R.: Lehrbuch der Ökobilanzierung, Springer Spektrum, 2020.
- Klöpffer, W., Grahl, B.: Ökobilanz (LCA), Wiley-VCH, 2019.

**Forms of teaching / Prerequisites for participation**

Workshop with Lecture.

There are no formal requirements for participation.

**Usability of module**

| |
|---|
| This module is mandatory for: Environmental and Recycling Technology |
| **Requirements for receiving ECTS credit points** |
| Students need to pass the module examination, which encompasses all contents of the lecture. Type of examination written scientific report (10 pages) and Power Point Presentation (15 minutes + 5 minutes Q&A). |
| **ECTS credit points and grading** |
| Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS (European Credit Transfer and Accumulation System). |
| **Frequency of offer / Duration of module** |

| | |
|---|---|
| SOMMER | The module is held within one semester. |

| |
|---|
| **Work load** |
| Course Participation = 20 h<br>Preparation and follow-up (of the lecture) = 20 h<br>Preparation for examination = 110 h<br>The entire workload encompasses 150 hours, which equals 5 ECTS credit points. |

| Modul-No. | 733 | MA | |
|---|---|---|---|
| **Modul name** | **Environmental and Sustainability Management** | | |
| Modul coordinator | Samtleben, Jantje | | |
| Title | Environmental and Sustainability Man. | | |
| Title of examination | Environmental and Sustainability Management | | |
| Course Type / SWS | 4 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**

- Strategic instruments of environmental management
- Organization and environmental protection
- Assessment of environmental protection investments
- Operational issues of environmental management
- Environmental management systems and environmental audit
- Sustainability accounting
- Material flow analyzes
- Procedure for evaluating ecological and social impacts: selected approaches in ecological and sustainability accounting
- Environmental cost management
- Environmental controlling

**Learning objectives:**

Students are able to classify, apply and evaluate approaches to sustainability accounting. They are familiar with not monetary methods of ecological and sustainability accounting and are familiar with the documentation and analysis of environmental costs. They also know how to position strategic product programs, taking ecological and social aspects into account. In operational environmental management, students have knowledge of models for environmentally oriented production planning, transport and route planning as well as warehouse planning and can use these in practice in the relevant decision-making areas. You will be able to set up appropriate optimization theorems and select suitable solution methods or heuristics. After completing the module, the students are also familiar with elements of certification in the environmental and sustainability area. The students develop technical and methodological as well as system and social skills.

**Recommended Literature**

For preparation and follow-up the following textbooks are recommended:


- Debnath, Somnath: Environmental Accounting, Sustainability and Accountability. Indien, SAGE Publications, 2019
- Handbook of Sustainability Management. Singapur, World Scientific, 2012
- Towards Life Cycle Sustainability Management. Niederlande, Springer Netherlands, 2011
- Brady, John, et al. Environmental Management in Organizations: The IEMA Handbook. Vereinigtes Königreich, Taylor & Francis, 2013
- Wang, L.: Handbook of Environmental Engineering: Integrated Natural Resources Management, Springer, 2021
- Azapagic, A.; Perdan, S. (Hrsg.): Sustainable Development in Practice. Case Studies for Engineers and Scientists, John Wiley & Sons, Ltd., 2011, Print ISBN:9780470718711 |Online ISBN:9780470972847
- Kurth; Oexle, Handbook of Recycling and Raw Materials Management, 2013
- Sailer, Ulrich: Nachhaltigkeitscontrolling, 3. Auflage Stuttgart UTB GmbH, 2020, : 978-3-8252-5332-5
- Müller-Christ, Georg: Nachhaltiges Management: über den Umgang mit Ressourcenorientierung und widersprüchlichen Managementrationalitäten, Handbuch für Studium und Praxis, 3. Auflage, Baden-Baden, Nomos, 2020, ISBN 978-3-8487-4956-0
- Engelfried, Justus: Nachhaltiges Umweltmanagement Schritt für Schritt, Uni-Taschenbücher-GmbH, 2017, ISBN 978-3-8385-8671-7


**Forms of teaching / Prerequisites for participation**

Lecture

There are no formal requirements for participation.

| **Usability of module** | |
|---|---|
| This module is mandatory for: Environmental and Recycling Technology | |
| **Requirements for receiving ECTS credit points** | |
| Students need to pass the module examination, which encompasses all contents of the lecture. Type of examination: written examination with a duration of 90 min. Alternative types of examination are possible. | |
| **ECTS credit points and grading** | |
| Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS | |
| **Frequency of offer / Duration of module** | |
| SOMMER | The module is held within one semester. |
| **Work load** | |
| Course Participation = 50 h<br>Preparation and follow-up (of the lecture) = 55 h<br>Preparation for examination = 45 h<br>The entire workload encompasses 150 hours, which equals 5 ECTS credit points. | |

| Modul-No. | 734 | MA | |
|---|---|---|---|
| **Modul name** | **Environmental Law** | | |
| Modul coordinator | Rutz, Michael | | |
| Title | Environmental Law | | |
| Title of examination | Environmental Law | | |
| Course Type / SWS | 4 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**
The lecture first presents the general principles of European and German environmental law, in particular the basic principles and instruments of environmental law. Then the most important areas of special environmental law are dealt with, in particular emission control law, recycling law, water protection law, nature conservation law and soil protection law. In the context of special environmental law, the structure and functioning of modern environmental laws and the application of the legal text to simple cases are also dealt with. The lecture deals with essential legal norms for the re-cycling industry. Based on the requirements of EU law, the basics of German recycling law on waste avoidance, waste recycling and waste disposal as well as the legal waste disposal obligations are presented. The circular econo-my regulations for special material flows, in particular packaging, electrical and electronic equipment, vehicles, batter-ies, PCB, waste oil, waste wood, sewage sludge and biowaste are presented in more detail.

**Learning objectives:**
Students acquire in-depth knowledge of environmental law with a national and international focus.
Legal framework of the recycling industry: The students can classify environmental law and recycling law in the goals of a sustainable economic order. The students have an overview of general and specific environmental law, which is fragmented through various laws. The students can explain the general basic terms and principles as well as the pub-lic-law instruments of environmental law and the structure of modern environmental laws as well as the main features of important laws of special environmental law. In the circular economy law, they can describe the multi-level system of Union, federal and state regulations. Under German law, they can explain to waste management facilities the ba-sics concept of waste, the waste hierarchy and the legal waste transfer obligations and the monitoring and reporting obligations and requirements. In addition, the students can identify the requirements and special problems of individual material flows such as packaging, electrical and electronic equipment, batteries or sewage sludge. With this knowledge the students are able to solve simple legal questions from the recycling industry. They can also identify po-tential legal problems and discuss them with internal or external contacts. They understand the underlying objectives, evaluations and conflicts of interest of the regulations. Environmental law: In the area of special environmental law, the students can describe the basics of the most important laws (in particular pollution control law; recycling law; water protection law; nature protection law; soil protection law; nuclear and radiation protection law). With this knowledge, the students are able to assess simple environmental law issues and present their position to lawyers and laypeople. In addition, the students got to know the relevance of conflicting objectives of the legal system, which is characterized by the balance between economy and ecology.

**Recommended Literature**

For preparation and follow-up the following textbooks are recommended:
Legal text: KrWG (Recycling Management Act), dtv, latest edition Legal text: Environmental law, important laws and regulations for the protection of the environment, Beck texts in dtv, latest edition
Erbguth / Schlacke, Umweltrecht, ISBN-13: 978-3848728855, latest edition (currently 6th edition 2016)

A list of further literature will be given out in the lectures.

**Forms of teaching / Prerequisites for participation**

This module is a classical lecture.

There are no formal requirements for participation.

**Usability of module**

This module is mandatory for: Environmental and Recycling Technology

| **Requirements for receiving ECTS credit points** | |
|---|---|
| Students need to pass the module examination, which encompasses all contents of the lecture.<br>Type of examination: written examination with a duration of 90 min. Alternative types of examination are possi-ble. | |
| **ECTS credit points and grading** | |
| Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS. | |
| **Frequency of offer / Duration of module** | |
| SOMMER | The module is lectured in one semester. |
| **Work load** | |
| Course Participation = 50 h<br>Preparation and follow-up (of the lecture) = 55 h<br>Preparation for examination = 45 h<br>The entire workload encompasses 150 hours, which equals 5 ECTS credit points. | |

| Modul-No. | 735 | MA | |
|---|---|---|---|
| **Modul name** | **(ET) Environ. Poll. and Chemistry Asp.** | | |
| Modul coordinator | Hauschild, Petra | | |
| Title | (ET) Environ. Poll. and Chemistry Asp. | | |
| Title of examination | (ET) Environ. Poll. and Chemistry Asp. | | |
| Course Type / SWS | 4 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**

- environmental chemistry / environmental toxicology – overview
  - toxicological assessment
  - transport of pollutants
  - air pollution and atmospheric chemistry
  - water / groundwater, contamination and remediation
  - soil and sediments, contamination and remediation
  - pollutants in buildings and remediation

- pollutants and their effects, including persistent and water pollutant substances, cycle and lifetime of substances ecologic systems
  - inorganic pollutants
  - organic pollutants

- special toxicological effects and analysis
- diversity of environmental chemicals in ground- and surface waters, sediments and soils – especially in industrial regions
- important environmental pollutants in soil, water and air and their effects
- production residues and undesired byproducts in conversion- and degradation products
- properties, effects and detection of environmentally relevant pollutants like ozone, nitrogen and sulfur compounds, organic substances and heavy metals in the environment (air, water and earth)
- toxicological aspects
- detection reactions for selected pollutants

**Learning objectives:**

Students acquire in-depth knowledge in Environmental chemistry. In addition to scientific and engineering know-ledges which reflect the toxicological aspects, historical up-to-date engineering processes. In this way students are enabled, to recognize and evaluate application possibilities.

**Recommended Literature**


- Reh, F.: Environmental Chemistry, Chemistry of Major Envrionmental Cycles, 2005
- Paasivirta, Handbook of Environmental Chemistry, 3rd Edition
- Ortega-Calvo, Parsons: Bioavailability of Organic Chemicals in Soil and Sediment, Springer, 2018
- Jolliet, Saade-Sbeih et a.: Environmental Life Cycle Assessment, CRC Press 2016
- ASCE, Water Treatment Plant Design, 5 th Ed.
- Handbook Environmental Analysis, Patnaik, ISBN 978-1315151946, CRC press
- Neumaier, Weber: Altlasten: Erkennen, Bewerten, Sanieren, Springer Verlag; ISBN-13: 978-3642648311
- Paasivirta: New Types of Persistent Halogenated Compounds (The Handbook of Environmental Chemistry), Springer Verlag, ISBN-13: 978-3642085123,
- Fent: Ökotoxikologie (Umweltchemie-Toxikologie-Ökologie), Thieme-Verlag, ISBN -9783131099945


**Forms of teaching / Prerequisites for participation**

Lecture

Principles of chemistry and process engineering.

| **Usability of module** | |
|---|---|
| This module is a profile module for: Environmental and Recycling Technology | |
| **Requirements for receiving ECTS credit points** | |
| The module examination encompasses all contents of the lecture.<br>Exam: Written exam with a duration of 120 min. Alternative forms of exams are possible. | |
| **ECTS credit points and grading** | |
| Modules are assessed by a module examination which is credited by 5 credit points according to the ECTS. | |
| **Frequency of offer / Duration of module** | |
| WINTER | The module is held within one semester. |
| **Work load** | |
| - course participation = 50 h<br>- preparing and following-up of the lecture contents = 45 h<br>- exam preparation = 40h<br>- preparation for practical training =15 h<br>Total workload 150 h = 5 ECTS | |

| Modul-No. | 736 | MA | |
|---|---|---|---|
| **Modul name** | **(ET) Wastewater Engineering** | | |
| Modul coordinator | Breuer, Uta | | |
| Title | (ET) Wastewater Engineering | | |
| Title of examination | (ET) Wastewater Engineering | | |
| Course Type / SWS | 4 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**

- Introduction: history and technological changes for wastewater as a source of energy, nutrients, and potable water
- Legal foundations, including more stringent discharge requirements related to nitrogen and phosphorus
- Enhanced understanding of the fundamental microbiology and physiology of the microorganisms responsible for the removal of nitrogen and phosphorus and other constituents
- Bioprocess Engineering: aggregates, measurement, and regulation technology, plant design
- Increased emphasis on the treatment of sludge and the management of biosolids
- Development of energy neutral or energy positive wastewater plants through more efficient use of chemical and heat energy in wastewater

**Learning objectives:**

Students acquire in-depth knowledge in wastewater technology and engineering with microbial and biochemical as well as engineering focus.
In addition to scientific and engineering knowledges which reflect the link between microbial performance and technical implementation, historical and up-to-date engineering processes are shown especially considering the economically and ecologically feasibility. In this way students are enabled, to recognize and evaluate application possibilities and limits of wastewater engineering.

**Recommended Literature**

For preparation and following-up the following textbooks are suitable:

- Colin Ed. Ratledge and Björn Kristiansen, Basic Biotechnology, Cambridge University, 3rd ed. 2006, ISBN13: 9780521549585
- Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl: Brock Biology of Microorganisms, Pearson Education, 15th ed. 2017, ISBN 978-0134261928
- Metcalf & Eddy Inc., George Tchobanoglous, Franklin L. Burton, Ryujiro Tsuchihashi: Wastewater Engineer-ing: Treatment and Resource Recovery, McGraw-Hill Education - Europe; 5. Edition 2013, ISBN-10: 9780073401188
- Lattemann, S.; Kennedy, M. D.; Schippers, J.; Amy, G.: Global Desalination Situation. In. Elsevier, Amster-dam, 2016.
- World Bank: High and Dry: Climate Change, Water, and the Economy. World Bank Group, Washington, DC, USA, 2016.

Further literature will be announced during the lectures.

**Forms of teaching / Prerequisites for participation**

Lecture

Knowledge and abilities which are demonstrated in lectures as bioenergy or biogas as well as microbiology or bioengineering.

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Students need to pass a module examination, which encompasses all contents of the lecture. Exam: Written exam with a duration of 120 min. Alternative forms of exam are possible.

**ECTS credit points and grading**

| | |
|---|---|
| Modules are assessed by a module examination which is credited by 5 credit points according to the ECTS | |
| **Frequency of offer / Duration of module** | |
| WINTER | The module is held within one semester. |
| **Work load** | |
| course participation = 50 h<br>preparing and following-up of the lecture contents = 55 h<br>exam preparation = 45 h<br>Total workload 150 h = 5 ECTS | |

| Modul-No. | 737 | MA | |
|---|---|---|---|
| **Modul name** | **(ET) Plant Planning for ET** | | |
| Modul coordinator | Rutz, Michael | | |
| Title | (ET) Plant Planning for ET | | |
| Title of examination | (ET) Plant Planning for ET | | |
| Course Type / SWS | 1 SWS Exercise / 2 SWS Lecture / 1 SWS Project work | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

## Content and objectives

**Content:**
This module consists of a lecture and individual project work. During the semester the lecture will focus on Plant Plan-ning providing principles of planning and projecting environmental and recycling systems. Based on the basic project organization, the approach and methodology of the individual project phases will be introduced. Afterwards the prelim-inary project, basic engineering, detailed engineering as well as assembly and commissioning have to be realised. Fur-ther training will occur with the help of examples as a part of the lecture.
From the beginning of the semester the students will work on a specific project in the field of Environmental Technol-ogy. For that purpose, different projects will be offered and the students will be allocated to a project team. Each pro-ject can be organised individually based on topic, framework, supervisor,... containing timeslots for self-study, group activities and consultations with supervisor or external partners. After an adequate time the students of each project group should focus more and more on specific topics of their project (division of labour).
The realistic up-to-date cooperation projects are taken from companies, institutions or own research topics. Following the rules of scientific practice a project report has to be submitted by every student and the results has to be present-ed. The design or upscaling of selected system components (e.g. for waste water treatment, solid-liquid-separation, dedusting, supporting components,...) or the planning of complete systems should be part of the project.

**Learning objectives:**
The main objective is to work on an advanced project close to realistic conditions (working environment). To learn and apply specific knowledge in the different fields of Environmental Technology helps to develop or to focus on an ade-quate topic for Master Thesis in 3rd semester. Furthermore scientific working skills should be trained. Students are able to plan and design environmental systems and organize their implementation. The students have knowledge of project organization and the implementation of individual project phases and are able to apply this to specific projects. They can use planning software and special tools. They are able to present the design, the progress and the results.

## Recommended Literature


1. Gupta, A., Yan, D.S.: Mineral Processing Design and Operation, Elsevier 2006.
2. Pahl, G.; Beitz, W.; Feldhusen, J., Grote, K.: Engineering Design: A Systematic Approach, Springer, 2006. ISBN: 1846283183
3. Weber, K.: Engineering verfahrenstechnischer Anlagen, Praxishandbuch mit Checklisten und Beispielen, Springer 2016; ISBN 978-3-662-52897-6
4. Bernecker, G.: Planung und Bau verfahrenstechnischer Anlagen Projektmanagement und Fachplanungs-funktionen, Springer 4. Auflage 2012; ISBN-13: 9783642626111
5. Ripperger, S., Nikolaus, K.: Entwicklung und Planung verfahrenstechnischer Anlagen, Springer 2020; ISBN 978-3-662-60427-4


## Forms of teaching / Prerequisites for participation

The module consists of a lecture and individual project work.

There are no formal requirements for participation. Students should pass the examinations of M568 Project Management and M731 Proseminar / Softskills.

## Usability of module

This module is a profile module for: Environmental and Recycling Technology

| **Requirements for receiving ECTS credit points** | |
|---|---|
| Students need to pass the module examination, which encompasses all contents of the lecture. alternative examination performance: paper / weighting 50% + final presentation / weighting 25% + consultation, presentation, motivation during semester / weighting 25 % | |
| **ECTS credit points and grading** | |
| Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS. | |
| **Frequency of offer / Duration of module** | |
| WINTER | The module is lectured in one semester. |
| **Work load** | |
| Participation in the course = 20 h<br>Preparation and follow-up (of the lecture) = 20 h<br>Preparation for examination = 110 h<br>The entire workload encompasses 150 hours, which equals 5 ECTS credit points. | |

| Modul-No. | 738 | MA | |
|---|---|---|---|
| **Modul name** | **(ET) Renewable Raw Material** | | |
| Modul coordinator | Schreiber, Anja | | |
| Title | (ET) Renewable Raw Material | | |
| Title of examination | (ET) Renewable Raw Material | | |
| Course Type / SWS | 4 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**

**Various types of renewable materials**

Students are given a comprehensive picture of the various types of renewable raw materials. In addition to the subdivision of renewable raw materials into divergent groups – for example wood, annual plants - the occurrence, cultivation and harvest of selected materials should also be subject of the course.

**Use of renewable raw materials**

Students are introduced to the various areas of application and limits of renewable raw materials. Selected products made from renewable raw materials are explained and the process engineering for their production will be examined.
The module also deals with the Kassadian modelling use of renewable raw materials and their recyclability.

**Energetic utilization of renewable raw materials**

Students learn about the various energetic utilization possibilities of renewable raw materials. The types of process engineering for energy generation are demonstrated.

**Learning objectives:**

Students acquire in-depth knowledge in renewable materials. In addition to scientific and engineering knowledges which reflect the link between renewable materials and technical implementation, historical and up-to-date engineering processes are shown especially considering the economically and ecologically feasibility. In this way the students are enabled, to recognize and evaluate application possibilities and limits of using renewable materials.

**Recommended Literature**

For preparation and follow-up the following textbooks are recommended:


- Forest Products Laboratory. 2010. Wood handbook—Wood as an engineering material. General Technical Report FPL-GTR-190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 508 p.
- Wellmer, F.W.; Buchholz, P.; Gutzmer, J.; Hagelüken, C.; Herzig, P.; Littke, R.; Thauer, R.K. (2019): Raw Materials for Future Energy Supply. Springer International Publishing, 225 S.
- Imhof P.; van der Waal J-K.; van der Waal J.C. (2013): Catalytic Process Development for Renewable Materials. Wiley VCH Verlag GmbH, Weinheim
- Ulber, R.; Sell, D.; Hirth T. (2011): Renewable Raw Materials - New Feedstocks for the Chemical Industry. Wiley VCH Verlag GmbH, Weinheim, 230 S.
- Deng, L.; Liu, Y.; Wang, W.: Biogas Technology. Springer Verlag, 2020, ISBN 978-981-15-4940-3
- Jayasinghe, G. Y. ; Dassanayake, K. B.; Wijesinghe, D. T. N: Organic waste anaerobic digestion. Lambert Academic Publishing, 2015, ISBN 365-939-60-60
- Lamb, L. J.: Anaerobic Digestion: From Biomass to Biogas. Sico Publishing, 2020, ISBN 9788269203318
- Kaltschmitt, M.; Hartmann,H. ; Hofbauer, H. (2016): Energie aus Biomasse - Grundlagen, Techniken und Verfahren. Springer Vieweg, Berlin, 2016.
- Diepenbrock, W.: Nachwachsende Rohstoffe. Utb GmbH, 2014.


**Forms of teaching / Prerequisites for participation**

Lecture

There are no formal requirements for participation.

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

| **Requirements for receiving ECTS credit points** | |
|---|---|
| Students need to pass the module examination, which encompasses all contents of the lecture. Type of examination: written examination with a duration of 90 min. Alternative types of examination are possible. | |
| **ECTS credit points and grading** | |
| Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS. | |
| **Frequency of offer / Duration of module** | |
| WINTER | The module is held within one semester. |
| **Work load** | |
| Participation in the course = 50 h<br>Preparation and follow-up (of the lecture) = 55 h<br>Preparation for examination = 45 h<br>The entire workload encompasses 150 hours, which equals 5 ECTS credit points. | |

| Modul-No. | 739 | MA | |
|---|---|---|---|
| **Modul name** | **(RT) Urban Mining / Circular Economy** | | |
| Modul coordinator | Schmidt, Sebastian | | |
| Title | (RT) Urban Mining / Circular Economy | | |
| Title of examination | (RT) Urban Mining / Circular Economy | | |
| Course Type / SWS | 4 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**

**Basics Urban Mining**

Urban mining - the city as a raw material store.

Identification of anthropogenic deposits and quantification of the secondary raw materials they contain. Value chain in urban mining. Economic feasibility studies against the background of the available technical recovery variants and the currently achievable and future forecast revenues. Economic processing and recovery of the identified recyclable materials as well as the integral management of anthropogenic deposits.

**Building materials recycling**

Materials cycles and material flow management in construction creation, processing (machine technology, plant types) and recycling of construction waste (asphalt, broken concrete, broken masonry, other types of construction waste) regulations for handling construction waste

**Learning objectives:**

In the further development of the circular economy, which focuses on the closure of material cycles, urban mining is a holistic approach that should be conveyed to the students.

There is a special focus on building materials.

**Recommended Literature**

For preparation and follow-up the following textbooks are recommended:

- Lacy, P.; Long, J. Spinder, W.: The Circular economy Handbook: Realizing the Circular; Palgrave Macmillan, 2020; ISBN 1349959677
- Worell, E.; Reuter, M. (ed.): Handbook of Recycling, Elsevier Inc., 2014.
- Förtsch, G.; Meinholz, H.: Handbook of operational circular economy, 2015
- Kurth, P.; Oexle,, A.; Faulstich, M.: Handbook of Recycling and Raw Materials Management, 2013, ISBN 978-3-658-17045-5
- GTOG: From production to recycling: a circular economy fort he European Gypsum Industry with the demolition and recycling industry. Report on production process parameters, 2015.
- McDonough, W.; Braungart, M.: Cradle to cradle: remaking the way we make things; London: Vintage Books, 2009; ISBN 978-0-09-953547-8
- Kranert, M.: Einführung in die Kreislaufwirtschaft: Planung-Recht-Verfahren; 5. Auflage Wiesbaden, Springer Vieweg, 2017; ISBN 3-8348-1837-2 und 978-3-8348-1837-9
- Oehlmann, C.: Vom Abfall als Problem zum Abfall als Ressource, Baden-Baden: Nomos Verlagsgesellschaft, 2017; Dissertation Uni Bremen 2016; 978-3-8452-8060-8
- Hillebrandt, A.; Riegler-Floors; Rosen, A.; Seggewies, J.: Atlas Recycling: Gebäude als Materialressource; München: Detail Business Information GmbH, 2018; ISBN 3-95553-415-4

**Forms of teaching / Prerequisites for participation**

Lecture

There are no formal requirements for participation.

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

| **Requirements for receiving ECTS credit points** | |
|---|---|
| Students need to pass the module examination, which encompasses all contents of the lecture. Type of examination: written examination with a duration of 90 min. Alternative types of examination are possible. | |
| **ECTS credit points and grading** | |
| Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS). | |
| **Frequency of offer / Duration of module** | |
| WINTER | The module is held within one semester. |
| **Work load** | |
| Course participation = 50 h<br>Preparation and follow-up (of the lecture) = 55 h<br>Preparation for examination = 45 h<br>The entire workload encompasses 150 hours, which equals 5 ECTS credit points. | |

| Modul-No. | 740 | MA | |
|---|---|---|---|
| **Modul name** | **(RT) Recycling Technologies of Anthropogenic Material Flows** | | |
| Modul coordinator | Rutz, Michael | | |
| Title | (RT) Recyc. Technol. of AMV | | |
| Title of examination | (RT) Recyc. Technol. of AMV | | |
| Course Type / SWS | 2 SWS Lecture / 2 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**

**Metal recycling**

1. Introduction to metal recycling
2. Recycling of iron and steel
3. Copper recycling
4. Zinc recycling
5. Lead recycling
6. Aluminum recycling
7. Magnesium recycling
8. Comparison of metal extraction processes with regard to energy requirements and emissions

**Plastic recycling**

9. Introduction to plastics, historical development
10. Overview of types of plastic, properties, processability and application of selected plastics
11. Methods of identifying plastics and plastics testing procedures
12. General overview of plastics recycling
13. Legal framework (European and national)
14. Possibilities of plastic recycling
15. Facts and figures
16. Plastics and waste management
17. Requirements for recycling
18. Overview of materials recycling
19. Quality by sorting
20. Recycling technologies
21. Recycling of mono-fraction plastics and mixed plastics
22. Plastic refinement and areas of application for recycled products

**Learning objectives:**

The objective for the students is to discuss the most important processes of metals and plastics recycling containing mechanical, chemical, pyro- and hydrometallurgical aspects. Diverse connections between the processing of primary and secondary resources will be figured out. They can evaluate known processes, assign individual material flows and define the required qualities of secondary raw materials to enable Circular Economy. The students mainly develop technical and system skills.

**Recommended Literature**


1. Worell, E.; Reuter, M. (ed.): Handbook of Recycling, Elsevier Inc., 2014. ISBN: 9780123964595
2. Ullmanns Encyclopedia of Industrial Chemistry. 6th ed. 2002, ISBN 978-3-527-30385-4.
3. Wills, B.A.; Napier-Munn, T.J.: Wills´Mineral Processing Technology, 7th edition, Elsevier Ltd., 2006.
4. Nienhaus, K., Pretz, T., Wotruba, H. (eds.): Sensor Technologies: Impulses for Raw Materials Industry; RWTH Aachen, Schriftenreihe zur Aufbereitung und Veredlung Nr. 50, Shaker Verlag, Aachen, 2014.
5. Letcher, T.; Vallero, D.: Waste: a handbook of management; London, Academic Press, 2019
6. Schmitz, Chr.: Handbook of Aluminium Recycling, 2. Auflage Vulkan Verlag, 2014.
7. Habashi, F.: Handbook of extractive metallurgy, Wiley-VCH, Weinheim, New York, 1997.
8. UNEP: Recycling Rates of Metals – A Status Report. http//www.unep.org/resourcepanel/Portals/24102/PDFs/Metals_Recycling_Rates_110412-1.pdf
9. UNEP 2013: Metal Recycling, www.unep.org/resourcepanel/Portals/24102/PDF.

10. Niaounakis, M.: Recycling of flexible plastic packaging, Oxford Cambridge, Plastics design library (PDL),PDL handbook series, 2020.
11. Vauck,W.R.A., Müller,H.A.: Grundoperationen chemischer Verfahrenstechnik. 11. Auflage 2003, ISBN 978-3527-30964-1.
12. Ditze, A.; Scharf, C.: Recycling of Magnesium, ISBN 978-3-89720-957-2.
13. Martens, H.; Goldmann, D.: Recyclingtechnik – Fachbuch für Lehre und Praxis, 2. Auflage, Springer Vieweg 2016, ISBN 3-658-02785-1
14. Smil, V.: Making the modern world; Chichester, West Sussex : Wiley, 2014, ISBN: 978-1-119-94253-5 pbk
15. Nickel, W.: Recycling-Handbuch, VDI-Verlag, Düsseldorf, 1996; ISBN 978-3-642-95769-7
16. Willeke, R.: Recycling: Fachbuch Stahlrecycling, Reed Elsevier, München-Gräfelfing, 1998
17. Krone, K.: Aluminiumrecycling, Verlag Vereinigung Deutscher Schmelzhütten, Düsseldorf, 2000
18. Schwarz, Otto: Kunststoffkunde; Vogel Verlag, Würzburg, 2015; ISBN 3-8023-1815-3
19. Baur, Brinkmann, Osswald, Schmachtenberg: Saechtling Kunststoff Taschenbuch; Hanser Verlag¸ 2013 31. Auflage; ISBN 978-3-446-43442-4

**Forms of teaching / Prerequisites for participation**

This module is a classical lecture with included Excursions.

There are no formal requirements for participation. Basics concerning chemistry and process engineering are recommended.

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Students need to pass the module examination, which encompasses all contents of the lecture.
Type of examination: written examination with a duration of 120 min. Alternative types of examination are pos-sible.

**ECTS credit points and grading**

Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS.

**Frequency of offer / Duration of module**

| | |
|---|---|
| WINTER | The module is lectured in one semester. |

**Work load**

Participation in the course = 50 h
Preparation and follow-up (of the lecture) = 55 h
Preparation for examination = 45 h
The entire workload encompasses 150 hours, which equals 5 ECTS credit points.

| Modul-No. | 742 | MA | |
|---|---|---|---|
| **Modul name** | **(RT) Preparation of Energy Raw Materials and Recovery** | | |
| Modul coordinator | Rutz, Michael | | |
| Title | (RT) Preparation of ERM and Recovery | | |
| Title of examination | (RT) Preparation of ERM and Recovery | | |
| Course Type / SWS | 3 SWS Lecture / 1 SWS Exercise | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**

- Energy potential of waste
- Waste incineration
- Treatment of residues from waste incineration
- Definition of "substitute fuel", "secondary fuel" or "substitute fuel"
- Mechanical processing of solid waste to produce secondary fuels or substitute fuels
- Function of secondary fuels or substitute fuels in industrial plants
- Systems for energy conversion (RDF mono power plants; biomass power plants)
- Systems for material formation (cement works)
- Quality assurance of secondary fuels or substitute fuels

**Learning objectives:**

The main objective of this module is to discuss important strategies to treat wastes in the context of using the energy / thermal potential (waste to energy). An overview about the most important waste streams for waste incineration and for the production of substitute fuels will be given. The process of waste incineration will be discussed as well as the processes to treat by-products and residues. Specific processes for the production of substitute fuels from waste will be introduced. The students should understand the challenge to manage waste in the stress field between recycling and thermal treatment in a global context.

**Recommended Literature**


1. Worell, E.; Reuter, M. (ed.): Handbook of Recycling, Elsevier Inc., 2014.
2. Letcher, T.; Vallero, D.: Waste: a handbook of management; London, Academic Press, 2019
3. Ministry of Environment and Forrest and Climate Change, MoEFCC: Solid waste Management Rules 2016, April 8th 2016.
4. Ministry of Housing and Urban Development (MoUD), Central Public Health & Environmental Engineering Organisation (CPHEEO): Municipal Solid Waste Management Manual (MSWMM), 2016.
5. Martens, H.; Goldmann, D.: Recyclingtechnik – Fachbuch für Lehre und Praxis, 2. Auflage, Springer Vieweg 2016, ISBN 3-658-02785-1
6. Nagel, J.: Nachhaltige Verfahrenstechnik; Hanser Verlag, 2015
7. Bilitewski, B., : Abfallwirtschaft. Handbuch für die Praxis. Springer, 2013
8. Grech, H.: Ersatzbrennstoffe und das Abfallende Praxisleitfaden zur Umsetzung der Abfallverbrennungsver-ordnung; ISBN 9783854022893
9. Kranert, M.: Einführung in die Abfallwirtschaft; Vieweg und Teubner-Verlag, 2010
10. Thome-Kozmiensky, K., Beckmann, M. Grundmann, J.: Ersatzbrennstoffe, Springer-VDI-Verlag, 2002


**Forms of teaching / Prerequisites for participation**

This module consists of a classical lecture combined with exercises.

There are no formal requirements for participation. Basic knowledge of Process Engineering and Thermodynamics are recommended.

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

| | |
|---|---|
| Students need to pass the module examination, which encompasses all contents of the lecture. Type of examination: written examination with a duration of 90 min. Alternative types of examination are possi-ble. | |
| **ECTS credit points and grading** | |
| Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS . | |
| **Frequency of offer / Duration of module** | |
| WINTER | The module is lectured in one semester. |
| **Work load** | |
| Participation in the course = 50 h<br>Preparation and follow-up (of the lecture) = 55 h<br>Preparation for examination = 45 h<br>The entire workload encompasses 150 hours, which equals 5 ECTS credit points. | |

| Modul-No. | 743 | MA | |
|---|---|---|---|
| **Modul name** | **(RT) Plant Planning for RT** | | |
| Modul coordinator | Rutz, Michael | | |
| Title | (RT) Plant Planning for RT | | |
| Title of examination | (RT) Plant Planning for RT | | |
| Course Type / SWS | 1 SWS Lecture / 1 SWS Exercise / 2 SWS Project work | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**
This module consists of a lecture and individual project work. During the semester the lecture will focus on Plant Plan-ning providing principles of planning and projecting environmental and recycling systems. Based on the basic project organization, the approach and methodology of the individual project phases will be introduced. Afterwards the prelim-inary project, basic engineering, detailed engineering as well as assembly and commissioning have to be realised. Further training will occur with the help of examples as a part of the lecture.
From the beginning of the semester the students will work on a specific project in the field of Recycling Technology. For that purpose, different projects will be offered and the students will be allocated to a project team. Each project can be organised individually based on topic, framework, supervisor,... containing timeslots for self-study, group activ-ities and consultations with supervisor or external partners. After an adequate time the students of each project group should focus more and more on specific topics of their project (division of labour).
The realistic up-to-date cooperation projects are taken from companies, institutions or own research topics. Following the rules of scientific practice a project report has to be submitted by every student and the results has to be present-ed. The design or upscaling of selected system components (e.g. for comminution, classification, sorting, supporting components,...) or the planning of complete systems should be part of the project.

**Learning objectives:**
The main objective is to work on an advanced project close to realistic conditions (working environment). To learn and apply specific knowledge in the different fields of Recycling Technology helps to develop or to focus on an adequate topic for Master Thesis in 3rd semester. Furthermore scientific working skills should be trained. Students are able to plan and design recycling systems and organize their implementation. The students have knowledge of project organi-zation and the implementation of individual project phases and are able to apply this to specific projects. They can use planning software and special tools. They are able to present the design, the progress and the results.

**Recommended Literature**


1. Gupta, A., Yan, D.S.: Mineral Processing Design and Operation, Elsevier München, 2006. ISBN: 0444635890, EAN: 9780444635891.
2. Pahl, G.; Beitz, W.; Feldhusen, J., Grote, K.: Engineering Design: A Systematic Approach, Springer, 2006. ISBN: 1846283183.
3. Worell, E.; Reuter, M. (ed.): Handbook of Recycling, Elsevier Inc., 2014. ISBN: 9780123964595 eBook ISBN: 9780123965066.
4. Claus, J. : Planung komplexer Abfallbehandlungsanlagen; Dissertation TU Berlin, 2002
5. Sattler, Kasper: Verfahrenstechnische Anlagen – Planung, Bau und Betrieb. Wiley-VCH, 2000
6. Bernecker, G.: Planung und Bau verfahrenstechnischer Anlagen; 3.Auflage; VDI-Verlag Düsseldorf; 1984
7. Höffl, K.: Zerkleinerungs- und Klassiermaschinen, Dt. Verlag für Grundstoffindustrie, Leipzig 1985
8. Schubert, H.: Handbuch der Mechanischen Verfahrenstechnik, Bd. 1+2,WILEY-VCH-Verlag, Weinheim 2003
9. Weber, K.: Engineering verfahrenstechnischer Anlagen, Praxishandbuch mit Checklisten und Beispielen, Springer 2016; ISBN 978-3-662-52897-6
10. Bernecker, G.: Planung und Bau verfahrenstechnischer Anlagen Projektmanagement und Fachplanungsfunktionen, Springer 4. Auflage 2012; ISBN-13: 9783642626111
11. Ripperger, S., Nikolaus, K.: Entwicklung und Planung verfahrenstechnischer Anlagen, Springer 2020; ISBN 978-3-662-60427-4


**Forms of teaching / Prerequisites for participation**

This module consists of a lecture and individual project work.

There are no formal requirements for participation. Students should pass the examinations of M568 Project Man-agement and M731 Proseminar / Softskills.

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Students need to pass the module examination, which encompasses all contents of the lecture. Presentation of the results, final report, excursion report

**ECTS credit points and grading**

Students need to pass the module examination, which encompasses all contents of the lecture.
alternative examination performance: paper / weighting 50% + final presentation / weighting 25% + consultation, presentation, motivation during semester / weighting 25 %
Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS.

**Frequency of offer / Duration of module**

| | |
|---|---|
| WINTER | The module is lectured in one semester. |

**Work load**

Participation in the course = 20 h
Preparation and follow-up (of the lecture) = 20 h
Preparation for examination = 110 h
The entire workload encompasses 150 hours, which equals 5 ECTS credit points.

| Modul-No. | 744 | MA | |
|---|---|---|---|
| **Modul name** | **(RT) Future Technologies of Recycling Practice** | | |
| Modul coordinator | Rutz, Michael | | |
| Title | (RT) Future Technol. of RP / Project | | |
| Title of examination | (RT) Future Technol. of RP / Project | | |
| Course Type / SWS | 4 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**
The following strategic waste streams will be discussed (examples):

- batteries
- electronic scrap
- scrap cars
- photovoltaics
- wind turbines
- fuel cells
- wastes from additive manufacturing

Next to recycling different reuse strategies will be discussed. Strategic ressources especially for high-tech-applications (e. g. rare earth metals) will be introduced in the context of sustainability.

**Learning objectives:**
The main objective of this module is to discuss state-of-the-art recycling processes and approaches for the complex waste streams mentioned above. Next to technical details, legal framework, social aspects and other challenges will be introduced. For established or existing strategies the students learn the technology. Opportunities for the manage-ment and treatment of new technologies without an established strategy for waste treatment will be designed. The students are able to outline the recycling industry as well as the areas of research and development for technolog-ical fields of the future. The students can recognize conflicts in the practical field of technology application and devel-opment in the raw materials area.

**Recommended Literature**


1. Worell, E.; Reuter, M. (ed.): Handbook of Recycling, Elsevier Inc., 2014.
2. Prasad, M.N.V. (Hrsg.); Vithanage, M. (Hrsg.); Borthakur, A. (Hrsg.): Handbook of electronic waste management: International best practices and case studies; Oxford Cambridge, MA: Buuterworth-Heinemann, Elsevier, 2020, ISBN 9780128170304; 0128170301
3. Randers, J.: 2052: A Global Forecast fort he Next Forty Years, Rotterdam, 2012.
4. Baipai, P.: Carbon Fiber, San Diego: Elsevier, 2021, ISBN 9780128219058, 012821905X (electronic books)
5. Park, S.-J.:Carbon Fibers. Dordrecht: Springer, 2015
6. Mouritz, A. P.: Fire properties of polymer composite materials. Dordrecht: Springer, 2006
7. World Trade Organisation: International trade statistics, Genf 2020
8. Akhil, A.; Huff, G.; Currier, A.; Kaun, B.: DOE/EPRI 2013, Electricity Storage Handbook in Collaboration witrh NRECA. Sandia National Laboratories, 2013.
9. Lienhard, J.: A Heat Transfer Textbook. Dover Civil and Mechanical Engineering. Cambridge, Massachusetts, 2017.
10. Stevels, A.; Huismann, J. Goodship, V.: Waste electrical and electronic equipment (WEEE) handbook, Oxford, England Philadelphia, PA : Woodhead Publishing Limited, 2019
11. Hu, Bin; Golloch, A.: Handbook of Rare Earth Elements: Analytics, Berlin/Boston : De Gruyter 2017, e-books
12. Adler, B.: Strategische Metalle – Eigenschaften, Anwendung und Recycling, Springer Spektrum 2017, ISBN 3-662-53035-X
13. Martens, H.; Goldmann, D.: Recyclingtechnik – Fachbuch für Lehre und Praxis, 2. Auflage, Springer Vieweg 2016, ISBN 3-658-02785-1
14. Hofmann, H., Spindler, J.: Aktuelle Werkstoffe – Neue Materialien für innovative Produkte, Springer Verlag, 2019. ISBN 978-3-662-59440-7


**Forms of teaching / Prerequisites for participation**

This module is a classical lecture.

There are no formal requirements for participation.

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Students need to pass the module examination, which encompasses all contents of the lecture.
Type of examination: written examination with a duration of 120 min. Alternative types of examination are possible.
In addition to regular participation, the preparation and discussion of a thesis paper is also planned, which exemplifies the above topics and includes future technologies.

**ECTS credit points and grading**

Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS.

**Frequency of offer / Duration of module**

| | |
|---|---|
| WINTER | The module is lectured in one semester. |

**Work load**

Participation in the course = 50 h
Preparation and follow-up (of the lecture) = 55 h
Preparation for examination = 45 h
The entire workload encompasses 150 hours, which equals 5 ECTS credit points.

| Modul-No. | 747 | MA | |
|---|---|---|---|
| **Modul name** | **Introduction in Environmental and Recycling Technology** | | |
| Modul coordinator | Rutz, Michael | | |
| Title | Introduction in ERT | | |
| Title of examination | Introduction in ERT | | |
| Course Type / SWS | 3 SWS Lecture / 1 SWS Exercise | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**
Basics of environmental technology:
Dealing with the subject-specific and societal problems at an early stage draws attention to sustainable development, taking into account the applicable legal regulations as well as environmentally relevant aspects. At the same time, with the interdisciplinary transfer of knowledge, the natural and engineering basis of the environmental and recycling tech-nology course is addressed. Problems and tasks of environmental technology are presented and an introduction to the circular economy / recycling is given.
Using selected waste streams as an example, the basic waste management problems and possible solutions are to be worked out.
Environmental technology: causes of environmental problems, environmental pollutants, introduction to environmental technologies
Circular Economy: Definition and History; Legal basis; Circular Economy Act in a European context; Concept of waste; Types of waste; Waste composition; Waste generation; Waste accounting and verification; DSD; Collection, handling and transport of waste; Corporate waste management; Overview of residual waste treatment (thermal and mechanical-biological treatment); Solution approaches for waste management in industrial, emerging and developing countries are presented.
Recycling: recycling term; selected examples of material recycling are presented.

Basics of process engineering:
Definition, areas of application, structure and tasks of the Process Engineering; Process Engineering and the envi-ronment; Professional requirements and perspectives; Apparatus, plant, process; Basic procedure; Process engineer-ing systems; Flow diagrams; Working methods; Material and energy balances; Development of a new process
Theoretical basics - microprocesses using the example of mechanical process engineering: disperse systems; settling rate; Particle size; specific surface; Particle shape; Particle size distribution and its representation; Adhesive forces; Porous systems; Measurement method of particle size analysis; Sampling, sample division
Introduction to applied mechanical process engineering - macro processes using the example of mechanical Pro-cessing: Terms and definitions of mechanical processes: comminution, classification, sorting
The module gives an overview about the topics of environmental technology, circular economy, recycling and pro-cess engineering. It delivers the necessary basics for the advanced modules of the ERT study programme.

**Learning objectives:**
The students know the basics of environmental technology, circular economy, recycling and process engineering. They have a basic understanding of environmental and procedural processes. The students mainly develop technical and system skills.By focusing on the specific professional field at an early stage, they have increased their motivation to study.

**Recommended Literature**


1. Worell, E.; Reuter, M. (ed.): Handbook of Recycling, Elsevier Inc. 2014. ISBN: 9780123964595, eBook ISBN: 978012396506
2. Letcher, T.; Vallero, D.: Waste: a handbook of management; London, Academic Press 2019
3. Clark, H.: Handbook of recycling technology; New York, NY: Syrawood Publishing House 2019, ISBN 9781682867518¸168286751X
4. Christensen, T.: Solid Waste Technology & Management, 1 & 2, Blackwell Publishing Ltd 2011, ISBN:9781405175173 | Online ISBN:9780470666883 |DOI:10.1002/9780470666883
5. Wills, B., Napier-Munn, T. (Hrsg.): Mineral Processing Technology, Elsevier 2006
6. Fuerstenau, K.: Mineral Processing, SME 2003, ISBN:
7. Rhodes, M.: Introduction to Particle Technology, Wiley 1986
8. Kelly, E., Spottiswood, D.: Introduction to Mineral Processing, Wiley 1982

9. Svarovsky, L.: Solid-Liquid Separation, Butterworth-Heinemann 2000
10. Martens, H., Goldmann, D.: Recyclingtechnik, Springer 2016
11. Bilitewski, B.: Abfallwirtschaft: Handbuch für Praxis und Lehre, Springer, Berlin 2013
12. Kranert, M.: Einführung in die Abfallwirtschaft, Vieweg und Teubner-Verlag 2010
13. Förstner, U.: Umweltschutztechnik, Springer Verlag, Heidelberg 2008
14. Müller, W.: Mechanische Grundoperationen u. ihre Gesetzmäßigkeiten. Oldenbourg Wissenschaftsverlag 2008
15. Stiess, M.: Mechanische Verfahrenstechnik 1 und 2, Springer Verlag 2009
16. Schwister, K.: Taschenbuch der Verfahrenstechnik, Fachbuchverlag Leipzig 2001

**Forms of teaching / Prerequisites for participation**

This module is a classical lecture combined with exercise.

There are no formal requirements for participation.

**Usability of module**

This module is mandatory for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Students need to pass the module examination, which encompasses all contents of the lecture.
Type of examination: written examination with a duration of 120 min. Alternative types of examination are possible.

**ECTS credit points and grading**

Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS

**Frequency of offer / Duration of module**

| | |
|---|---|
| WINTER | The module is lectured in one semester. |

**Work load**

Participation in the course = 50 h
Preparation and follow-up (of the lecture) = 55 h
Preparation for examination = 45 h
The entire workload encompasses 150 hours, which equals 5 ECTS credit points.

| Modul-No. | 864 | MA | |
|---|---|---|---|
| **Modul name** | **(ET) Bioengineering** | | |
| Modul coordinator | Breuer, Uta | | |
| Title | (ET) Bioengineering | | |
| Title of examination | (ET) Bioengineering | | |
| Course Type / SWS | 4 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**

- I Microbiology and Physiology of Microorganisms: cell biology, biochemical basic processes in the microbial metabolism, enzyme kinetics, microbial growth (kinetic and process management)
- II Bioprocess Engineering: bioreactors, sterilization and sterile technology, measurement and regulation technology at bioreactors, upstream and downstream processing
- III Biotechnological Syntheses: biomass ( feed and food, agriculture, pharmacy), low-molecular products (methane, alcohols, organic acids, amino acids, lipids and fatty derivatives, nucleotides und coenzymes, vitamins, sweeteners) macromolecules (microbial enzymes, Insulin, recombinant drugs, products of secondary metabolism)
- IV Biotechnological Remediation Procedures: aerobic and anaerobic degradation, composting and special systems, anaerobic processes and process variants, liquid and gaseous emissions as well as treatments of wastes, bioremediation of pollutants in soil and ground water, bioleaching, phytoremediation
- V Biodegradables Materials: biologically degradable materials, renewable biomass, PHA – PHB
- VI Environmental Microbiology: C-, S-, N-, Fe-cycles, biosensors

**Learning objectives:**

Students acquire in-depth knowledge in bioengineering with microbial and biochemical-biotechnological focus. In addition to scientific and engineering knowledges which reflect the link between microbial performance and technical implementation, historical and up-to-date engineering processes are shown especially considering the economically and ecologically feasibility. In this way students are enabled, to recognize and evaluate application possibilities and limits of bioengineering as well as to compare with conventional technologies.

**Recommended Literature**

For preparation and following-up the following textbooks are suitable:

1. Colin Ed. Ratledge and Björn Kristiansen, Basic Biotechnology, Cambridge University, 3rd ed. 2006, ISBN13: 9780521549585
2. Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl: Brock Biology of Microorganisms, Pearson Education, 15th ed. 2017, ISBN 978-0134261928
3. D.L. Nelson, M.M. Cox: Lehninger Principles of Biochemistry: International Edition, WH Freeman, 7th ed. 2017, ISBN 978-1319108243
4. J.L. Slonczewski, J.W. Foster: Microbiology: An Evolving Science, WW Norton & Co Inc., 2013, ISBN 978-0393123678

Further literature will be announced during the lectures.

**Forms of teaching / Prerequisites for participation**

Lecture

Knowledges and abilities which are demonstrated in lectures as bioenergy or biogas (B.Eng. RET) as well as bioengineering (B.Eng. URT). These prior knowledges could also be acquired by individual study or appropriate textbooks.

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

| |
|---|
| Students need to pass a module examination which encompasses all contents of the lecture.<br>Exam: Written exam with a duration of 120 min. Alternative forms of exam are possible. |
| **ECTS credit points and grading** |
| Modules are assessed by a module examination which is credited by 5 credit points according to the ECTS (European Credit Transfer and Accumulation System). |
| **Frequency of offer / Duration of module** |

| | |
|---|---|
| WINTER | The module is held within one semester. |

| |
|---|
| **Work load** |
| - course participation = 50 h<br>- preparing and following-up of the lecture contents = 55 h<br>- exam Preparation = 45 h<br><br>Total workload 150 h = 5 ECTS |

| Modul-No. | 870 | MA | |
|---|---|---|---|
| **Modul name** | **Basics in Electrical Engineering** | | |
| Modul coordinator | Wang, Jiayi | | |
| Title | Basics in Electrical Engineering | | |
| Title of examination | Basics in Electrical Engineering | | |
| Course Type / SWS | 2 SWS Lecture / 2 SWS Exercise / 0.5 SWS Lab | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content**

Part 1: DC Systems

- Resistances and Temperatures
- Serial and parallel connections Feld
- Voltage & Current Divider
- Kirchhoff's Laws
- Mesh Flow Analyses

Part 2: Single Phase Systems

- Complex Numbers
- Complex Operators
- Simple circuits driven by sinusoidal voltage
- Real, Reactive and Apparent Power
- Power Factor and compensation

Part 3: Three Phase Systems

- Introduction multiphase systems
- Star and Delta connection
- Basics Generators
- Basics Transformers

**Learning goals:**

The students will get a basic introduction of Electrical Engineering. Part I contains the knowledge to analyze easy circuits, feed by direct voltage. Resistances as a function of the temperature and serial and parallel connections will be treated. Finally Kirchhoff's Laws will be introduced. All contents of part I also can be applied for Part II & III. Complex numbers will be used to deal with sinusoidal functions as a basic procedure.

Part II will be focused to the basic calculation of simple circuits, driven by DC voltage. The meaning of the Power Factor and the apparent power will be clarified.

Part III will be more practical orientated. The students will deal with the multiphase systems and the possibility to connect the systems into Star- or Delta-Connection. Generators and Transformers will be introduced with their practical applications. Complicate calculations etc. will be avoided.

**Recommended Literature**

**Literatur:**

- Lecture Scripts will be uploaded
- Sample task will be uploaded

**Forms of teaching / Prerequisites for participation**

Teaching forms as stated above

There are no formal requirements for participation. Basics in physics, mathematics and mechanics are recommended. Basic

| |
|---|
| knowledge in thermodynamics, heat transfer and renewable energies is useful. Lecture Scripts will be uploaded and sample task will be uploaded |
| **Usability of module** |
| This module is mandatory for: Environmental and Recycling Technology |
| **Requirements for receiving ECTS credit points** |
| Assessment is performed as written examination (90 minutes). Other permissible forms of examination (online, oral, homework, etc.) are possible if they are announced by the person responsible for the module at the beginning of the semester. |
| **ECTS credit points and grading** |
| The grade of the module M870 corresponds to the grade of the exam. With the grading, 5 credit points (ECTS) are awarded. |
| **Frequency of offer / Duration of module** |

| | |
|---|---|
| WINTER | 1 Semester |

| |
|---|
| **Work load** |
| The total workload for this module is 150 hours; this corresponds to 5 ECTS credits. This workload results from the presence at the lectures with an active participation of the students in the (virtual) laboratory (about 45 hours). As part of the self-study, the lecture material should be reworked (about 55 hours). The preparation and execution of the examination is about 50 hours. |

| Modul-No. | 871 | MA | |
|---|---|---|---|
| **Modul name** | **Basics in Thermal Engineering** | | |
| Modul coordinator | Rathje, Rio | | |
| Title | Basics in Thermal Engineering | | |
| Title of examination | Basics in Thermal Engineering | | |
| Course Type / SWS | 4 SWS Lecture / 0.5 SWS Exercise | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Contents:**

Thermodynamics

1. Thermodynamics
2. Systems, States, and Processes
3. First Law of Thermodynamics (Conservation of Energy)
4. The Second Law of Thermodynamics (Entropy and the Trend Toward Equilibrium)
5. Energy conversion and the second law
6. Properties and property relations of fluids (pure substances, multiphase, mixtures, psychrometrics)
7. Thermodynamic processes in closed and open systems and cycles
8. Thermodynamic Machines and Components: Efficiencies and Irreversible Losses

Heat Transfer

1. Conduction (steady state, transient)
2. Convection (external and internal flow and free convection)
3. Boiling and Condensation
4. Radiation

**Learning Goals:**

The students have reviewed the principles of thermodynamics and heat transfer and their calculation. Even if these basics were not part of the first bachelor's course, they have acquired the necessary knowledge in these areas to be able to take more advanced courses in this area at master's level in the following semesters.
In the virtual lab, students learned how to use thermodynamic and computational fluid dynamics software to calculate complex processes such as cyclic processes and multiphase flows.

**Recommended Literature**


- Wesselak; Schabbach; Link; Fischer: Handbuch Regenerative Energietechnik. Berlin: Springer Vieweg, 2017
- H. Struchtrup, Thermodynamics and Energy Conversion. Berlin, Heidelberg: Springer Berlin Heidelberg, 2014.
- S. Bhattacharjee, Thermodynamics. New York: Pearson, 2016.
- Nellis; Klein: Heat Transfer. 1st Edition. Cambridge University Press, Cambridge (2008)
- VDI, VDI Heat Atlas. Berlin London: Springer, 2010.


**Forms of teaching / Prerequisites for participation**

The Basics in Thermal Engineering are mainly taught in a classical lecture. The lecture is supplemented by exercises in which application examples are discussed and a practical laboratory course.

There are no formal prerequisites for participation. Basic knowledge in physics, mathematics and mechanics is recommended. Basic knowledge in thermodynamics, fluid dynamics and heat transfer is helpful.

**Usability of module**

This module is mandatory for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

| |
|---|
| The assessment will take the form of a written, presence-based exam (90 minutes). Other permissible forms of examination (online, oral, homework, etc.) are possible if they are announced by the responsible person of the module at the beginning of the semester. |
| **ECTS credit points and grading** |
| The grade of the module M871 corresponds to the grade of the exam. With the grading, 5 credit points (ECTS) are awarded. |
| **Frequency of offer / Duration of module** |

| | |
|---|---|
| WINTER | The module is lectured in one semester. |

| |
|---|
| **Work load** |
| The total workload for this module is 150 hours, corresponding to 5 ECTS. This workload results from the attendance of lectures including an active participation of the students in the (virtual) laboratory (approx. 45 hours) and supervised exercises in a tutorial (approx. 11 hours). Self-study should include a review of the lecture material (approximately 50 hours). Preparing for and taking the exam requires approximately 44 hours. |

| Modul-No. | 873 | MA | |
|---|---|---|---|
| **Modul name** | **Scientific Practice and Writing** | | |
| Modul coordinator | Wesselak, Viktor<br>Aberle, Alexandra | | |
| Title | A: Scientific Practice<br>B: Scientific Writing | | |
| Title of examination | Scientific Practice and Writing | | |
| Course Type / SWS | 4 SWS Lecture | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**A: Scientific Practice**

Contents:

Students are taught the acquisition, evaluation and preparation of technical information as a central working technique in the engineering sciences, both in preparation for their master thesis and for their professional life.

1. What does scientific research mean?
2. Literature research
   Libraries and databases for the engineering sciences - Search techniques - Online search in free and fee-based databases - Content indexing of a library using the example of the University of Applied Sciences Nordhausen - Dealing with thessaurs
3. Technical standards
   Objectives and procedures of technical standardization - National and international standards boards - Researching and reading technical standards
4. Patents and industrial property rights
   Objectives and procedures in industrial property protection – patents, utility models, trademarks and designs - national and international patent organizations – German employee invention law - searching and reading patents - patentability of software
5. Writing of academic texts and lectures
   Presentation and structure - Literature references - Lecture structure - Presentation techniques - Examples of bad practice

Learning goals:

After successful completion of the module, students are able to research scientific or technical information, to procure it and to classify the research results with regard to their completeness and credibility. Furthermore, they are aware of the importance and practice of correct citation.

**B: Scientific Writing**

Contents:

1. Analysing academic languages: style and register, language structures
2. Elements of writing professional and/or academic texts: writing a paragraph; referencing, citing, quoting
3. Writing different text types: e.g. writing a tender, a quote, report and/or article

Learning goals:

Students have essential theoretical knowledge of writing different types of texts, e.g. typical professional documents. They have knowledge of the linguistic characteristics of the written language English as a scientific language, but also for use in a professional context. Students can gather information from specialised texts and internet sources and produce their own texts on topics relevant to their studies in English. They can deal with primary and secondary sources as well as the usual reference methods and citation styles.

**Recommended Literature**

1. Griffiths, P. (2007), Scientific Writing, Reading.
2. Macgilchrist, F. (2014), Academic Writing, Paderborn.
3. McCarthy, M. / O'Dell, F. (2011) English Vocabulary in use, Cambridge.
4. McCarthy, M. / O'Dell, F. (2016), Academic Vocabulary in Use, Cambridge, Stuttgart.
5. Oshima, A. / Hogue, A. / Curtis, J. (2020), Longman Academic Writing Series, White Plains, NY.

**Forms of teaching / Prerequisites for participation**

The module is a lecture with practical exercises and with active participationt of the students. The students apply their knowledge in writing short acedemic texts on a given technical topic.

No course specific requirements

**Usability of module**

This module is mandatory for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Prerequisite for the award of credit points is regular course participation and:
A: the successful completion of the academic paper and its timely submission or presentation,
B: written and/or oral examination.

**ECTS credit points and grading**

The module grade corresponds to the arithmetic mean of the successfully completed examinations in the two parts A and B. With an examination grade of at least 4.0, 2.5 credit points (ECTS) are awarded in each part, with the module grade thus totalling 5 credit points.

**Frequency of offer / Duration of module**

| | |
|---|---|
| WINTER | The module must be completed within one semester. |

**Work load**

Participation in both courses (50 h); preparation and follow-up (to the lectures/seminars) (25 h); writing an academic paper in part A (50 h), preparation for examination in part B = 25 h. The entire workload encompasses 150 hours, which corresponds to 5 ECTS credit points.

| Modul-No. | 908 | MA | |
|---|---|---|---|
| **Modul name** | **German as a Foreign Language I** | | |
| Modul coordinator | Aberle, Alexandra | | |
| Title | German as a Foreign Language I | | |
| Title of examination | German as a Foreign Language I | | |
| Course Type / SWS | 4 SWS Seminar | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

The module consists of 4 SWS and takes the promotion of individual language skills in the context of obtaining a UNIcert certificate into account.

**A1.1**
**Vocabulary:** introduction; communication in a very simple manner in relation to everyday needs, place of living, family and friends, hobbies and preferences
**Grammar:** simple word order; different sentence types (statement, question and command); adjectives; singular and plural nouns; present tense of special verbs; definite and indefinite articles; personal pronouns

**A2.1**
**Vocabulary:** communication about one's past and education; showing emotions; expressing advantages and disadvantages
**Grammar:** sub-clauses (weil, dass, wenn), adjectives (comparative and superlative), preterite forms of modal verbs, reflexive verbs, genitive with names, possessive articles in dative

**B1.1**
**Vocabulary:** expressing reasons for preferences and dislikes; arrange/book a holiday; understand announcements; write a comment; express past experiences, describe changes in life; apply for a job/internship; environmental protection
**Grammar:** Use of Infinitiv mit zu and the verb lassen; subordinate clauses with weil, da and obwohl; prepositions: genitive (trotz and wegen), prepositions used with time (dative and genitive); subordinate clauses with damit and um zu; conjunctive II with modal verbs, sein and haben

**Recommended Literature**

Bahn, Steve et al.: Kurs DaF A2, Deutsch für Studium und Beruf. Stuttgart: Klett 2024.
Dengler, Stefanie; Paul Rusch, Helen Schmitz and Tanja Sieber: Netzwerk neu A1B1. Klett, 2019.
Dengler, Stefanie; Paul Rusch, Helen Schmitz and Tanja Sieber: Netzwerk neu B1. Klett, 2021.
Jin, Friederike and Ute Voss: Grammatik aktiv: A1 –B1. Üben, Hören, Sprechen. Berlin: Cornelsen, 2023.

**Forms of teaching / Prerequisites for participation**

Interactive Language Course

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Active seminar participation obligatory

**ECTS credit points and grading**

ECTS: 5 credit points according to the ECTS (European Credit Transfer and Accumulation System).
Types of examination: written examination (60 min.) and oral examination.
The final grade is the arithmetic mean of the examinations.

**Frequency of offer / Duration of module**

| | |
|---|---|
| WINTER | 1 Semester |

| Work load |
| --- |
| Participation in the course = 50 h<br>Preparation and follow-up (of the lecture) = 55 h<br>Preparation for examination = 45 h<br>The entire work load encompasses 150 hours, which equals 5 ECTS credit points. |

| **Modul-No.** | **910** | **MA** | |
|---|---|---|---|
| **Modul name** | **German as a Foreign Language II** | | |
| Modul coordinator | Aberle, Alexandra | | |
| Title | Deutsch als Fremdsprache II | | |
| Title of examination | German as a Foreign Language II | | |
| Course Type / SWS | 4 SWS Seminar | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

The module consists of 4 SWS and takes the promotion of individual language skills in the context of obtaining a UNIcert certificate into account.

**A1.2**
**Vocabulary**: simple and direct communication skills in routine situations; participants understand commonly used expressions related to them directly (personal information, education, shopping and geography)
**Grammar**: details of time, manner and place; perfect tense of haben and sein; auxiliary and modal verbs; separable and inseparable verbs; nominative and dative nouns and prepositions; imperative forms

**A2.2**
**Vocabulary**: enquire: ask for information and direction; express one´s opinion; give recommendations; express apologies, complaints and consequences; ask for a favour; describe a picture in detail
**Grammar**: indirect questions; conjunctive II (sollte) to give a recommendation; adverbs: deshalb, trotzdem; changing prepositions (dative and accusative); verbs used with dative and accusative; subordinate clauses with als and wenn; verbs with fixed prepositions; indefinite pronouns

**B1.2**
**Vocabulary**: understand and describe relationships; discuss/solve conflict situations; offer, accept and/or reject help; participate in a discussion; selective reading (finding key words in articles); descriptions of people and processes
**Grammar**: Plusquamperfekt; subclauses used with time (bevor, bis, nachdem, seit, während); sentence structure (use of nicht); the passive voice (Präsens, Präteritum, Perfekt and modal verbs); adjectives used as nouns, articles used as pronouns (irgendein/-eine/-welche); sentences with je..., desto/umso...; use of participle I and II as adjectives

**Recommended Literature**

Bahn, Steve et al.: Kurs DaF A2, Deutsch für Studium und Beruf. Stuttgart: Klett 2024.
Dengler, Stefanie; Paul Rusch, Helen Schmitz and Tanja Sieber: Netzwerk neu A1B1. Klett, 2019.
Dengler, Stefanie; Paul Rusch, Helen Schmitz and Tanja Sieber: Netzwerk neu B1. Klett, 2021.
Jin, Friederike and Ute Voss: Grammatik aktiv: A1 –B1. Üben, Hören, Sprechen. Berlin: Cornelsen, 2023.

**Forms of teaching / Prerequisites for participation**

Interactive Language Course

**Usability of module**

This module is a profile module for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Active seminar participation obligatory

**ECTS credit points and grading**

ECTS: 5 credit points according to the ECTS (European Credit Transfer and Accumulation System).
Types of examination: written examination (60 min.) and oral examination.
The final grade is the arithmetic mean of the examinations.

**Frequency of offer / Duration of module**

| | |
|---|---|
| SOMMER | 1 Semester |
| **Work load** | |
| Participation in the course = 50 h<br>Preparation and follow-up (of the lecture) = 55 h<br>Preparation for examination = 45 h<br>The entire work load encompasses 150 hours, which equals 5 ECTS credit points. | |

| Modul-No. | 912 | MA | |
|---|---|---|---|
| **Modul name** | **Technical English I** | | |
| Modul coordinator | Aberle, Alexandra | | |
| Title | Technical English I | | |
| Title of examination | Technical English I | | |
| Course Type / SWS | 4 SWS Seminar | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

| **Content and objectives** |
|---|
| Topics in Technical English I include materials engineering and properties, tools and equipment, general chemistry as well as mechanics. Language skills encompass selected chapters of grammar for language correctness, reading comprehension and writing skills (reports and instructions). With the acquired skills, students can follow presentations and understand written texts on scientific issues as well as describe technical processes. In doing so, they use appropriate terminology from the fields of engineering as well as adequate grammatical structures. They understand manuals and can give instructions in written form. |
| **Recommended Literature** |
| Bonamy, David: Technical English, Pearson 2022.<br>Ibbotson, Mark: Cambridge English for Engineering, Cambridge 2008.<br>Murphy, Raymond: English Grammar in Use, Cambridge, current edition. |
| **Forms of teaching / Prerequisites for participation** |
| Participation in placement test as a pre-requisite.<br><br>Active seminar participation required. |
| **Usability of module** |
| This module is a profile module for: Environmental and Recycling Technology |
| **Requirements for receiving ECTS credit points** |
| Students need to pass the module examination, which encompasses all contents of the language course.<br>Types of examination: written examination (60 min.) and oral examination (15 min.). Alternative types of examination are possible. |
| **ECTS credit points and grading** |
| Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS (European Credit Transfer and Accumulation System). The final grade results from the arithmetic mean of the partial performances. |
| **Frequency of offer / Duration of module** |

| | |
|---|---|
| WINTER | The module is performed and must be completed within one semester. |

| **Work load** |
|---|
| Participation in the course = 50 h<br>Preparation and follow-up (of the lecture) = 55 h<br>Preparation for examination = 45 h<br>The entire work load encompasses 150 hours, which equals 5 ECTS credit points. |

| Modul-No. | 914 | MA | |
|---|---|---|---|
| **Modul name** | **Technical English II** | | |
| Modul coordinator | Aberle, Alexandra | | |
| Title | Technical English II | | |
| Title of examination | Technical English II | | |
| Course Type / SWS | 4 SWS Seminar | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

| **Content and objectives** |
|---|
| Topics include Materials Sciences and Chemistry, Environmental Sciences and Ecology, Process Engineering (bio/chem/mech), lab reports and analyses. Language skills encompass reading comprehension, giving instructions, giving presentations, explaining processes, referring to plans and structural design and various aspects of the English grammar (e.g. passive voice, conditionals, modal verbs, adverbs and adjectives). Endowed with these skills, students describe scientific issues and technical processes. They use appropriate terminology from the fields of academia and engineering as well as grammatical structures. They can give instructions in oral and written form and hold scientific presentations. |
| **Recommended Literature** |
| Bonamy, David: Technical English, Pearson 2022.<br>Ibbotson, Mark: Cambridge English for Engineering, Cambridge 2008.<br>Murphy, Raymond: English Grammar in Use, Cambridge, current edtion. |
| **Forms of teaching / Prerequisites for participation** |
| Prerequisite: participation in placement test. This module only applies to students with mother tongue German.<br>Active seminar participation required. |
| **Usability of module** |
| This module is a profile module for: Environmental and Recycling Technology |
| **Requirements for receiving ECTS credit points** |
| Students need to pass the module examination, which encompasses all contents of the lecture.<br>Type of examination: written examination (60 min.) and oral examination with a duration (30 min). Alternative types of examination are possible. |
| **ECTS credit points and grading** |
| Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS (European Credit Transfer and Accumulation System). |
| **Frequency of offer / Duration of module** |

| | |
|---|---|
| SOMMER | The module is performed and must be completed within one semester. |

| **Work load** |
|---|
| Participation in the course = 50 h<br>Preparation and follow-up (of the lecture) = 55 h<br>Preparation for examination = 45 h<br>The entire work load encompasses 150 hours, which equals 5 ECTS creditpoints. |

| Modul-No. | 941 | MA | |
|---|---|---|---|
| **Modul name** | **Master Thesis and Colloquium ERT** | | |
| Modul coordinator | N., N. | | |
| Title | Master Thesis and Colloquium ERT | | |
| Title of examination | Master Thesis and Colloquium ERT | | |
| Course Type / SWS | | | |
| Language / CP / Workload | English | 30.0 | 900 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**
A: Master Thesis:
With the master thesis the students develop an independent scientific work. The results are usually derived from the practical activity to a given topic in a company or in another enterprise of professional scientific experience.

B: Presentation and Defence
In the Colloquium, students should present the results of their master thesis in an oral presentation and answer the questions of the supervisors and the audience.

**Learning goals:**
By completing the master thesis module, the students prove their professional qualification, to solve a practice-relevant engineering problem within a given time limit independently and with scientific methods, to present the results succinctly in a professional manner and to defend it in a colloquium.

**Recommended Literature**

There are no specific literature recommendations for this module.

**Forms of teaching / Prerequisites for participation**

A: Preparation of a scientific work supervised by an examiner of the university and a supervisor of the company/enterprise
B: Independent presentation of the results during a colloquium

A: The requirements are documented in §21 of the examination regulations.
B: The requirements are documented in §23 of the examination regulations.

**Usability of module**

This module is mandatory for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

A: Assessment is performed with an at least sufficient graded master thesis.
B: Assessment is performed with an at least sufficient graded colloquium.

**ECTS credit points and grading**

A: 26 ECTS credits
B: 4 ECTS credits

**Frequency of offer / Duration of module**

| JEDES | 1 Semester |
|---|---|

**Work load**

The total workload for this module is 900 hours; this corresponds to 30 ECTS credits. This workload results mainly from the independent and self-responsible handling of the master thesis project (700 hours), the preparation of the master thesis (100 hours) and the presentation (100 hours).

| Modul-No. | 1012 | MA | |
|---|---|---|---|
| **Modul name** | **Basics of Mechanical Engineering** | | |
| Modul coordinator | Link, Thomas | | |
| Title | A: Mechanical Engineering<br>B: Fluid Dynamics | | |
| Title of examination | Basics of Mechanical Engineering | | |
| Course Type / SWS | 2 SWS Lecture / 2 SWS Exercise | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

**Content:**

A: Mechanical Engineering

1. Static and dynamic equilibrium for forces and torques
2. Loads of components and load distribution in components
3. Material Properties of components
4. Mechatronic components for machines
5. Design of mechanical elements
6. Manufacturing of mechanical elements

B: Fluid Dynamics

1. Bernoulli's equation in branched systems
2. Linear Momentum Equation and Rankine’s Momentum Theory
3. Angular Momentum Equation
4. Euler’s pump and turbine equation
5. Flow past blunt bodies
6. Compressible flows
7. Similarity theory

**Competence**

The students define Static and dynamic equilibrium for forces and torques. This is the base for the calculation of the loads in the components. With the knowledge of the material properties they are able to design mechanical elements. The students get an overview on mechatronic components and can use them to design complex mechanical components. At the end they learn how to manufacture this parts.

Students can apply Bernoulli's equation in branched systems. Using the momentum theorem, they are able to calculate forces on components with flow around and through them for two- and three-dimensional flow problems. Students are familiar with Rankine's jet theory and thus have the basics to understand Betz's theory for wind turbines. They are familiar with the differences between incompressible and compressible flows and are able to calculate simple compressible flow cases. Students are familiar with the application of the pi theorem in similarity theory and are able to derive similarity indices for a wide variety of problems and thus correctly transfer measurements on a model scale to large-scale designs.

**Recommended Literature**

- Munson et. al. Introduction to Fluid Dynamics. Wiley
- Mark Huber. The Beginner's Guide to Engineering: Mechanical Engineering
- Erik Oberg et. al. Machinery's Handbook

**Forms of teaching / Prerequisites for participation**

The course takes the form of a lecture with 2 SH. Accompanying and partly integrated into the lecture, exercises of 2 SH are offered.

No course specific requirements.

| **Usability of module** | |
|---|---|
| This module is mandatory for: Environmental and Recycling Technology | |
| **Requirements for receiving ECTS credit points** | |
| Assessment is performed as written examination (120 minutes). | |
| **ECTS credit points and grading** | |
| 5 ECTS credits | |
| **Frequency of offer / Duration of module** | |
| WINTER | 1 Semester |
| **Work load** | |
| 150 h of total work load, from:<br>• 45 h of presence at lectures/exercises<br>• 55 h of self-study<br>• 50 h of preparation for examination | |

| Modul-No. | 1024 | MA | |
|---|---|---|---|
| **Modul name** | **IT-Service Management** | | |
| Modul coordinator | Dotsenko, Alexander | | |
| Title | IT-Service Management | | |
| Title of examination | IT-Service Management | | |
| Course Type / SWS | 3 SWS Lecture / 1 SWS Seminar | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

Aims:

- The module aims to provide students with the knowledge of common IT management frameworks and stand-ards.

Outline of Syllabus:

- The role of Information Systems
- Overview of the ITIL framework
- Planning, Implementation and Optimization of transition services
- COBIT, Prince2, CMMI
- Impact of emerging technologies
- Fundamentals of IT security management
- International standards relevant to IT service management
- Current tools for IT service management

Learning Objectives:

Upon successfully completing the module the students shall

- be able to plan and assess IT services using proven industry tools
- be able to choose an appropriate IT management methodology and to justify the decision
- know the common internation standards regarding cybersecurity and software operations
- understand the business implications of IT design and development methodologies.

**Recommended Literature**


- J. Sansbury, E. Brewster, A. Lawes, R. Griffiths, IT Service Management, 3rd Edition, BCS, The Char-tered Institute for IT, 2016
- C. Bentley , The Concise PRINCE2® - Principles and Essential Themes, 3rd Edition, IT Governance Publishing, 2019
- C. Agutter, ITIL® Foundation Essentials – ITIL 4 Edition - The ultimate revision guide, IT Governance Publishing, 2019


**Forms of teaching / Prerequisites for participation**

Lectures and Case Studies

No course specific prerequisites

**Usability of module**

This module is elective for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

The credits will be awarded to students who successfully pass the exam.

**ECTS credit points and grading**

| | |
|---|---|
| The exam grade is the grade of the module. 5 ECTS credit points will be awarded to the students who successfully passed the exam. | |
| **Frequency of offer / Duration of module** | |
| WINTER | 1 Semester |
| **Work load** | |
| 150 h of total work load<br>45 h of classroom teaching (lectures and workshops)<br>30 h of review and preparation for classroom teaching<br>45 h of self-study<br>40 h of preparation for exam | |

| **Modul-No.** | **8000** | **MA** | |
|---|---|---|---|
| **Modul name** | **Study success and career progression** | | |
| Modul coordinator | Aberle, Alexandra | | |
| Title | Study success and career progression | | |
| Title of examination | Study success and career progression | | |
| Course Type / SWS | 2 SWS Seminar | | |
| Language / CP / Workload | English | 5.0 | 150 |
| Requirements for attendance | no | | |

**Content and objectives**

A: Students are familiar with the formal and legal aspects of being a student at a German university embodying requirements, enrolment processes as well as examination regulations, master thesis, finals and colloquium/defence. They know how to plan and structure learning routines successfully. This includes time-management, meeting tight deadlines, avoiding procrastination, progression control and learning intervals. Students manage to prepare for examinations and identify special types of examinations and their requirements. They use personalized strategies for memorizing, reviewing and testing knowledge as well as self-evaluation, motivation and stress reduction.
B: Students are familiar with work and working conditions (dos and don´ts) in Germany. They are aware of important regulations and the legal German framework. They are able to apply for jobs or internships in Germany and know the contents of the relevant documents (CV, cover letter etc.), application strategies and processes. Students master typical interview situations and are able to talk about personal qualities, career skills and achievements.

**Recommended Literature**

Bosewitz, Annette und René (2022). Erfolgreiche Vorstellungsgespräche auf Englisch, Haufe.
Bosewitz, Annette und René (2021). Professionell bewerben auf Englisch. Haufe.
Bowler, Jade (2021). The Only Study Guide You'll Ever Need: Simple tips, tricks and techniques to help you ace your studies and pass your exams! Blink Publishing.
Laufer, Coley (2015). Conquering Exams, Never Fail Exams Again. CreateSpace Independent Publishing Platform.

**Forms of teaching / Prerequisites for participation**

Seminar: face-to-face teaching, speaking and writing practices and group-work activities

**Usability of module**

This module is elective for: Environmental and Recycling Technology

**Requirements for receiving ECTS credit points**

Students need to pass both parts of the module examination in order to acquire ECTS. Part A: Oral exam/presentation (30 mins). Part B: Written examination (60 min.). The final grade is the arithmetic mean of the examinations.
Active seminar participation is obligatory.

**ECTS credit points and grading**

The module is assessed by a module examination, which is credited by 5 credit points according to the ECTS (European Credit Transfer and Accumulation System).

**Frequency of offer / Duration of module**

| | |
|---|---|
| WINTER | 1 semester |

**Work load**

Participation in the course = 60 h, preparation and follow-up = 50 h, preparation for examination = 40 h. The entire work load encompasses 150 hours, which equals 5 ECTS credit points.