

**Modulhandbuch für den Studiengang Chemistry: Materials, Engineering and Sustainability (universitäres Profil),
Master of Science, Prüfungsordnung 2025**
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Module 14310 Practical Research Training

assign to: Total Account

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14310	Mandatory

Modul Title	Practical Research Training
	Forschungspraktikum
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Klepel, Olaf
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	30
Learning Outcome	In the practical research training programme, students can apply and deepen the theoretical concepts, methods and strategies they have learnt during their studies when working on a complex scientific problem in the field of materials chemistry or process engineering. Using the infrastructure of external research institutions, students also acquire knowledge and skills in new methods and technologies. They become familiar with organisational forms of research networks. At the end of the module, students will have consolidated skills in dealing with scientific information sources, in data collection, documentation and evaluation as well as in summarising, presenting and discussing scientific results.
Contents	- Reviewing and analysing scientific information sources including primary literature - Processing a scientific task using experimental and/or theoretical methods - Collecting, documenting and analysing data - Preparation of the written thesis - Colloquium with oral presentation and discussion
Recommended Prerequisites	Completion of at least 5 modules of the specialisation "Materials Chemistry" or "Fluid- and Process Engineering"
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Self organised studies - 900 hours
Teaching Materials and Literature	Original scientific literature on the research topic to be addressed; provided by the supervisor

Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	Written report about 20 pages, 50% Colloquium including discussion, 45 min 50%
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	The research internship is usually completed at a research institution outside the BTU under the supervision of a university lecturer involved in the curriculum. The choice of research institution is up to the students. In reasonable exceptional cases, the internship can also be completed in a working group within the BTU.
Module Components	- self organized studies - colloquium
Components to be offered in the Current Semester	No assignment

Module 14311 Master Thesis

assign to: Total Account

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14311	Mandatory

Modul Title	Master Thesis
	Master-Arbeit
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Klepel, Olaf
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	30
Learning Outcome	Students acquire the ability to solve a scientific problem within a limited time budget under the guidance of a supervisor. They use their acquired theoretical and practical knowledge to justify scientifically their solution of the problem as well as their improvements. The development of new knowledge and techniques is a major objective. They acquire the ability to present scientific facts clearly in written and oral form. Students have acquired practical personal skills related to the degree programme through communicative interaction with members of the working groups.
Contents	- Guided, mostly experimental work on a complex scientific problem - Accompanying study of primary literature on the research topic - Participation in literature and progress seminars of the working group - Laboratory report on the establishment of the experimental approach for the elaboration of the task and discussion of the first results - Preparation of the written thesis - Colloquium with oral presentation and discussion
Recommended Prerequisites	none
Mandatory Prerequisites	Students will be admitted to the Master's thesis if they have acquired at least 72 CP including the Practical Research Training at the time of registration for the Master's thesis.
Forms of Teaching and Proportion	Self organised studies - 900 hours
Teaching Materials and Literature	It depends on the individual subject. Corresponding material will be named and provided by the supervisor.

Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	The grade of the Master thesis results from the thesis, which accounts for 50 percent, and its defense, which accounts for 50 percent. The presentation and the discussion go into equal parts in the grade of the colloquium.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	- Self organised studies - Colloquium with oral presentation and discussion
Components to be offered in the Current Semester	No assignment

Module 11803 Fundamentals of Additive Manufacturing

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	11803	Compulsory elective

Modul Title	Fundamentals of Additive Manufacturing
	Grundlagen der additiven Fertigung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Härtel, Sebastian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The students will • gain systematic knowledge of the physical and technological fundamentals of welding engineering in view of additive manufacturing technologies, • be able to describe relevant additive manufacturing technologies and will know their respective strengths and weaknesses, • have a critical understanding for the selection of appropriate additive manufacturing technologies based on the specific task, • learn the basics of the finite element method and part-scale modelling techniques to predict residual stresses and distortions.
Contents	Fundamentals of welding engineering and additive manufacturing technologies with particular attention to powder bed fusion and directed energy deposition. Design and Construction of 3D printed parts. Microstructure evolution during the build process and postprocessing. Modelling and numerical simulation in additive manufacturing processes, in particular part-scale thermo-mechanical models to predict thermal stresses and distortions in powder bed fusion. Knowledge is applied in a project using commercial software (Simufact.Additive) to analyze the influence of build orientation and support structures on final build quality.
Recommended Prerequisites	• Fertigungstechnik Grundlagen (or similar)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester

	Study project - 2 hours per week per semester Self organised studies - 90 hours
Teaching Materials and Literature	• Script • You can find further informations on moodle.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Final presentation, ~30 min. (30%) and • Written exam, 60 min. (70%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• VL Fundamentals of Additive Manufacturing Current Description • ÜB Fundamentals of Additive Manufacturing Current Description • Proj Fundamentals of Additive Manufacturing Current Description
Components to be offered in the Current Semester	No assignment

Modul 12274 Laborkurs Prozesse in porösen Materialien

zugeordnet zu: Specialisation Materials Chemistry

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	12274	Wahlpflicht

Modultitel	Laborkurs Prozesse in porösen Materialien
	Lab course Processes in Porous Materials
Einrichtung	Fakultät 2 - Umwelt und Naturwissenschaften
Verantwortlich	Prof. Dr. rer. nat. habil. Klepel, Olaf
Lehr- und Prüfungssprache	Deutsch
Dauer	1 Semester
Angebotsturnus	jedes Wintersemester
Leistungspunkte	6
Lernziele	Nach der Teilnahme am Modul sind die Studierenden in der Lage physikalisch-chemische Prozesse in hochporösen Materialien experimentell zu untersuchen, auszuwerten und daraus auf Eigenschaften des untersuchten Materials zu schließen. Sie sind befähigt, anhand der Auswertung wissenschaftlicher Fachliteratur Strategien zur Synthese poröser Materialien abzuleiten und praktisch umzusetzen. Die Teamfähigkeit wird durch Arbeit in Kleingruppen gefördert. Die Studierenden können sich selbständig in ein Thema einarbeiten und Handlungsabläufe unter gegebenen Randbedingungen planen. Sie haben durch die kommunikative Auseinandersetzung im Praktikum studiengangbezogene personale Kompetenzen erworben und sind in der Lage, in Kleingruppen Fragestellungen zum Praktikum zu bearbeiten und zu diskutieren.
Inhalte	• Erarbeiten von Strategien zur Synthese poröser Materialien • Charakterisierung von Oberflächenfunktionalitäten poröser Materialien • Experimentelle Untersuchung adsorptiver Eigenschaften poröser Materialien (z.B. silikatische oder kohlenstoffbasierte Materialien) • Experimentell Untersuchungen zum Transportverhalten von Stoffen in porösen Materialien
Empfohlene Voraussetzungen	Modul 12264 Allgemeine Chemie, Modul 12265 Anorganische Chemie, Modul 11850 Physikalische Chemie, Modul 12529 Kinetik und Transportprozesse
Zwingende Voraussetzungen	keine
Lehrformen und Arbeitsumfang	Praktikum - 5 SWS

	Selbststudium - 105 Stunden
Unterrichtsmaterialien und Literaturhinweise	• Baerns, M., Behr, A. Brehm, A. et al.: Technische Chemie, Wiley-VCH, 2013. • Marsh, H., Rodriguez Reinoso, F.: Activated Carbon, Elsevier Science & Technology, 2006. • Weitkamp J., Puppe, L.: Catalysis and Zeolites, Springer, 1999. • Schüth, F., Sing, K.S.W., Weitkamp, J.: Handbook of porous Solids, Wiley-VCH, 2002. • Anleitungen zum Praktikum
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	Praktikumsversuche mit Protokoll (70%) sowie zusammenfassende 20-minütige Präsentation (30%)
Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	keine
Bemerkungen	Das Modul wird nicht angeboten ab WiSe 25/26.
Veranstaltungen zum Modul	• Praktikum Prozesse in porösen Materialien
Veranstaltungen im aktuellen Semester	keine Zuordnung vorhanden

Modul 12276 Poröse Materialien

zugeordnet zu: Specialisation Materials Chemistry

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	12276	Wahlpflicht

Modultitel	Poröse Materialien Porous Materials
Einrichtung	Fakultät 2 - Umwelt und Naturwissenschaften
Verantwortlich	Prof. Dr. rer. nat. habil. Klepel, Olaf
Lehr- und Prüfungssprache	Deutsch
Dauer	1 Semester
Angebotsturnus	jedes Semester
Leistungspunkte	6
Lernziele	Nach der Teilnahme am Modul sind die Studierenden in der Lage, wesentliche Aspekte der Synthese, Charakterisierung und Anwendung hochporöser Materialien zu verstehen. Die Studierenden werden somit befähigt, wissenschaftliche Aufgabenstellungen zu porösen Materialien im hohen Maße selbstständig zu bearbeiten. Durch das Selbststudium wissenschaftlicher Originalliteratur können die Studierenden deutsche und englische Texte erschließen sowie deren Inhalte im Kontext des Vorlesungsstoffes reflektieren.
Inhalte	• Texturelle Charakterisierung poröser Materialien verschiedener Porenweitenbereiche (Nanometer bis Mikrometer) mittels adsorptiver und anderer Methoden • Synthesemethoden, Aufbau, Struktur, Anwendung wichtiger Klassen poröser Materialien (z.B. silikatische Materialien, kohlenstoffbasierte Materialien, poröse Polymere)
Empfohlene Voraussetzungen	Kenntnisse in anorganischer und physikalischer Chemie
Zwingende Voraussetzungen	<div ><p="" ><span="" >kein="" <="" 14293="" <="" abschluss="" class="western" data-coolorigin="https%3A%2F%2Fwww.b-tu.de%2Forgcloud%2Fapps%2Frichdocumentscode%2Fproxy.php%3Freq%3D%2Fcool%2Fclipboard%3FWOPIsrc%3Dhttps%253A%252F%252Fwww.b-tu.de%252Forgcloud%252Findex.php%252Fapps%252Frichdocuments%252Fwopi%252Ffiles%252F9418675_ochtzip9yafk%26ServerId%3D2b3e65df%26ViewId%3D7%26Tag%3D5e4d8ab844db3108" div>="" erfolgreicher="" id="meta-origin" materials.<="" modul="" porous="" span>="" style="font-family: Carlito, serif;" td="" von=""></div>

Lehrformen und Arbeitsumfang	Seminar - 1 SWS Selbststudium - 165 Stunden
Unterrichtsmaterialien und Literaturhinweise	• Marsh, H.; Rodriguez Reinoso, F.: Activated Carbon, Elsevier Science & Technology, 2006. • Weitkamp, J.; Puppe, L.: Catalysis and Zeolites, Springer, 1999. • Schüth, F.; Sing, K.S.W.; Weitkamp, J.: Handbook of porous Solids, Wiley-VCH, 2002. • videobasiertes Lehrmaterial
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	2 Klausuren jeweils 45 min
Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	keine
Bemerkungen	Das Modul kann nicht belegt werden, wenn das Modul 14293 Porous Materials bereits belegt wurde.
Veranstaltungen zum Modul	• Seminar Poröse Materialien
Veranstaltungen im aktuellen Semester	220527 Seminar Poröse Materialien - 1 SWS

Module 14041 Processes in Porous Materials

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14041	Compulsory elective

Modul Title	Processes in Porous Materials
	Prozesse in porösen Materialien
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Klepel, Olaf
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	6
Learning Outcome	The students acquire basic knowledge on the nature of highly porous materials (pore widths between 0.5 and 50 nm) and their characterization. They acquire knowledge of important processes which take place in highly porous materials such as adsorption and mass transport processes. By studying original scientific literature on their own, students are able to analyse scientific texts and reflect on their content in the context of the lecture material. In addition, students have acquired further personal skills related to the degree programme through communicative discussion in seminars.
Contents	• nature of porosity • equilibrium adsorption and adsorption kinetics in porous materials • transport processes in porous materials • interplay of chemical reaction and transport processes in heterogeneous catalysis (macro kinetics) • the interplay of mass transport and adsorption of molecules in porous materials investigated by temperature-programmed desorption
Recommended Prerequisites	basic knowledge of porous materials and knowledge of physical chemistry
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Seminar - 1 hours per week per semester Self organised studies - 165 hours
Teaching Materials and Literature	- Video-based teaching material (asynchronous) - Original scientific literature provided by the lecturer

Text books:

M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken,
A. Renken, K.-O. Hinrichsen, R. Palkovits, Technische Chemie, Wiley-
VCH, various editions

H. Scott Fogler, Elements of Chemical Reaction Engineering: Pearson
New International Edition, Pearson Education Limited, Harlow, 2013

Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	2 written exams, each 45 minutes, weighted 50%
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Seminar
Components to be offered in the Current Semester	220522 Seminar Processes in Porous Materials - 1 Hours per Term

Module 14284 Heterogeneous Equilibria (Constitution Theory of Metallurgy)

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14284	Compulsory elective

Modul Title	Heterogeneous Equilibria (Constitution Theory of Metallurgy) Heterogene Gleichgewichte (Konstitutionslehre der Metallkunde)
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. habil. Weiß, Sabine
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The students are introduced to the basics and application methods of phase diagrams. An expanded knowledge of binary phase diagrams is communicated. The students will be able to interpret unknown and complicated binary phase diagrams. They can analyze phase contents and phase reactions during the cooling process of an alloy and can discuss the microstructure. The students learn to interpret elementary unknown ternary phase diagrams. They can evaluate phase contents and phase reactions followed by the construction of isothermal and concentration sections through the three-dimensional system. Using the examples of binary and ternary systems constitution theory and the basics of thermo-dynamic methods will be trained with the aim to understand the construction and practical use of phase diagrams.
Contents	Lecture and exercises will merge. Based on the fundamentals of the lecture the interpretation of phase diagrams will be developed in collaboration with the students. The students will receive exercises and master copies which will be explicated during the lecture and subsequently solved in cooperation. The main contents of the lecture are • one-, two- and three-component diagrams, • naming the phase rooms, • construction of schematic cooling curves, • calculation of phase contents, • application of the lever principle and the Gibbs law. • Using simplified ternary systems as examples the construction of isothermal- and concentration sections is trained.

Recommended Prerequisites	• Module 36104 or 11915 Grundlagen der Werkstoffe (or equivalent expertise in fundamentals of materials)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Study project - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The teaching materials are provided via the Moodle learning platform. The structure of the module as an "inverted classroom" (provision of the lecture and exercise materials as well as accompanying literature, study-units and learning videos prior to the event) enables students to familiarize with a topic independently, to plan courses of action under given conditions and to work within the module to organize themselves. Furthermore, they can reflect on their learning progress in short tests, check their own results using sample solutions and communicate and discuss their open questions during the event. If necessary, the event can also be held as an online event.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Online processing of submissions which are graded. The 10 best of in total 11 submissions result in the overall grade. Each of the relevant submissions generates 10% of the points for the overall grade.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Heterogeneous Equilibriums (Lecture) • Heterogeneous Equilibriums (Exercise)
Components to be offered in the Current Semester	No assignment

Module 14285 Interfacial Chemistry

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14285	Compulsory elective

Modul Title	Interfacial Chemistry Grenzflächenchemie
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Acker, Jörg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After completing the module, students will be able to analyze and apply modern concepts, methods and theories of physical interfacial chemistry. Students will gain a sound understanding of the fundamentals of the thermodynamics of phase boundaries and interfacial processes, methods for determining interfacial tension, films, interfaces with amphiphilic molecules (surfactants and micelles), colloids and adsorption phenomena. Students will also learn the fundamentals and applications of physical methods for characterizing solid surfaces using microscopic and spectroscopic methods. The module should enable students to transfer and apply the acquired knowledge independently and across disciplines to problems of interfacial chemistry. They learn the methodology of structuring scientific questions and using the methods of physical chemistry to examine them qualitatively and quantitatively, while making critical preliminary assessments, considerations and quantitative estimates and evaluating scientific plausibility. Students also learn problem-solving strategies, the description and communicative discussion of physical-chemical issues in interfacial chemistry and acquire social skills such as communication, creativity and scientific discourse.
Contents	Section 1: Thermodynamics of phase boundaries and interfacial processes Thermodynamic description of interfaces Phase boundaries between two pure phases, between two phases with several components and involving three phases: Interfacial tension, pressure difference of two phases on curved surfaces (Young/Laplace equation), vapor pressure of a liquid (Kelvin equation), nucleation and growth of phases, wetting phenomena (contact angle, Young equation, wetting transitions);

	measurement methods, examples from interfacial chemistry, including surfactants, micelles and colloids; adsorption phenomena and examples of interfaces with unique properties. Section 2: Spectroscopic and microscopic methods for the characterisation of solid surfaces: - Electron Spectroscopy (UPS, XPS, Augerelectron spectroscopy) - Ion Spectroscopic Techniques (SIMS, Laser-MS) - Surface Photon Spectroscopic Methods (linear/non-linear methods) - Electron-Stimulated Microanalysis Methods (Scanning electron microscopy) - Scanning Probe Microscopy (Atomic force microscopy, Scanning tunnelling microscopy) - Thin films / Optical coatings (Fabrication (PLD), Characterization, Application)
Recommended Prerequisites	Inorganic Chemistry, Inorganic Materials, Physical Chemistry, Quantum Theory and Spectroscopy, Instrumental Analysis
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 4 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	P.W. Atkins, J. de Paula „Physikalische Chemie“, 4. Aufl., Wiley-VCH, 2006 G. Wedler „Lehrbuch der Physikalischen Chemie“, 5. Aufl., Wiley-VCH, 2004 G. Brezesinski, H.-J. Mögel, Grenzflächen und Kolloide, Spektrum 1993 H.-D. Dörfler, Grenzflächen und kolloid-disperse Systeme, Springer Berlin, Heidelberg, 2002 H. Naumer, W. Heller „Untersuchungsmethoden in der Chemie: Eine Einführung in die moderne Analytik“, Wiley-VCH, 2010 D.A. Skoog, F.J. Holler, R.S. Crouch „Instrumentelle Analytik, Grundlagen-Geräte-Anwendungen“, Springer Spektrum, 2013
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	Written exam, 120 minutes, (graded)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	No offer in WiSe 2025/26.
Module Components	Lecture Examination
Components to be offered in the Current Semester	220641 Lecture Interfacial Chemistry - 4 Hours per Term 220649 Examination Interfacial Chemistry

Module 14286 Principles of Spectrochemistry

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14286	Compulsory elective

Modul Title	Principles of Spectrochemistry Prinzipien der Spektrochemie
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Acker, Jörg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After completing the module, students will be able to evaluate and analyze the fundamental relationships, measurement principles and experimental methods of element analysis. The aim is to provide a basic understanding of the advantages and disadvantages of the various methods for individual problems in applied quantitative element analysis. To this end, students gain a sound understanding of the physical principles of the methods, the most important components and instrumental details of the measuring devices, data analysis and data evaluation as well as sources of error and how to avoid them. They will be able to understand systematic processes for identifying known and unknown substances and the classification of compounds in complex substance systems. At the end of the module, students should be able to apply the acquired knowledge independently and across disciplines to problems of identification and characterization of predominantly inorganic materials.
Contents	Review and practice-oriented consolidation of concepts of physical chemistry: quantum chemical structure of atoms (electronic states) and statistical thermodynamics (state sums and occupation probabilities) Atomic absorption spectrometry: structure and measuring principles, device components, methods of background correction, data evaluation, application examples, special techniques: different flame types, graphite tube, hydride and cold vapor, atomic emission spectrometry Atomic absorption and emission spectrometry with high-resolution continuum AAS: structure and measuring principles, device components, methods of background correction, data evaluation, advantages and disadvantages compared to classical AAS, molecular absorption and emission spectrometry, application examples

	Plasma spectrometric methods: ICP-OES and GD-OES, structure and measuring principles, device components, methods of background correction, data evaluation, application examples Elemental mass spectrometry: fundamentals of mass spectrometry, overview of MS separation methods, technical conditions and requirements for the MS detection of atoms, GD-MS/ICP-MS: differences and similarities Techniques of element analysis: Sample preparation, sample digestion, trace analysis
Recommended Prerequisites	Physical Chemistry, Quantum Theory and Spectroscopy, Instrumental Analysis
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 4 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	P.W. Atkins, J. de Paula „Physikalische Chemie“, Wiley-VCH, 2006. D.A. Skoog, F.J. Holler, S.R. Crouch „Instrumentelle Analytik“, Springer, 2013. J. M. Hollas „Moderne Methoden in der Spektroskopie“, Vieweg & Sohn, 1995. B. Welz, H. Becker-Ross, S. Florek, U. Heitmann „High-resolution continuum source AAS“, Wiley-VCH, 2005. B. Welz, M. Sperling „Atomic Absorption Spectrometry“, Wiley-VCH, 1999. J.A.C. Broekaert „Analytical Atomic Spectrometry with Flames and Plasmas“, Wiley-VCH, 2005. J. Nölte „ICP Emission Spectrometry“, Wiley-VCH, 2003.
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	written exam, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• lecture Principles of Spectrochemistry, 4 SWS • written exam, 90 minutes
Components to be offered in the Current Semester	220660 Lecture Principles of Spectrochemistry - 4 Hours per Term 220668 Examination Principles of Spectrochemistry

Module 14287 Materials for Energy Conversion and Storage

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14287	Compulsory elective

Modul Title	Materials for Energy Conversion and Storage
	Materialien für Energiewandlung und Energiespeicherung
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Acker, Jörg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	After completing the module, students will have a broad overview of chemical and physical concepts for storing and converting energy and their technical implementation. In the module, students gain a chemical and physical understanding of processes and materials for storing and converting energy, including theoretical principles, measurement methods and performance parameters. Students are familiarized with the most important aspects and procedures for the extraction and processing of the required raw materials as well as their recovery and recycling. Students reflect on the course content and communicate open questions. They learn to make references to current issues, carry out literature research, open up scientific texts and formulate and present content in a structured manner. After completing the module, students will be able to apply materials for energy storage and energy conversion, their functionality and applicability as well as their production, recovery and recycling and to understand, analyze, evaluate and communicate associated processes.
Contents	Theoretical principles of electrochemistry Electrochemical characterization methods Supercapacitors Battery storage technology Fuel cell Electrolysis Redox flow battery Lithium-ion batteries Battery materials for lithium-ion batteries New developments in battery materials

	Recycling of lithium-ion batteries Battery as an economic sector
Recommended Prerequisites	Inorganic Chemistry, Inorganic Materials, Physical Chemistry, Quantum Theory and Spectroscopy, Instrumental Analysis
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 4 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	A. Kwade, J. Diekmann (Eds.); „Recycling of Lithium-Ion Batteries - The LithoRec Way“ Springer International Publishing AG 2018, ISBN 978-3-319-70571-2 R. Korthauer (Ed.); „Lithium-Ion Batteries: Basics and Applications“ Springer-Verlag GmbH Germany, part of Springer Nature 2018, ISBN 978-3-662-53069-6 G. Wedler, H.-J. Freund; „Lehr- und Arbeitsbuch Physikalische Chemie“, Wiley-VCH, Weinheim 2018, ISBN: 978-3-527-34611-0 R.A. Huggins; „Energy Storage“, Springer Science&Business Media, LLC 2010, ISBN 978-1-4419-1023-3 C. Breitkopf, K. Swider-Lyons (Eds.); „Springer Handbook of Electrochemical Energy“ Springer-Verlag Berlin Heidelberg 2017, ISBN: 978-3-662-46656-8 R. Dronskowski, S. Kikkawa, A. Stein (Ed.); <i>Handbook of Solid State Chemistry: Materials and Structure of Solids, Synthesis, Characterization, Nano and Hybrid Materials, Theoretical Description, Applications: Functional Materials</i>; Verlag Wiley-VCH Verlag; Weinheim; 1. Auflage 2017; ISBN: 978-3527325870. J. Goldstein, D. Newbury, D. Joy, J. Michael, N.W.M. Ritchie, J.H. Scott, <i>Scanning Electron Microscopy and X-Ray Microanalysis</i>; Verlag Springer, Berlin, Heidelberg; 4. Auflage 2017; ISBN: 978-1493966745. G. Schwedt, T. Schmidt, O. J. Schmitz; <i>Analytische Chemie: Grundlagen, Methoden und Praxis</i>; Verlag Wiley-VCH; Weinheim; 3. Auflage 2016; ISBN: 978-3527340828. E. Tag, Elektrochemie, Studienbücher Chemie, Diesterweg, Salle, Sauerländer, ISBN:3425053884 V.S. Bagotsky, Fundamentals of Electrochemistry, Verlag Wiley-VCH, 2005, ISBN:9780471700586 R. Holze, Y. Wu, Elektrochemische Energiewandler und -speicher: Eine Einführung, Verlag Wiley-VCH, 2023, ISBN: 9783527334308 C. Daniel, J.O. Besenhard, Handbook of Battery Materials, Verlag Wiley-VCH, 2011, ISBN:9783527326952
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	written exam, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lecture

**Components to be offered in the
Current Semester**

220678 Examination
Materials for Energy Conversion and Storage

Module 14293 Porous Materials

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14293	Compulsory elective

Modul Title	Porous Materials
	Poröse Materialien
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Klepel, Olaf
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	6
Learning Outcome	The students acquire comprehensive knowledge on important classes of porous materials, their preparation and characterization. By studying original scientific literature on their own, students are able to analyse scientific texts and reflect on their content in the context of the lecture material. In addition, students have acquired further personal skills related to the degree programme through communicative discussion in seminars.
Contents	• nature of porosity • textural characterization of porous materials by adsorption methods • material classes: zeolites, activated carbons, silica gel, porous glass, metal organic frameworks, porous polymers, ordered mesoporous material, membranes
Recommended Prerequisites	Knowledge of inorganic, organic and physical chemistry
Mandatory Prerequisites	Module 12276 Porous Materials was not successfully completed.
Forms of Teaching and Proportion	Seminar - 1 hours per week per semester Self organised studies - 165 hours
Teaching Materials and Literature	• Video-based teaching material (asynchronous) • Original scientific literature
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	2 written exams, each 45 minutes, weighted 50%

Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	Cannot be taken if Module 12276 Porous Materials has already been taken or is being taken at the same time.
Module Components	Seminar Porous Materials
Components to be offered in the Current Semester	220526 Seminar Porous Materials - 1 Hours per Term

Module 14294 Lab Course Processes in Porous Materials

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14294	Compulsory elective

Modul Title	Lab Course Processes in Porous Materials
	Laborkurs Prozesse in porösen Materialien
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Klepel, Olaf
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	After completing the module, students will be able to experimentally investigate and analyse physico-chemical processes in highly porous materials and draw conclusions about the properties of the investigated material. They are able to derive strategies for the synthesis of porous materials based on the evaluation of scientific literature and to implement them in practice. The ability to work in a team is promoted by working in small groups. Students are able to familiarise themselves independently with a topic and plan courses of action under given boundary conditions. They have acquired personal skills related to the degree programme through the communicative discussion during the practical course and are able to work on and discuss questions relating to the practical course in small groups.
Contents	- development of strategies for the synthesis of porous materials - Characterisation of surface functionalities of porous materials - Experimental investigation of adsorptive properties of porous materials (e.g. silicate or carbon-based materials) - Experimental investigations into the transport behaviour of substances in porous materials
Recommended Prerequisites	• Knowledge in the field of porous materials such as porous carbons, zeolites or porous silicate materials • Knowledge of adsorption, diffusion and heterogeneous catalysis • Successfully completed the modules 14293 Porous Materials, 14041 Processes in Porous Materials and 14641 Heterogeneous Catalysis
Mandatory Prerequisites	none

Forms of Teaching and Proportion	Laboratory training - 5 hours per week per semester Self organised studies - 105 hours
Teaching Materials and Literature	- Instructions for the laboratory course - Marsh, H., Rodriguez Reinoso, F.: Activated Carbon, Elsevier Science & Technology, 2006. - Weitkamp J., Puppe, L.: Catalysis and Zeolites, Springer, 1999. - Schüth, F., Sing, K.S.W., Weitkamp, J.: Handbook of porous Solids, Wiley-VCH, 2002.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	5 Practical experiments with 10 pages protocol (70%) and summarising 20-minute presentation (30%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• laboratory training
Components to be offered in the Current Semester	No assignment

Module 14296 Thermo-mechanical Treatment of Metallic Materials

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14296	Compulsory elective

Modul Title	Thermo-mechanical Treatment of Metallic Materials Thermomechanische Behandlung von metallischen Werkstoffen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. habil. Weiß, Sabine
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students will gain an in-depth knowledge of the fundamentals of hot forming of metallic materials and the microstructure evolution during hot forming. They will learn about the main defects that occur during different thermomechanical processes and how to mitigate their formation. They will also learn how to apply the Dynamic Materials Model to evaluate the hot formability of various metals and alloys. The thermo-mechanical treatment of different types of steels will be reviewed, giving students further knowledge of forming and deformation of steels in different applications, e.g. car body and pipeline applications.
Contents	Introduction to plasticity: • Flow stress and strains • Yield criteria • Fracture Hot deformation: • Flow stresses • Hot deformation microstructures • Hot deformation and dynamic softening mechanisms • Recovery • Recrystallization of single-phase and two-phase alloys • Grain growth following recrystallization Hot workability assessment • Dynamic materials model • Processing maps Forming techniques:

	• Forging • Rolling • Extrusion • Wire drawing
	Defects in thermo-mechanical processing: • Form defects • Surface defects • Cracking • Other structural and process-related defects
	Thermomechanical processing of steel: • Low carbon steels • Dual phase and TRIP steels • HSLA steels
	Severe plastic deformation
Recommended Prerequisites	• 11915 Grundlagen der Werkstoffe (or equivalent expertise in fundamentals of materials)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Study project - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	none
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Study project with final presentation, ~30 min. (30%) and • Written exam, 60 min. (70%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	none
Components to be offered in the Current Semester	340644 Lecture Thermo-mechanical Treatment of Metallic Materials - 2 Hours per Term 340645 Project Seminars Thermo-mechanical Treatment of Metallic Materials - 2 Hours per Term

Module 14297 Polymer Chemistry

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14297	Compulsory elective

Modul Title	Polymer Chemistry
	Polymerchemie
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. Neffe, Axel T.
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	After completing the module, students will be able to correlate the chemical structures of polymers with their physico-chemical properties. They have become familiar with the structure, various methods for the synthesis, properties and modern applications of functional polymers. Students have knowledge and practical skills in the planning, implementation and evaluation of laboratory projects. They are able to plan tasks assigned to them with the aid of literature research, implement them using standard laboratory equipment, evaluate, document and present the results. In the practical laboratory work, students are familiarized with basic operations for the synthesis and purification of polymers. The synthesis operations enable students to set up and operate standard reaction apparatus and encourage them to develop purification strategies for polymer reaction products. Using the example of carrying out syntheses that follow known reaction mechanisms and processing organic analyses, the practical part pursues the fundamental aim of consolidating existing theoretical knowledge of the reactivity of functional groups and applying it in practice. This provides students with knowledge and practical skills in the planning, implementation and evaluation of laboratory projects. They are able to plan the tasks assigned to them with the aid of literature research, implement them using standard laboratory equipment, evaluate, document and present the results. Students have acquired course-related personal skills through communicative discussion in seminars / practical training.
Contents	Technical polymerizations, materials from regrowing resources and circular polymer economy, ring-opening polymerization, stereocrystallization, gelatin- and silk-based materials, advanced

	polymer synthesis, functional polymers and their applications such as electrically conducting polymers, liquid-crystalline elastomers, self-healing materials, and shape-memory polymers, AI in polymer research.
Recommended Prerequisites	A preliminary introduction to polymer chemistry and some practical experience with organic chemical reactions and purification procedures are highly recommendend. Modules 14309 (Modern Concepts of Materials Design) and 14298 (Methods in Material Analytics) will be helpful.
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Practical training - 4 hours per week per semester Self organised studies - 90 hours
Teaching Materials and Literature	All lecture contents are provided as slides for download. In addition to the stated original literature, text books of help could e.g. be • Hiemenz, P.C.: Polymer Chemistry. The Basic Concepts. • Young RJ, Lovell PA, Introduction to Polymers (3rd Ed), CRC Press. • Hiemenz PC, Lodge TP, Polymer Chemistry (2nd Ed), CRC Press. • Bovey, F.A. and Winslow, F.H., Eds.: Macromolecules, an introduction to polymer science. • Cowie, J.M.G.; Arrighi, V: Polymers: Chemistry and Physics of Modern Materials, CRC Press. • Koltzenburg, S.; Maskos, M.; Nuyken, O.: Polymere: Synthesis, Properties and Applications, Springer Spektrum. • Tieke, B.: Makromolekulare Chemie – Eine Einführung, Wiley VCH.
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisites: Participation in the practical course with 6-8 experiments, at least 2/3 of the experiments successfully performed, and an accepted version of the protocols to each of the experiments. MAP: oral examination on the lecture and practical part, 30 min.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	20
Remarks	This module is offered the last time in Summer Semester 2026.
Module Components	• Lecture Polymer Chemistry • Practical training Polymer Chemistry • Module examination (oral)
Components to be offered in the Current Semester	220377 Examination Polymer Chemistry

Module 14298 Methods in Material Analytics

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14298	Compulsory elective

Modul Title	Methods in Material Analytics Methoden der Materialanalytik
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Schmidt, Peer Prof. Dr. rer. nat. Neffe, Axel T.
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The aim is for students to be able to apply classical methods of inorganic and organic analytical chemistry to materials and to become familiar with other analytical methods that have been developed specifically for the characterization of materials. After completing the module, students will be able to select suitable characterization methods for a specific problem, reproduce and explain the physicochemical principles of the measurement methods, and evaluate and correlate the data obtained from the various methods. In the practical laboratory work, students are familiarized with typical methods of material analysis and learn about sources of error. Practical work includes the evaluation and assessment of the data obtained. This provides students with knowledge and practical skills in the planning, implementation and evaluation of laboratory projects. They are able to plan tasks assigned to them with the help of literature research, implement them using standard laboratory equipment, evaluate, document and present the results. Students have acquired course-related personal skills through communicative discussion in seminars / practical training.
Contents	• Introduction: Symmetry of solid state and molecular structures • Introduction: Interactions of electromagnetic radiation with matter • Diffraction (XRD/WAXS/SAXS) • Electron microscopy (SEM, SE, BSE, Auger, EDX/WDX) • Thermal analysis methods (DTA, DSC, TGA, coupling methods) • Mechanical investigations (rheology, tensile strain experiments) • Spectroscopy (NMR, IR, Raman) • Mass spectrometry of surfaces and macromolecules

	• Light scattering, viscosimetry • Chromatographic methods (GPC/SEC, HPLC)
Recommended Prerequisites	Basics in instrumental analytics and spectroscopy
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Practical training - 3 hours per week per semester Self organised studies - 105 hours
Teaching Materials and Literature	All content of the lecture can be downloaded as slides. In addition, selected parts of: • Koltzenburg, S.; Maskos, M.; Nuyken, O.: Polymer Chemistry, Springer Spektrum. • Spectroscopic Techniques for Polymer Characterization (Ed. by Yukihiro Ozaki and Harumi Sato), Wiley-VCH • K. Tashiro: Structural Science of Crystalline Polymers, Springer • U.W. Gedde, M.S. Hedenqvist, M. Hakkarainen, F. Nilsson, O. Das, Applied Polymer Science, Springer • I. Fleming, D. Williams: Spectroscopic Methods in Organic Chemistry, Springer
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisite: Conducting all scheduled experiments and approved protocol MAP: Written exam, 120 min.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	This module combines well with Module 14777 Advanced Organic and Polymer Synthesis
Module Components	• Lecture Methods in Analytical Chemistry • Practical Course Methods in Analytical Chemistry • Module Examination (written)
Components to be offered in the Current Semester	220270 Lecture Methods in Material Analytics - 2 Hours per Term 220273 Practical training Methods in Material Analytics - 3 Hours per Term 220278 Examination Methods in Material Analytics

Module 14309 Modern Concepts of Materials Design

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14309	Compulsory elective

Modul Title	Modern Concepts of Materials Design
	Moderne Konzepte der Materialentwicklung
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Klepel, Olaf
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Upon completion of the module, students will be familiar with various techniques for the chemical preparation and characterisation of materials and their precursors. This includes the safe use of various glassware and laboratory equipment, the assembly of chemical apparatus, and the safe handling of hazardous substances in accordance with applicable legislation. In addition, students will be introduced to current topics in chemical materials research. Through active engagement in discussions, students acquire personal skills relevant to their degree programme. They are able to work on and discuss basic questions relating to materials chemistry in small student groups or research groups.
Contents	• Experimental design, record-keeping, handling of chemicals and hazardous substances • Setting up apparatus for chemical material synthesis • Preparation of materials in the field of chemical material synthesis • Characterisation of synthesised materials and discussion of the results
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 1 hours per week per semester Laboratory training - 4 hours per week per semester Self organised studies - 105 hours

Teaching Materials and Literature	Scientific literature on the research topics of the Institute's working groups
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	1. Conducting chemical experiments (6-9), including the associated reports; marked (70%) 2. Colloquium consisting of a presentation (15 mins) and a discussion (10 mins); marked (30%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	20
Remarks	Students perform the practical course either within a working group of the Institute of Materials Chemistry of BTU Cottbus-Senftenberg or conduct experiments in a teaching lab, based on their prior knowledge and educational background. In the practical course, they either focus on fundamental laboratory experiments to learn general and specific laboratory techniques, or undertake simple research tasks in the field of materials chemistry. This module is a prerequisite for module 14777 "Advanced Organic and Polymer Synthesis"
Module Components	Lecture and practical course
Components to be offered in the Current Semester	220560 Lecture Modern Concepts of Materials Design - 1 Hours per Term 220563 Laboratory training Modern Concepts of Materials Design - 4 Hours per Term

Module 14326 Solid State Chemistry

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14326	Compulsory elective

Modul Title	Solid State Chemistry Festkörperchemie
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Schmidt, Peer
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The students will be able to recognize the connection between bonding theory concepts for solids and the formation of characteristic structural motifs and distinguish the typical crystal structures of inorganic solids. They are also able to demonstrate the structure-property relationships of inorganic solids. With the help of their acquired knowledge of the thermodynamics and kinetics of solid-state reactions, students gain a rational approach to methods and processes of inorganic solid-state and materials synthesis. The students reflect on the lecture material and are able to discuss relevant scientific problems in solid state and materials chemistry. With reference to current issues, they can carry out literature research and open up scientific publications and reports. They will be able to combine different concepts in relation to synthesis approaches, the description of ideal and real structures, and the structure-property relationships of inorganic solids and materials. The students can collaborate in small working groups, develop solutions to given problems and present their results orally and in writing. Students will also be enabled to transfer their knowledge to laboratory work. They are able to familiarize themselves independently with an experimental topic, plan work processes under given conditions, organize themselves in a laboratory group and carry out chemical experiments. Finally, they can save experimental data, document their work in reports and communicate in presentations. The specialist knowledge in theory and laboratory work provides students with in-depth expertise of syntheses, structures and properties

of inorganic solids and materials and qualifies them for further involvement in scientific research as well as in application-oriented research and development of new materials.

Contents

Lecture:

- Bonding concepts for inorganic solids
- Structures of crystalline inorganic solids
- Structure-property relationships of inorganic solids and materials
- Thermodynamics and kinetics of phase formation
- Synthesis of inorganic solids and materials
- Crystal growth processes of inorganic solids and materials
- Current concepts in solid state chemistry

Practical course:

- Modern laboratory methods of chemical synthesis of inorganic solids and materials
- Chemical analysis and structure determination of inorganic solids and materials
- Application of basic thermodynamic calculation methods for rational synthesis planning

Recommended Prerequisites

Knowledge of the topics/basic courses in general chemistry, inorganic chemistry, physical chemistry, instrumental analytics

Mandatory Prerequisites

none

Forms of Teaching and Proportion

Lecture - 2 hours per week per semester
Laboratory training - 3 hours per week per semester
Self organised studies - 105 hours

Teaching Materials and Literature

- L. Smart, E. Moore, *Solid State Chemistry: An Introduction*, CRC Press; 5. Edition, 2020, ISBN: 978-0367135720.
- A.R. West, *Solid State Chemistry and its Applications*, Wiley & Sons; 2. Edition, 2022, ISBN: 978-1118447444
- U. Müller, *Inorganic Structural Chemistry (Inorganic Chemistry, Band 22)*, Wiley & Sons Inc; 2. Edition (2006), ISBN: 978-0470018644.
- U. Schubert, N. Hüsing; *Synthesis of Inorganic Materials*; Verlag Wiley-VCH; Weinheim; 4. Auflage 2019; ISBN: 978-3527344574.
- D. Klimm, *Thermal Analysis and Thermodynamics: In Materials Science*, De Gruyter; 1. Edition, 2022, ISBN: 978-3110743777.
- R. Dronskowski, S. Kikkawa, A. Stein (Edt.); *Handbook of Solid State Chemistry: Materials and Structure of Solids, Synthesis, Characterization, Nano and Hybrid Materials, Theoretical Description, Applications: Functional Materials*; Verlag Wiley-VCH Verlag; Weinheim; 1. Auflage 2017; ISBN: 978-3527325870.

Module Examination

Prerequisite + Final Module Examination (MAP)

Assessment Mode for Module Examination

Prerequisite:

- Successful completion of the practical course

Final module examination:

- Written examination, 120 min.

Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Lecture solid state chemistry • Laboratory training solid state chemistry • Module examination (written exam)
Components to be offered in the Current Semester	220260 Lecture Solid State Chemistry - 2 Hours per Term 220263 Laboratory training Solid State Chemistry - 3 Hours per Term 220268 Examination Solid State Chemistry

Module 14408 Biomaterials I

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14408	Compulsory elective

Modul Title	Biomaterials I
	Biomaterialien I
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. Rosencrantz, Ruben R.
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Lernziele / <i>Learning Outcome*</i> At the end of the module the students are able to understand the use of biomaterials in various modern concepts as well as the definition of biomaterials versus biofunctional materials. The module is designed to provide students with a comprehensive understanding of the principles, design, and applications of materials used in biological settings. By the end of the module, students will have acquired theoretical knowledge essential for the development, characterization, and evaluation of biomaterials. Specifically, students will be able to: Understand the fundamental principles of biomaterials - Identify the different types of biomaterials and understand their chemical, physical, and biological properties. - Comprehend the key concepts of biocompatibility, biodegradability, and biofunctionality. Explore the interactions between biomaterials and biological systems - Analyze the chemical and physical interactions between biomaterials and biological tissues, focusing on factors such as protein adsorption, immune responses, and tissue integration. Design and tailor biomaterials for specific biomedical applications - Evaluate the materials' suitability for specific uses, such as in tissue engineering, drug delivery, and medical devices. - Understand the requirements and strategies for tailoring material properties to improve functionality Characterize and assess the performance of biomaterials - Master analytical techniques for the characterization of biomaterials, including mechanical, chemical, and biological properties.

In the seminar students will critically analyze recent advances and emerging trends in biomaterials research

- Stay up to date with the latest scientific and technological advancements in biomaterials, including nanomaterials, smart materials, and 3D bioprinting.

Contents	- Definition biomaterials, degradable polymers, biodegradation - Polymer synthesis and characterization - Functional Polymers - Functional Biomolecules (Proteins, DNA, Glycans) - Combining functional biomolecules and polymers - Bioassays - Interactions of polymeric materials and cells
Recommended Prerequisites	Basic knowledge of organic and inorganic chemistry, polymer science, and physical chemistry is recommended.
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 105 hours
Teaching Materials and Literature	Materials will be provided (lecture script, publications and other materials) at the start of the lecture and subsequently during the module
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisite: • Presentation on given topic in the seminar (15 minutes) and discussion (not graded) MAP: • Written or oral exam on the topics of the lecture (graded), 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Lecture Biomaterials I • Seminar Biomaterials I
Components to be offered in the Current Semester	220720 Lecture Biomaterials I - 3 Hours per Term 220725 Seminar Biomaterials I - 2 Hours per Term 220728 Examination Biomaterials I

Module 14409 Biomaterials II Lab Course

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14409	Compulsory elective

Modul Title	Biomaterials II Lab Course
	Biomaterialien II Laborkurs
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. Rosencrantz, Ruben R.
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The Biomaterials module is designed to provide students with a comprehensive understanding of the principles, design, and applications of materials used in biomedical settings. By the end of the module, students will have acquired both theoretical and practical knowledge essential for the development, characterization, and evaluation of biomaterials. Specifically, students will be able to: • Understand the fundamental principles of biomaterials • Comprehend the key concepts of biocompatibility, biodegradability, and biofunctionality • Explore the interactions between biomaterials and biological systems • Synthesize biomaterials • Analyze the chemical and physical interactions between biomaterials and biological matter • Design and tailor biomaterials • Assess the degradation of materials • Utilize 3D-bioprinting
Contents	• Synthesis and characterization of biomaterials or components thereof • Functional Biomolecules • Bioassays • 3D printing of biomaterials
Recommended Prerequisites	Successfully completed Module „Biomaterials I“
Mandatory Prerequisites	none

Forms of Teaching and Proportion	Seminar - 1 hours per week per semester Laboratory training - 4 hours per week per semester Self organised studies - 105 hours
Teaching Materials and Literature	Materials will be provided (script for practical course, publications and other materials) at the start of the module and subsequently during the semester.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Reports on the laboratory work of approx. 10 to 20 pages (60%) • Presentation (15 min) and discussion (10 min) of the results (40%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	5
Remarks	none
Module Components	• Seminar Biomaterials II • Laboratory training Biomaterials II
Components to be offered in the Current Semester	No assignment

Module 14641 Heterogeneous Catalysis

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14641	Compulsory elective

Modul Title	Heterogeneous Catalysis Heterogene Katalyse
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Klepel, Olaf
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	6
Learning Outcome	After completing this module, students will be able to investigate the course of heterogeneously catalysed reactions by linking knowledge from inorganic, physical and organic chemistry. They will be able to describe the structure and mode of action of important catalyst systems and characterise important catalyst types. Through self-study of original scientific literature, students will be able to understand German and English texts and reflect on their content in the context of the lecture material. In addition, students will have acquired further personal skills relevant to their degree programme through communicative interaction in seminars.
Contents	Fundamentals of micro- and macrokinetics, synthesis and characterisation of solid catalysts (acid catalysts, metal catalysts, transition metal oxides, carbon materials) and mechanisms of associated catalysed reactions, fundamentals of electrocatalysis and heterogeneous photocatalysis
Recommended Prerequisites	fundamental knowledge in general, inorganic, physical chemistry and physics
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Seminar - 1 hours per week per semester Self organised studies - 165 hours
Teaching Materials and Literature	• Video-based teaching material (asynchronous) • Baerns, M.; Behr, A.; Brehm, A. et al.: Technische Chemie, Wiley-VCH, 2013.

- Reschetilowski, W.: Einführung in die Heterogene Katalyse, Springer 2015.
- Weitkamp J., Puppe, L.: Catalysis and Zeolites, Springer, 1999.

Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	2 written exams, each 45 minutes, weighted 50%
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Seminar, examination
Components to be offered in the Current Semester	220582 Seminar Heterogeneous Catalysis - 1 Hours per Term

Module 14777 Advanced Organic and Polymer Synthesis

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14777	Compulsory elective

Modul Title	Advanced Organic and Polymer Synthesis
	Organische und Polymersynthese für Fortgeschrittene
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. Neffe, Axel T.
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	After successfully finishing the module, students have knowledge and practical skills in the planning, implementation and evaluation of laboratory projects. They are able to plan tasks assigned to them with the aid of literature research, implement them using standard laboratory equipment, evaluate, document and present the results.

In the practical laboratory work, students are familiarized with basic operations for the synthesis and purification of polymers as well as advanced organic reactions (e.g. under inert conditions). The synthesis operations enable students to set up and operate standard reaction apparatus and encourage them to develop purification strategies for small molecule and polymer reaction products. Using the example of carrying out syntheses that follow known reaction mechanisms and processing organic analyses, the practical part pursues the fundamental aim of consolidating existing theoretical knowledge of the reactivity of functional groups and applying it in practice. Students have acquired course-related personal skills through communicative discussion in seminars / practical training

Furthermore, the students know how to

- prepare risk assessments for syntheses,
- set up and operate advanced reaction apparatus,

- perform advanced operations in organic and polymer synthetic chemistry,
- evaluate and select purification methods for reaction mixtures and means of characterization,
- solve problems that arise during experiments,
- evaluate experimental results based on their quality and formulate suggestions for improvement,
- identify the causes of failed experiments,
- relate experimental results to theoretical concepts,
- independently organize a day in the laboratory through individual or group work,
- communicate using technical terminology during laboratory work

Contents

- advanced organic reactions such as under inert conditions, with metalorganic reagents and catalysts etc.

- Free radical and controlled radical polymerization, polycondensation, polymer analogous reactions, ring-opening polymerization

Recommended Prerequisites

14995 Advanced Organic and Polymer Chemistry; 14298 Methods in Material Analytics

Practical experience with fundamental procedures in experimental organic chemistry

Mandatory Prerequisites

14309 (Modern Concepts in Material Design)

Forms of Teaching and Proportion

Laboratory training - 90 hours
Self organised studies - 90 hours

Teaching Materials and Literature

- Original and review articles
- D. Braun, H. Cherdrón, M. Rehahn, H. Ritter, B. Voit: Polymer Synthesis: Theory and Practice, Springer 2005 [available online as ebook via the BTU library]
- Organikum: organisch-chemisches Grundpraktikum, Wiley or alternatives in English, typically named "Experimental Organic

	Chemistry" or John Leonard, Barry Lygo, Garry Procter: Advanced Practical Organic Chemistry, CRC Press 2013
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Precondition: Participation in the practical course with 9 experiments, at least 2/3 of the experiments successfully performed, and an accepted version of the protocol MAP: oral examination, 30 min.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	20
Remarks	Module cannot be taken when successfully having passed module 14297 (Polymer Chemistry) The module may be a part of focussing on polymeric materials and will combine well with the modules Modern Concepts of Material Design (14309), Methods in Material Analytics (14298), Biomaterials (14408), and Advanced Organic and Polymer Chemistry (14995)
Module Components	• Lab Course Advanced Organic and Polymer Synthesis – mandatory • Module Examination (oral) – mandatory
Components to be offered in the Current Semester	No assignment

Module 14995 Advanced Organic and Polymer Chemistry

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14995	Compulsory elective

Modul Title	Advanced Organic and Polymer Chemistry Organische und Polymerchemie für Fortgeschrittene
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. Neffe, Axel T.
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After completing the module, students will be able to comprehend and plan multistep and stereoselective syntheses, as well as explain and apply reaction mechanism beyond the undergraduate level. The students will furthermore be able to correlate the chemical structures of polymers with their physico-chemical properties and functions. They have become familiar with the structure, various methods for the synthesis, properties and modern applications of functional polymers.
Contents	Stereoselective syntheses, pericyclic reactions, re-arrangements, metalorganic reactions, multistep synthesis and synthesis planning. Technical polymerizations and advanced polymer synthesis, Materials from regrowing resources and circular polymer economy, ring-opening polymerization, stereochemistry in polymer science, biopolymer-based materials, functional polymers and their applications such as in battery research, liquid-crystalline elastomers, self-healing materials, and shape-memory polymers, AI in polymer research
Recommended Prerequisites	Sound knowledge of basic organic and polymer chemistry
Mandatory Prerequisites	Students must not have previously taken and passed Module 14297 (Polymer Chemistry)
Forms of Teaching and Proportion	Lecture - 4 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	- All lecture contents are provided as slides for download. - Vitomir Sunjic, Vesna Petrovic Perokovic: Organic Chemistry from Retrosynthesis to Asymmetric Synthesis, Springer 2016 [available online as ebook via the BTU library] - Jie Jack Li: Name Reactions, Springer 2021 [available online as ebook via the BTU library] - Sebastian Koltzenburg, Michael Maskos, Oskar Nuyken: Polymers: Synthesis, Properties and Applications. Springer 2022 [available online as ebook via the BTU library] - March's advanced organic chemistry: reactions, mechanisms, and structure, Wiley - Original articles and reviews from the chemical literature
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	MAP = oral examination, 30 min.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	Module cannot be taken when successfully having passed module 14297 (Polymer Chemistry) The module may be a part of focussing on polymeric materials and will combine well with the modules Modern Concepts of Material Design (14309), Methods in Material Analytics (14298), Biomaterials (14408), and Advanced Organic and Polymer Synthesis (14777)
Module Components	• Lecture Advanced Organic and Polymer Chemistry – mandatory • Module Examination (oral) – mandatory
Components to be offered in the Current Semester	220370 Lecture Advanced Organic and Polymer Chemistry - 4 Hours per Term 220378 Examination Advanced Organic and Polymer Chemistry

Module 14999 Radio- and Coordination Chemistry

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14999	Compulsory elective

Modul Title **Radio- and Coordination Chemistry**

Radio- und Koordinationschemie

Department Faculty 2 - Environment and Natural Sciences

Responsible Staff Member Prof. Dr. rer. nat. habil. Schmidt, Moritz

Language of Teaching / Examination English

Duration 1 semester

Frequency of Offer Every winter semester

Credits 6

Learning Outcome Participation in this module allows students to identify coordination compounds (complexes), assign correct nomenclature and derive structures from it. Students will be able to derive electronic and spectroscopic properties from the molecular structures and to understand and predict periodic trends within the periodic table for the elements. This includes analyzing chemical bond properties and applying the derived understanding to current questions in materials chemistry, separation science, or in (radio)pharmaceutical contexts.

Further, participation in the module will enable a student to evaluate the stability of atomic nuclei based on sound theoretical foundations. They will be able to understand and predict which type of radiation (α , $\beta^{+/-}$, ϵ , γ ,) is to be expected based on a given nuclear composition and how these types of radiation interact with matter. The latter can then be applied for radiation shielding as well as detection. The student will be capable of assessing the chemical properties of radioactive elements particularly relating the specialties separating the chemistry of heavy elements from their lighter homologues (relativity, spin-orbit coupling). The student will understand how these chemical properties affect processes in the context of a nuclear fuel cycle.

The students will be enabled to understand physical principles of nuclear fission and fusion and how these processes can be applied for the generation of electricity. This will include general processes in the nuclear fuel cycle from mining and raffination to reprocessing and final disposal of nuclear wastes.

Contents

Bonding in coordination compounds; dative bonds; Hydration, solvation, hydrolysis, Olation and oxolation; Nomenclature of complexes; Isomery; Pearson's concept of hard and soft acids and bases; Mass action law and complex stability

Structures of coordination compounds: Symmetry, Coordination numbers and polyhedra, Valence shell electron pair repulsion concept, Solution vs. solid state;

Electronic structure: Ligand field, Low and high spin, Molecular orbital theory, σ -, π -, (and ϕ -) bonds, Jahn-Teller effect, Electronic terms and spectra, Charge transfer; NMR spectroscopy; EPR spectroscopy; SQUID magnetometry

Complex stability and reactivity: Chelate and macrocyclic effects, bands, Redox chemistry, Marcus theory, Non-innocent ligands, NO chemistry, Ligand activation; Organometallic Chemistry: Fundamental reactions

Actinide chemistry: Fundamentals; Redox chemistry; Actinyl ions and cation-cation interactions; Separation chemistry; Bond analysis MOF chemistry | Fundamentals | Applications

Radioactivity: Nuclear stability and types of radiation; interaction of radiation and matter; natural and anthropogenic radioactivity

Nuclear fuel cycle: Uranium mining and processing; Enrichment; Nuclear energy generation and reactor concepts; Reprocessing; Nuclear waste disposal

Applications: Nuclear medicine; Radioecology; Nuclear weapons; Isotope production

Recommended Prerequisites

General Chemistry, Organic Chemistry, Spectroscopy

Mandatory Prerequisites

none

Forms of Teaching and Proportion

Lecture - 4 hours per week per semester
Self organised studies - 120 hours

Teaching Materials and Literature

B. Weber, Koordinationschemie: Grundlagen und aktuelle Trends, 1. Auflage, SpringerSpektrum, 2014

N. Wiberg, A. Holleman, Lehrbuch der Anorganischen Chemie, De Gruyter; 102. Auflage, 2007

L. Gade, Koordinationschemie, 1. Auflage, WileyVCH, 2010

J.-V. Kratz, K.H. Lieser: Nuclear and Radiochemistry: Fundamentals and Applications, Zwei Bände, 3. Auflage, Wiley-VCH, 2013

S. Cotton, Lanthanide and Actinide Chemistry, Wiley, 1. Auflage, 2006

Module Examination

Final Module Examination (MAP)

Assessment Mode for Module Examination

Module examination: oral exam of 20 min duration

Evaluation of Module Examination

Performance Verification – graded

Limited Number of Participants

none

Remarks

none

Module Components

Lecture Coordination chemistry – Mandatory

Lecture Radiochemistry – Mandatory

Module exam (Oral exams) – Mandatory

Components to be offered in the Current Semester

220062 Lecture
Coordination Chemistry - 2 Hours per Term
220063 Lecture
Radiochemistry - 2 Hours per Term
220069 Examination
Radio- and Coordination Chemistry

Module 15016 Current Topics in Polymer Science

assign to: Specialisation Materials Chemistry

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	15016	Compulsory elective

Modul Title	Current Topics in Polymer Science
	Aktuelle Themen in der Polymerwissenschaft
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Dr. rer. nat. Reinicke, Stefan
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After participating in the module, students will be able to acquire detailed knowledge on current research questions and developments in the field of polymer science, including synthesis, characterization, processing, and application of new polymer types and formulations from review articles and other sources, and to critically evaluate reports in the scientific literature. Students will be able to fully comprehend and reproduce described novel concepts based on available sources and classify them according to their significance for the respective research field. Through the module content, students will acquire comprehensive knowledge of modern synthesis methods and analysis techniques.
Contents	The following topics will be addressed, among others: • Modern Synthesis Methods: Sequence-controlled polymerization; enzyme-catalyzed polymerization; post polymerization modification • Stimuli-responsive Polymers: Synthesis, characterization, and application • Out-of-equilibrium (Supramolecular) Materials; Adaptive and autonomous systems • Protein-Polymer Conjugates: Synthesis and application • Polymer Recycling and Microplastics • 3D Printing and Biomedical Materials • Block Copolymer Self-Assembly • Functional Polymer Materials in the context of climate change
Recommended Prerequisites	Fundamentals in organic chemistry and polymer chemistry, basic knowledge of fundamental polymerization methods and analysis techniques.

Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Selected individual publications, review articles, and textbook excerpts.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	Presentation (15 min) of a module topic (50% of the grade) and scientific colloquium (15 min) (50% of the grade).
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lecture and Seminar "Current Topics in Polymer Science"
Components to be offered in the Current Semester	220070 Lecture Current Topics in Polymer Science - 2 Hours per Term 220075 Seminar Current Topics in Polymer Science - 2 Hours per Term

Module 12233 Experiments in Aerodynamics and Fluid Mechanics

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	12233	Compulsory elective

Modul Title	Experiments in Aerodynamics and Fluid Mechanics Experimente in Aerodynamik und Strömungslehre
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Egbers, Christoph
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Participants of the module Experiments in aerodynamics and fluid mechanics will be able to understand the topic from an analytic and a practical point of view. The main scope is the understanding of fundamental Fluid mechanics. At the end of the module the students are able to understand basic aerodynamic and fluid mechanics phenomena as well as measurement techniques which are state of the art.
Contents	The specific topics will be explained theoretically in the lecture while in the exercise experiments will be performed. The experiments will focus on different fundamental flow phenomena and investigate them using different measurement techniques. The main contents of the module will be: • Wind tunnel • Water tunnel • Flow around bodys • Principle of Airfoil • Laminar flow • Turbulence • Pipe flow • Rotating Machinery • Flow Instabilities • Taylor-Couette flow • Convection • Aeroacoustics • Aeolsharp • Karman Vortex street • Car Aerodynamics • Wheel housing

	• Flow Visualization techniques • Pressure measurements • LASER-based measurement techniques • Particle Image Velocimetry • Laser Doppler Anemometry
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 1 hours per week per semester Exercise - 3 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Selected literature will be presented at the beginning of the module. • Guidelines for the experiments will be given in first lecture
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Written project reports of 10 experiments (2/3) • Oral defense of one experiment, 10 minutes (1/3)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	This module is based on experimental and fluid mechanical knowledge. The interested students should bring skills on these fields.
Module Components	participation in lecture, exercise
Components to be offered in the Current Semester	350124 Lecture Experiments in Aerodynamics and fluid mechanics - 1 Hours per Term 350125 Exercise Experiments in Aerodynamics and fluid mechanics - 3 Hours per Term

Module 12886 Flow Measurements

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	12886	Compulsory elective

Modul Title	Flow Measurements
	Flow Measurements
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Egbers, Christoph
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Understanding the bases of the experimental and optical measurement techniques. The students learn and know the basics of optical flow measurements for Fluid Mechanics and Aerodynamics. After successful completion of the module, they are able to apply the basic methods and measurement techniques to solve experimental Fluid Mechanics and Aerodynamics problems. They are able to work in a team and they are able to present their work in a seminar.
Contents	Methods of Flow Visualization, Overview on Optical Measurement Techniques, Laser-Doppler-Anemometry; Particle-Image-Velocimetry; Particle-Tracking-Velocimetry; Liquid Crystal Technique, Dye-Injection Method; Hot-Wire- and Hot-Film Anemometry, Doppler-Global Velocimetry, Oil-Fim-Technique, Measurement Techniques for Channeland Pipe Flows, Wind Tunnel Measurement Techniques (i.e. Pressure Sensitive Paints).
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	- Selected literature will be presented at the beginning of the module. - Guidelines for the experiments will be given in first lecture
Module Examination	Prerequisite + Final Module Examination (MAP)

Assessment Mode for Module Examination	Prerequisite: • Successful written project reports of 10 experiments Final Module Examination: • Oral examination, 30 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	The lecturer also answers questions in German.
Module Components	• Flow Measurements (Lecture) • Flow Measurements (Exercise) • Flow Measurements (Examination)
Components to be offered in the Current Semester	350147 Lecture Flow Measurements - 2 Hours per Term 350148 Exercise Flow Measurements - 2 Hours per Term 350186 Examination Flow Measurements

Module 12989 Process System Technology II

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	12989	Compulsory elective

Modul Title	Process System Technology II
	Prozesssystemtechnik II
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Arellano-Garcia, Harvey
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The students are able to describe dynamic and locally distributed systems of process engineering with the help of mathematical models. For this purpose, you can make suitable assumptions and neglects for the derivation of a model from the context of a task, then compile them on the basis of material, momentum, energy and property balances and complete them with kinetic approaches, thermodynamic equations of state and suitable boundary and initial conditions , In addition, students are able to apply systematic methods for model reduction, in particular for the reduction of spatial coordinates, for the introduction of quasi-stationarity assumptions and equilibrium assumptions. The students can use the finite-volume method to transform spatially distributed process models into systems of ordinary differential equations, to implement and solve them in a numerical simulation environment.
Contents	1. Modeling strategy: relevant scales, inputs / outputs, assumptions 2. Balancing: partial mass balances, total mass balances, momentum balance, energy balances. Substantive and local formulations 3. Entropy Balance: Source terms, drivers and rivers 4. Balancing of multiphase systems 5. Constitutive equations: Overview of kinetics (reaction, mass and heat transport, impulse transport), thermodynamic equations of state. Stefan Maxwell kinetics of mass transport. 6. Boundary and initial conditions: species, bad and well-posed problems 7. finite volume method 8. method of characteristics 9. Model reduction: quasi stationarity, balance, integration

	10. Differential Algebra Systems: Differential Index, Index Reduction, Solution Methods
Recommended Prerequisites	44303 Prozesssystemtechnik
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• M. Jischa, Konvektiver Impuls-, Wärme- und Stoffaustausch, Vieweg, 1982. • R. Taylor, R. Krishna, Multicomponent Mass Transfer, Wiley, 1993. • B. Bird, et al., Transport Phenomena, Wiley, 2002. • S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, Wiley, 2006. • S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill, 1980. • A. Varma et al., Mathematical Methods in Chemical Engineering, Oxford U. Press, 1997.
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	Examination 120 min
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Summer semester: • Lesson/Exercise Process System Technology II • Examination Process System Technology II
Components to be offered in the Current Semester	360381 Examination Process System Technology II

Module 13278 Energy Systems Engineering

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	13278	Compulsory elective

Modul Title	Energy Systems Engineering
	Energiesystemtechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Arellano-Garcia, Harvey
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	At the end of the module the students are able to analyse, formulate, and solve energy-related engineering problems. They will be able to evaluate, improve and design engineered systems and processes, using modern engineering tools and approaches and demonstrate in-depth knowledge of energy systems in research, manufacturing and management. They will develop an interdisciplinary understanding of the variety of approaches to development, deployment and sustainability of global energy resources.
Contents	• Fundamentals of energy analysis: thermodynamics of energy conversion; mass, energy and exergy balance; systems modelling, analysis, design, and optimisation; control systems • Energy issues, definitions and resources; energy economics. • Sustainable energy technologies; design and operation of distributed energy systems
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Handouts and reading list • Manual and tutorial of the modelling programmes
Module Examination	Final Module Examination (MAP)

Assessment Mode for Module Examination	• Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Energy Systems Engineering, Lecture / Exercises
Components to be offered in the Current Semester	No assignment

Module 13515 Advanced Methods in Process, Energy and Systems Engineering

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	13515	Compulsory elective

Modul Title	Advanced Methods in Process, Energy and Systems Engineering Erweiterte Methoden zur Prozessmodellierung und Optimierung in der Energie- und Verfahrenstechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Arellano-Garcia, Harvey
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	6
Learning Outcome	The module requires a basic background in calculus and linear algebra, thus allowing easy understanding of mathematical reasoning. In addition, numerous examples in process, energy, environmental and systems engineering will demonstrate key concepts and algorithms. The practical exercises will involve theoretical derivations and small-size numerical problems in modelling systems like matlab, python, octave, GAMS thus putting knowledge into practice.
Contents	As part of the block course, students also gain an insight into German technical and everyday language, as well as into German culture. This module will teach approaches to modelling and optimization frameworks to address the complex process and energy problems, which arise in design and operation of process and energy systems in an integrated way. Moreover, the presented theoretical and methodological concepts are joined conceptionally with optimal designed experiments to adjust the fundamental mathematical models and to validate the developed process concepts. The taught methods are of generic character, and thus, producing optimal design and operational plans for process and energy systems ranging from microscale to mega-scale stages over operative time horizons from milliseconds to years. The approaches to be discussed will mainly be around superstructure-based modelling, mixed-integer linear and nonlinear programming, multiobjective optimization, optimization under uncertainty, and life-cycle assessment. The presented case studies will

	be around advanced process systems for renewable energy conversion, separation and reaction systems as well as biotechnological production systems.
Recommended Prerequisites	• Basic background in process engineering • calculus and linear algebra
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 90 hours
Teaching Materials and Literature	• Script zur Vorlesung • Advanced Optimization for Process Systems Engineering. Ignacio E. Grossmann, Cambridge University Press • Optimization for Chemical and Biochemical Engineering: Theory, Algorithms, Modeling and Applications. Vassilios S. Vassiliadis, Walter Kähm, Ehecatl Antonio del Rio Chanona, Cambridge University Press • Systematic Methods of Chemical Process Design. Lorenz T. Biegler, Ignacio E. Grossmann, Arthur W. Westerberg, Prentice Hall • Nonlinear Programming: Concepts, Algorithms, and Applications to Chemical Processes. Lorenz T. Biegler, SIAM, 2010
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written Examination 90 min
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	• The module takes place as a block course • The appointment will be announced in the current semester
Module Components	• VL Advance Methods in Process, Energy and systems Engineering • Ü Advance Methods in Process, Energy and systems Engineering • P Advance Methods in Process, Energy and systems Engineering
Components to be offered in the Current Semester	360352 Seminar Advanced Methods in Process, Energy and Systems Engineering - 2 Hours per Term 360351 Lecture/Exercise Advanced Methods in Process, Energy and systems Engineering - 4 Hours per Term 360390 Examination Advanced Methods in Process, Energy and systems Engineering

Module 13519 CFD 1

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	13519	Compulsory elective

Modul Title	CFD 1
	CFD 1
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schmidt, Heiko
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	6
Learning Outcome	After successful participation the students are able to understand the basic concepts of numerical flow simulation. In the practicals they learn to apply methods to solve sample problems in computational fluid dynamics.
Contents	The topics covered include: • Basic concepts for flows of fluids • Basics of Discretization • Methods for solving large systems of equations • Methods for steady and unsteady flows Conservation property • flow regimes • finite differences • finite volume • lattice types • consistency • stability • convergence • compact differences • up wind schemes • central schemes • implementation of boundary conditions • Gaussian processes and variations • iterative equationsolver • CG-type methods • ADI method • multigrid method • Newton's method • time method for unsteady problems

	• Application to convection and diffusion equation • pressure correction methods
Recommended Prerequisites	• Mathematical knowledge (calculus) • Basics of Fluid Mechanics • Module 11844 <i>Grundlagen der Computersimulation von Strömungen</i>
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• D. Hänel: Mathematische Strömungsmodellierung, Skript • Ferziger, J./ Peric, M.: Computational Methods for Fluid Dynamics, Springer 1996
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	The exam can be in written form or held as an oral exam. • For the written examination: 90 minutes duration • For the oral exam mode: 30 - 40 min duration
	Until the end of the first three weeks of lectures it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• VL/Ü CFD 1 • P CFD 1
Components to be offered in the Current Semester	350440 Lecture/Exercise CFD 1 - 4 Hours per Term 350477 Examination CFD 1

Module 13717 Decarbonisation of Industrial Processes

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	13717	Compulsory elective

Modul Title	Decarbonisation of Industrial Processes Dekarbonisierung von Industrieprozessen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. habil. Riedel, Uwe
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	6
Learning Outcome	Participants of the module will be able to understand the specific challenges of CO₂-reduction in the industrial sectors. Readiness of current and emerging technologies (technology readiness level) and significance for a successful energy transition for various industrial sectors will be discussed. Focus is on the decarbonization of heat as a crosscutting technology and the steel, chemistry, cement sector – each having specific challenges. At the end of the module the students will be able to name the requirements for achieving climate goals in various industrial sectors. Furthermore, students will be able to assess, evaluate, and select different decarbonization strategies for specific industrial processes. Specific cognitive learning goals are: • Apply analysis tools like pinch analysis, techno-economics, and energy-hub designs • Analyze selected industrial processes in case studies • Derive and evaluate suitable decarbonization options in a group-project • Get insights into options for process changes and decarbonization in the sectors steel, chemistry, and cement as well as process heat • Understand the role of Carbon Capture and Use (CCU) and Carbon Capture and Storage (CCS) for unavoidable CO₂-emissions. Affective learning goals are: • Integration in a team and potential conflicts, • deal with feedback in an open presentation session, • deal with potential frustration in a research project.
Contents	The specific topics will be explained in the lecture while the exercise and the project parts will provide more in-depth deeper qualitative and

quantitative analyses. The projects will focus on specific industries and their options to reduce their carbon footprint.

The lecture part is structured as follows:

- Introduction
- Techno-Economic Analysis
- Pinch Analysis
- Renewable Energy Hub Design
- Industrial Heat
- Steel Industry
- Chemical Industry
- Cement Industry

These lectures are supported by exercises on techno-economic analysis, Pinch Analysis, energy hub design and CCU/CCS. The decarbonization techniques learned will then be applied as part of a study project.

Recommended Prerequisites	Bachelor in Engineering or Natural Sciences
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Study project - 2 hours per week per semester Self organised studies - 105 hours per week per semester
Teaching Materials and Literature	• Selected literature will be recommended at the beginning of the module. • Handouts for the lecture will be provided. • Options and guidelines for the project work will be given in the first lecture.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	Option A: • A 10-minute electronic presentation of the study project at the beginning of the exam (1/3 weight) and • Oral exam, 20 minutes, questions related to the lecture and the exercise (2/3 weight) Option B: • Multiple-choice test, 20 minutes (30% weight) • Written examination, 60 minutes: Questions related to the lecture, the exercise, and the outcome of study project (70% weight) The lecturer decides and informs at the beginning of the course which option is used as assessment mode.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• VL Decarbonization of Industrial Processes

- Ü Decarbonization of Industrial Processes
- PROJ Decarbonization of Industrial Processes

**Components to be offered in the
Current Semester**

322201 Lecture

Decarbonization of Industrial Processes - 2 Hours per Term

322202 Exercise

Decarbonization of Industrial Processes - 1 Hours per Term

Module 13831 Process Simulation in Chemical and Process Engineering

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	13831	Compulsory elective

Modul Title	Process Simulation in Chemical and Process Engineering Prozesssimulation in der Chemie- und Verfahrenstechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Arellano-Garcia, Harvey
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After completing the module, students will be able to analyse physical and chemical phenomena involved in different processes, develop mathematical models and use different process simulation approaches using ASPEN PLUS.
Contents	• Fundamentals: Continuity equations, energy conservation, momentum conservation and state equations; Transport properties; Equilibrium and chemical kinetics; Thermodynamic correlations for estimating physical properties. • Use and scope of mathematical modelling; principles of model formulation; principles of steady-state and dynamic simulation; simulation of models; sequential modular approach; Equation-based approach; analysis of simulation data. • Introduction and use of process simulation software for flowchart simulation • Modelling and simulation of specific systems: e.g., heat conduction in a rod; laminar flow of Newtonian fluid in a pipe; heat exchanger; gravity tank, Power Engineering
Recommended Prerequisites	Physics, Mathematics, Thermodynamics
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Practical training - 2 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	• Handouts and reading list • Manual and tutorial of the modelling programs
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination (90 min)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	none
Components to be offered in the Current Semester	360351 Lecture/Exercise Prozesssimulation/Process Simulation - 4 Hours per Term 360385 Examination Process Simulation in Chemical and Process Engineering

Module 13832 Optimisation in Process and Energy Systems Engineering

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	13832	Compulsory elective

Modul Title	Optimisation in Process and Energy Systems Engineering Optimierung in der Verfahrens- und Energiesystemtechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Arellano-Garcia, Harvey
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After participating in this module, the students master the basic knowledge, in terms of mathematical optimization methods and tools. Relevant examples from Energy and Process Engineering are used to enhance the understanding of the various tools and methods taught. The focus is on the formulation of the problems and the approaches for their mathematical solution. The methods covered are applied in accompanying calculation exercises.
Contents	• Introduction: Definition, problem formulation, applications • Linear programming • Non-linear programming • Mixed integer non-linear programming • Dynamic optimization • Stochastic optimization
Recommended Prerequisites	• Chemical Engineering • Thermodynamics • Process Systems Engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 135 hours
Teaching Materials and Literature	• T. F. Edgar, D. M. Himmelblau, Optimization of Chemical Processes, McGraw-Hill, New York, 2001

- L. T. Biegler, I. E. Grossmann, A. W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall, New Jersey, 1997
- C. A. Floudas, Nonlinear and Mixed-Integer Optimization, Oxford University Press, 1995
- J. Nocedal, S. J. Wright, Numerical Optimization, Springer, 2006
- R. Baldick, Applied Optimization, Formulation and Algorithms for Engineering Systems, Cambridge University Press, 2006

Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination (90 min)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL + Ü + Prü Optimization in Process and Energy Systems Engineerin
Components to be offered in the Current Semester	360331 Lecture/Exercise Optimierung in der Energie- und Verfahrenstechnik/Optimization in Process and Energy Systems Engineering - 3 Hours per Term 360386 Examination Optimization in Process and Energy Systems Engineering

Module 14333 Downstream Processing for Products of Industrial Microbiology

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14333	Compulsory elective

Modul Title	Downstream Processing for Products of Industrial Microbiology Aufarbeitung von Produkten der Industriellen Mikrobiologie
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Stahmann, Klaus-Peter
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After completing the module, students should have acquired the following skills: • Lecture: familiarization with industrial applications of processing methods for microbial products to gain an overview; understanding the relationships between material properties and methods of enrichment; recognizing the advantages and disadvantages of different separation methods; understanding the causes of economic successes and failures • Seminar: practicing presentation and scientific discussion, i.e. logical and factual argumentation using appropriate technical language, concentrating on the essentials and dealing fairly with discussion partners. Seminar: Practicing presentation and scientific discussion, i.e. logical, factual argumentation in appropriate technical language, concentration on the essentials and fair treatment of discussion partners; developing a critical attitude towards experiments, results and conclusions; independent development of important connections from review articles and original papers
Contents	• Lecture: • The lecture deals with the recovery and purification of biotechnical products to achieve the desired specification while maximizing yield and minimizing process costs. Often down-stream processing is the most expensive part of the stream. • The focus is firstly on sedimentation of cells and solid particles as well as on alternatives like flocculation and flotation, filtration and

centrifugation. Disintegration techniques are discussed. Product isolation by extraction or sorption is a further chapter. Furthermore precipitation and chromatography as well as membrane separation, e.g. reverse osmosis or ultrafiltration, are interesting topics. Electrophoresis and drying are closing the separate discussion of single methods. After-wards combined operations are explained. A special chapter is the refolding of proteins, which have to gain function, e.g. enzymatic activity, after, e.g. production as inclusion bodies.

- Several examples show economic solutions: commercial enzymes, recombinant proteins, polysaccharides, antibiotics, organic acids, ethanol, and biomass.
- **Seminar:**
- Self-study of original publications, reviews and patents; presentation of a table or a figure with measurement data or scientific models; critical discussion of the data; comparison of the methods presented with alternative methods; discussion of the strengths and weaknesses of selected models

Recommended Prerequisites	Basic knowledge of physics, chemistry, organic chemistry, biochemistry, molecular biology, microbiology, cell biology
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 1 hours per week per semester Self organised studies - 135 hours
Teaching Materials and Literature	Textbooks: Wilson DB, Sahm H, Stahmann KP, Koffas M (2020) Industrial Microbiology, Wiley-VCH, Weinheim Jagschies, G., Lindskog, E., Lacki, K., & Galliher, P. M. (Eds.). (2018). <i>Biopharmaceutical processing: development, design, and implementation of manufacturing processes</i> . Elsevier. Selected reviews, e.g. Hohmann HP, Stahmann KP (2010) Comprehensive Natural Products II. Chemistry and Biology, 10, 115-139. Jungbauer, A. (2013). Continuous downstream processing of biopharmaceuticals. <i>Trends in biotechnology</i> , 31(8), 479-492. Nunes, D. D., Pillay, V. L., Van Rensburg, E., & Pott, R. W. M. (2024). Oleaginous microorganisms as a sustainable oil source with a focus on downstream processing and cost-lowering production strategies: A review. <i>Bioresource Technology Reports</i> , 101871.
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	Written exam graded 120 min
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none

Remarks	none
Module Components	• lecture • seminar • exam
Components to be offered in the Current Semester	210360 Lecture Downstream Processing for Products of Industrial Microbiology - 2 Hours per Term 210365 Seminar Downstream Processing for Products of Industrial Microbiology - 1 Hours per Term 210368 Examination Downstream Processing for Products of Industrial Microbiology

Module 44107 Safety- and Risk-Analysis for Process Plants

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	44107	Compulsory elective

Modul Title	Safety- and Risk-Analysis for Process Plants
	Sicherheits- und Risikoanalyse für Prozessanlagen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Arellano-Garcia, Harvey
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	After completing the module, students will be able to apply basic methods for performing and evaluating safety-related aspects for industrial plants. They learn methodical basics for the evaluation of probabilities of occurrence and the derivation of the resulting consequences. Using the methods taught for qualitative and quantitative risk assessment, students are able to independently develop sustainable concepts and solutions. They also have basic knowledge of safety-related plant optimization and can communicate this to plant operators, authorities, etc.
Contents	• Hazard identification methods (e.g. Checklists, FMEA, HAZOP) • Frequency evaluation methods (event tree, fault tree) • Consequence evaluation methods (e.g. one- and two phase flow (critical, sub-critical), dispersion of neutral and dense gas, fire, explosion and toxic hazards) • Qualitative and quantitative risk assessment methods • Safety related plant optimization Exercise: • Realization of safety and risk studies (method, case study)
Recommended Prerequisites	None
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Practical training - 1 hours per week per semester

	Self organised studies - 120 hours
Teaching Materials and Literature	• Lecture notes • Lees,F.P.: Loss prevention in the process industries, Butterworth 1996, Oxford • Guidelines for chemical process quantitative risk analysis AICHE,1989, New York • Guidelines for hazard evaluation procedures AICHE , 1992, New York • W.F.Kenney: Process risk management systems, VCH 1993, New York • D. A. Crowl;J. F. Louvar: Chemical process safety, Prentice Hall, Inc., 2002, New Jersey
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisite: • Successful completion of the exercises within the practical training Final module examination: • Written examination, 90 min.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	• 238227 Lecture Safety and risk analysis • 238231 Examination Safety- and risk-analysis
Components to be offered in the Current Semester	360375 Examination Safety- and Risk-Analysis for Process Plants

Module 44408 Safety Technology

assign to: Specialisation Fluid- and Process Engineering

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	44408	Compulsory elective

Modul Title	Safety Technology
	Grundlagen der Prozess-, Anlagen- und Betriebssicherheit
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Arellano-Garcia, Harvey
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	At the end of the module the student are able to prevent and mitigate reaction-, fire- and explosion hazards in process plants, storage tanks/ silos and during transport of hazardous materials.
Contents	1. Theory of heat explosion, fire protection, explosion prevention, reaction safety, theory of pressure relief 2. Basics of experimental determination of safety data and pressure relief devices 3. Experimental development of safety data used for the determination of storage and transport conditions according to national and international standards (EU, UN) , case study -team work- 4. Experiments for the design of pressure relief devices to, case study -team work-
Recommended Prerequisites	Strongly recommended: Fundamentals of mathematics, physics (thermodynamics, heat- and mass-transfer)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Practical training - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	1. Lecture notes 2. Power Point 3. Literature: see lecture notes
Module Examination	Prerequisite + Final Module Examination (MAP)

Assessment Mode for Module Examination	Prerequisite: Successful completion of laboratory tests, as well as the adjoining "check-of-knowledge"-test as part of the internship. Final module examination: Written examination, 90 min.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• 440503 LE Safety technology in process industries/Process and Plant Safety • 440531 Exercise/Practical Training Safety technology in process industries/Process and Plant Safety • 841232 Examination Safety Technology
Components to be offered in the Current Semester	360333 Lecture/Exercise Safety Technology - 4 Hours per Term 360377 Examination Safety Technology

Module 11647 Freshwater Conservation and Water Resource Management

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	11647	Compulsory elective

Modul Title	Freshwater Conservation and Water Resource Management Gewässerschutz und Gewässerbewirtschaftung
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. rer. nat. habil. Martin-Creuzburg, Dominik
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The module will provide the base for sustainable freshwater resource management. Understanding shall be achieved of the comprehensive water cycle with its abiotic and biotic processes, basics of hydrology and freshwater conservation, terms and methods related to water balance and the components of the water cycle, hydrological and ecological processes and their interaction relevant to water quantity and quality. Students will know main impacts to the freshwater resources and understand their relation to land use. The interaction of impacts with ecological processes and their consequences on ecology and use of freshwaters (flood water storage, drinking water supply, recreation, nature conservation) will be understood. The options and methods of surface water diagnosis and of management and conservation will be understood. The European Water Framework Directive as the base for evaluation and management of freshwater resources will be known. Students will be able to evaluate the consequences of major impacts on ecosystem functioning and ecosystem services. Principal strategies for restoring impacted freshwater systems will be known.
Contents	Part Hydrology Introduction to hydrology and water resources, definitions; hydrologic cycle; conservation equation; catchment; energy and water balance as a coupled system; water cycle as transport cycle, precipitation (types, measurement, areal analysis), water in the soil, soil water characteristics, infiltration, evapotranspiration, (processes, determination) runoff (controlling factors, measurement, interpretation of runoff data, hydrological regimes); Methods to estimate groundwater balance, present groundwater use and exploitation; vulnerability and

activities to protect groundwater resources. Impacts to the water resources; water balances under human influence; pathways of main pollutants of ground and surface waters; concepts of an integrated description of water quantity and water quality at catchment scale.

Part Freshwater Conservation

Main water quality problems related to agriculture, forestry, urbanization and mining; eutrophication, acidification, salinization, siltation, contamination, effects of neobiota; civil engineering and degradation of streams and rivers; loss of ecosystem services in degraded freshwaters; expected impacts of climate change. Principles of sustainable water management; principles of lake diagnosis, quality assessment and evaluation as prerequisites for mitigation and restoration; EU Water Framework Directive; strategies to improve and restore impacted freshwaters, current status of restoration.

Recommended Prerequisites	Module 41102 Ecology
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	All material will be provided (mostly via Moodle) during the semester: • Lecture notes, short learning clips and reading material, • Recommended literature, • Catalogue of questions and short self-tests in Moodle to support self-organized work and self-testing of learning success.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	Written examination (80 minutes), with the two parts Hydrology and Water Resource Management and Freshwater Conservation in the first examination period. The exam will contribute 60% to the module grade. Exercises and homework will contribute 40% to the module grade via video assessment (Freshwater Conservation; 20%) and 5 in-person quizzes (Hydrology and Water Resource Management; 20%).
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	in winter semester: • 240509 LE/EX Freshwater Conservation • 240613 LE/EX Hydrology and Water Resource Management
Components to be offered in the Current Semester	240509 Lecture/Exercise Freshwater Conservation - 2 Hours per Term 240613 Lecture/Exercise Hydrology and Water Resources Management - 2 Hours per Term 240533 Examination Freshwater Conservation and Water Resources Management

Module 11648 Sustainable Waste Management

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	11648	Compulsory elective

Modul Title	Sustainable Waste Management
	Nachhaltige Abfallwirtschaft
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Prof. Dr. habil. Abendroth, Christian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	In the field of waste management, the student will learn to analyse and to understand typical problems of disposal within the social, economical and technical framework of sustainability. New approaches to solutions of waste problems will be discussed. Students should learn to adapt technological solutions and to develop appropriate strategies to the conditions of their home countries. A deeper focus on biological treatment is given.
Contents	The module is about sustainability with a focus on biological treatment technologies. In preparation for the module "municipal solid waste management", this module gives already a glimpse into recent novelties, which address sustainability and biological treatments. To do so, recent research articles are going to be summarized in order to present novel substrates, integrated sustainability concepts, pre- and post-treatments, which are related to technologies like anaerobic digestion, dark fermentation, biofuel production and fuel cells. In this relation, the following topics will be covered. 1. History on sustainability 2. Legislation in sustainability 3. Waste types and their relation to biological treatments 4. Zero waste and smart cities 5. Novel and problematic substrates for anaerobic digestions 6. Dark fermentation 7. Microbial fuel cells 8. Microbial electrolysis cells 9. Power2Gas 10. Biochar and its application 11. Integrated concepts

	12. Treatment of mining waste - from waste to Value 13. Degradation of plastics using microorganisms and enzymes 14. Practical training
Recommended Prerequisites	None
Mandatory Prerequisites	None
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Seminar - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Lecture notes • List of recommended literature References/textbooks: • Wellinger, Arthuer, Murphy Jerry, Baxter David: The biogas handbook, 2013 Woodhead Publishing Series in Energy: Number 52, • Kalamdhad: Advances in Waste Management, 2019 • Thomé-Kozmiensky, Karl J.: Waste management, Volume1-4, 2010-2014, TK Verlag • Vesilind, Worrell, Reinhart: Solid Waste Engineering, Brooks/Cole 2002 • Kühle Weidemeier: Waste to resources 2011; mechanical biological waste treatment and material recovery facilities; 2011 • Rada, E.-C.: Biological treatment of solid waste enhancing sustainability, 2016
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• written work, 30 min. (30% of the final grade) • written examination, 60 min. (70% of the final grade)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• 230144 Lecture/Seminar Sustainable Waste Management - 4 Hours per Week per Semester • 238106 Examination Sustainable Waste Management
Components to be offered in the Current Semester	238178 Examination Sustainable Waste Management

Module 12165 Renewable Energy Technologies for Power Supply

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	12165	Compulsory elective

Modul Title	Renewable Energy Technologies for Power Supply Energieerzeugung auf Basis erneuerbarer Energien
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The participants of the module acquire advanced knowledge in the design, operation, and application of renewable energy systems, including solar energy (solar thermal and photovoltaics), wind energy, hydroelectric power, geothermal energy (both near-surface and deep), biomass, and energy storage technologies, with a focus on hydrogen technology. They can analyze and reflect on the interactions between these subfields, considering their technical and ecological implications, and are capable of making scientifically grounded judgments within the discipline. The participants of the module develop the ability to formulate their own research questions and address them using appropriate scientific methods. They can effectively engage in domain-specific and interdisciplinary discussions, presenting complex topics clearly and persuasively to diverse audiences. Additionally, they demonstrate the ability to independently acquire new knowledge and apply it to solve and critically evaluate application- or research-oriented challenges.
Contents	Design, operation and use of: • Solar energy (photovoltaics, solar thermal) • Wind energy • Geothermal energy (deep and near-surface) • Biomass • Hydroelectric power • Energy storage inclusive hydrogen technology
Recommended Prerequisites	<div class="qMYqUG_convSearchResultHighlightRoot"><div class="" data-turn-id-container="request-WEB:a3431c09-7954-4939-889f-9a2bd9d2dbf2-3" data-is-intersecting="true"><section class="text-token-text-primary w-

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is-only-node="">Completed Bachelor's degree in a relevant field such
as natural sciences, engineering, environmental engineering, energy
engineering, process engineering, or a comparable degree programme.
Very good knowledge and a solid understanding of engineering, physics,
chemistry, and mathematics are required. </div></div></div></div></
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Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 4 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The course documents are provided in the learning management system Moodle.
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Final written exam (120 min)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	60
Remarks	none
Module Components	Lectures, exam

**Components to be offered in the
Current Semester**

320461 Lecture

Renewable Energy Technologies for Power Supply - 4 Hours per Term

320483 Examination

Renewable Energy Technologies for Power Supply

Module 13234 Communication of Science and Technology

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	13234	Compulsory elective

Modul Title	Communication of Science and Technology
	Wissenschafts- und Technikkommunikation
Department	Faculty 5 - Business, Law and Social Sciences
Responsible Staff Member	Prof. Dr. rer. pol. habil. Lee, Roh Pin
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	6
Learning Outcome	Students will know about different techniques, tools and formats for communication of science & technology. They will develop skills to break down complex issues at the nexus of science, technology and society to communicate science/technical information in a clear, understandable and engaging way to different stakeholders. On completion of the module, students will be able to: • Articulate the key issues and challenges in communicating about science & technology; • Understand the nature of different audiences for better stakeholder engagement; • Demonstrate awareness of and ability to use a variety of different techniques and media for targeted audience; • Improve their skills in communication of scientific/technical information in both written and oral forms; • work as part of a team to develop effective measures for communication of science & technology; • Provide constructive feedback to other students on their communication skills.
Contents	Course coverage: • Key issues in communication of science & technology; • Identify and knowing your audiences (mental models, risk perception, heuristics and biases, ...); • Getting your audience's attention (Types of framing); • Communicating risk and uncertainty; • Formats for communication of science & technology.

Students will also be given opportunities to receive feedback and improve their own written and oral skills. They will also work in small teams on team projects to further their skills for communicating about sustainability issues. These projects will focus on communicating about a given scientific topic to a particular audience using spoken, visual, written or web-based communication.

Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Center for Research on Environmental Decisions (CRED). 2009. <i>The Psychology of Climate Change Communication: A guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public</i>. New York. • Nisbet, M.C., Scheufele, D.A. 2009. What's next for science communication? Promising directions and lingering distractions. <i>American Journal of Botany</i>, 96(10): 1767-1778. • Bubela, T., Nisbet, M., Borchelt, R. <i>et al.</i> 2009. Science communication reconsidered. <i>Nature Biotechnology</i>, 27, 514–518. • Nelkin, D. 1989. Communicating technological risk: The social construction of risk perception. <i>Annual Review Public Health</i>, 10, 95-113. • Tversky, A., Kahneman, D. 1974. Judgment under Uncertainty: Heuristics and Biases. <i>Science, New Series</i>, 185(4157), 1124-1131. Further material (including lecture slides and additional materials including videos, readings etc.) might be announced during the first class meeting.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Individual E-Assessment – 60 min (40%) • Group project - Part 1: Science Communication Material e.g., poster, video, etc. (30%) • Group project - Part 2: Group presentation– 15min oral presentation (30%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Lecture / Seminar
Components to be offered in the Current Semester	510601 Lecture/Seminar Communication of Science & Technology - 4 Hours per Term

Module 13659 Sustainability and Digitalisation

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	13659	Compulsory elective

Modul Title	Sustainability and Digitalisation
	Digitalisierung und Nachhaltigkeit
Department	Faculty 5 - Business, Law and Social Sciences
Responsible Staff Member	Prof. Dr. phil. Jaeger-Erben, Melanie
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The module provides knowledge and understanding of social science sustainability research at the interface of technology, environment and society. After attending the module, students will be able to adequately describe digitization as a comprehensive transformation process in terms of its advantages and disadvantages and analyse various digitization phenomena from a social science perspective. They can use digital media and communication formats (blogs, podcasts) in a targeted manner. Students are able to conduct case analyses after completing the module.
Contents	Digitalisation as well as sustainability are so-called mega-trends the 21st century. Digital technologies are increasingly integrated in society and economy. This process both poses environmental and social challenges, such as climate change or social injustice, as well as the potential to accelerate sustainable transition. An effective transition to renewable decentralized energy supplies for instance will only succeed with digital and connected devices. However, digitalisation is not per definition sustainable. It also has many negative impacts on the environment and society. For example, electronic devices require scarce non-renewable natural resources, and data processing uses vast amounts of energy. The reserves of the elements needed for digitalisation are depleting, while the volume of electronic waste is rapidly growing every year. How can digitalisation support sustainable transition without causing more harm than good? Is a green digitalisation possible? In the module, we cover the risks and potentials in of digital innovations in various sectors such as energy systems, mobility, agriculture o education. The module contains following topics:

	• Part 1: Is digitalisation sustainable? - An introduction to digital technologies and their social and environmental impact • Part 2: Is digitalisation serving sustainability? – Diving into sustainable human, technology and nature relationships and innovations for a sustainable world • Part 3: Assessing the effects of specific digital technologies (e.g., Artificial intelligence, Smart Everything or Platform economy) for sustainable development as well as their effects on specific spheres of life (e.g., data protection, effects on democracy and digital divide).
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The following literature can be used for preparation: • Lange, S., & Santarius, T. (2020). Smart Green World?: Making Digitalisation Work for Sustainability. Routledge. • Hilty, L., and Aebischer, B. (2015). ICT Innovations for Sustainability. Advances in intelligent systems and computing, 310, p. 351-365. • Vetter, A. (2018). The matrix of convivial technology–assessing technologies for degrowth. Journal of Cleaner Production, 197, 1778-1786.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Written exam (45 min.) - (30%) • Group presentation (max. 10 min/person) - (30%) • 2 exercises from the seminar, incl. a reflection on the topic of the exercises to hand in (3 pages per exercise) - (15% per exercise) • Active participation in class (10%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Lecture: Digitalisation and Sustainability: Evolution, Trends and Future Scenarios • Seminar: Digitalisation and Sustainability: Current Topics
Components to be offered in the Current Semester	No assignment

Module 13926 Hydrogen and Fuel Cells

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	13926	Compulsory elective

Modul Title	Hydrogen and Fuel Cells Wasserstoff und Brennstoffzellen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students are introduced to the entire hydrogen energy technology value chain, encompassing hydrogen production, storage, distribution, and utilization. Each chapter explores the physicochemical principles underlying specific hydrogen technologies, provides a detailed description of the respective systems and components (including material selection, manufacturing, and operational aspects), and illustrates its applications through practical examples. The course also incorporates numerical exercises to reinforce and deepen the understanding of the lecture content. Regular personal attendance is strongly recommended in order to directly grasp the course content, teaching approach, and the expectations regarding examination tasks; exclusive reliance on online self-study is explicitly not recommended.
Contents	1. Introduction to hydrogen and its properties 2. Hydrogen energy cycle 3. Hydrogen production 4. Hydrogen purification 5. Hydrogen storage 6. Distribution and infrastructure 7. Fuel cells 8. Hydrogen combustion 9. Hydrogen safety
Recommended Prerequisites	Very good knowledge and coherent understanding of power engineering, physics, chemistry, and mathematics (Master's level)
Mandatory Prerequisites	none

Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Supplementary lecture materials and exercise assignments are made available via the Moodle learning management system. They are intended solely to support and accompany the lectures and exercises and cannot substitute for regular attendance, active participation, and the preparation of individual notes during class. Further literature includes: • Compendium of Hydrogen Energy, Volumes 1-4 (Woodhead, 2015). • Hydrogen - Its Technology and Implications, Volumes 1-5 (CRC Press, 2018). • Fuel Cells and Hydrogen Production (Springer Science, 2019). • Hydrogen Energy - Challenges and Solutions for a Cleaner Future (Springer, 2019). • Hydrogen Production Technologies (Wiley, 2017). • Handbook of Hydrogen Energy (CRC Press, 2014). Hydrogen Safety (CRC Press, 2013).
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Final written exam (120 min)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Lecture Hydrogen and Fuel Cells • Exercise Hydrogen and Fuel Cells • Exam Hydrogen and Fuel Cells
Components to be offered in the Current Semester	320455 Lecture/Exercise Hydrogen and Fuel Cells - 4 Hours per Term 320477 Examination Hydrogen and Fuel Cells

Module 14132 Multidimensional Approaches for Technology Assessment

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	14132	Compulsory elective

Modul Title	Multidimensional Approaches for Technology Assessment Multidimensionale Ansätze für Technikfolgenabschätzung
Department	Faculty 5 - Business, Law and Social Sciences
Responsible Staff Member	Prof. Dr. rer. pol. habil. Lee, Roh Pin
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students know about a range of technology assessment approaches, methodologies and tools to facilitate the evaluation of decarbonization & sustainability transformation options along socio-technological-economical-ecological-political (<i>STEEP</i>) dimensions. On completion of the module, students are able to: • Demonstrate a deep understanding of the multidimensional aspects and systemic interactions in the transformation of energy- and carbon-intensive industries; • Gain familiarity with a range of qualitative and quantitative methodologies in conducting technology assessment; • Design and conduct studies to analyze the opportunities and challenges which will be associated with the transformation of energy- and carbon-intensive industries along multiple dimensions; • Identify, assess and evaluate appropriate sources of information and critically reflect on the methodologies commonly implemented for technology assessment and their usefulness/weaknesses.
Contents	Course coverage: • Relevance and development of technology assessment; • Common methodological approaches and their usefulness/weakness; • Data and approaches for assessment (e.g., primary vs. secondary; qualitative vs. quantitative); • Methodologies for socio-political evaluations, techno-economic evaluations and ecological evaluations; • Application on a case study to assess multidimensional opportunities and challenges associated with the transformation of a specific sector

	and derive implications along the <i>STEEP</i> dimensions based on assessment results.
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 1 hours per week per semester Exercise - 1 hours per week per semester Study project - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Lee, R.P., Meyer, B., Huang, Q.L., Voss, R. 2020. Sustainable waste management for zero waste cities in China: potential, challenges and opportunities. <i>Clean Energy</i>, 4(3): 169 – 201. • Lee, R.P. 2019. Alternative carbon feedstock for the chemical industry? – Assessing the challenges posed by the human dimension in the carbon transition, <i>Journal of Cleaner Production</i>, 219: 786-796. • Lee, R. P., Tschoepe, M., Voss, R. 2021. Perception of chemical recycling and its role in the transition towards a circular carbon economy: A case study in Germany. <i>Waste Management</i>, 125: 280-292. • Voss, R., Lee, R.P., Seidl, L., Keller, F., Fröhling, M. 2021. Global warming potential and economic performance of gasification-based chemical recycling and incineration pathways for residual municipal solid waste treatment in Germany. <i>Waste Management</i>, 134: 206 – 219. • Keller, F., Lee, R.P., Meyer, B. 2020. Life cycle assessment of global warming potential, resource depletion and acidification potential of fossil, renewable and secondary feedstock for olefin production in Germany. <i>Journal of Cleaner Production</i>, 250: 119484. • Lee, R.P., Scheibe, A. 2020. The politics of a carbon transition: An analysis of political indicators for a transformation in the German chemical industry, <i>Journal of Cleaner Production</i>, 244: 118629. Further materials are provided via Moodle (including lecture slides and additional materials including videos, readings etc.)
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Individual component (E-assessment), 60-90 min - 50% • Group Project - Part 1: Create a scientific poster (Analysis of e.g., a scientific article, industry report, case study, ...) - 25% • Group Project - Part 2: Presentation, 15min - 25%
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Lectures & Exercises • Projects

**Components to be offered in the
Current Semester**

No assignment

Module 15005 Sustainability Transformation: Systems, Actors and Pathways

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	15005	Compulsory elective

Modul Title	Sustainability Transformation: Systems, Actors and Pathways Nachhaltigkeitstransformation: Systeme, Akteure und Ausrichtungen
Department	Faculty 5 - Business, Law and Social Sciences
Responsible Staff Member	Prof. Dr. rer. pol. habil. Lee, Roh Pin
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After attending the module, students are able to: • explain sustainability as a systemic socio-ecological challenge at the intersection of planetary and societal boundaries; • apply the concepts of social metabolism and provisioning systems to analyze how societies interact with nature to satisfy human needs; • distinguish major historical milestones, discourses, and competing paradigms in sustainability thinking; • critically assess the roles, responsibilities, and conflicts among states, firms, civil societies, and NGOs; • analyze the governance function of political regulations and institutional frameworks across global, European, and national scales; • understand socio-technical transition frameworks, including path dependencies, lock-ins, leverage points, and multi-level dynamics; • evaluate alternative transformation approaches such as degrowth, rights of nature and sufficiency; • assess sectoral sustainability challenges in multiple sectors ranging from food, energy, mobility, housing to care systems; • explain how historical inequalities, colonial structures, and justice dimensions shape sustainability concepts and transformation pathways; • reflect on the role of science, models, expertise, and transdisciplinary research in transformation processes.
Contents	By attending the module, students will gain a fundamental understanding of sustainability concepts including their developments,

contexts, tools and actors as well as alternative transformation approaches. Especially:

- Introduction to sustainability as a socio-ecological crisis and problem framing
- Historical evolution of sustainability thinking, concepts, and contested discourses
- Actors, governance, legitimacy, and societal responsibility
- Political regulations and institutional sustainability frameworks
- Transformation pathways, socio-technical models, and leverage points
- Alternative approaches: Degrowth, Sufficiency, Rights of nature

Case examples:

- Food systems: provisioning, agroecology, land use, and food sovereignty
- Energy systems: historical regimes, fossil lock-ins, decentralization, and energy democracy
- Mobility systems: car-centered infrastructures and fossil vs. electric transport
- Housing systems: housing justice, secure living, renovation, and ecological building
- Care systems: social reproduction, gender justice, and sustainable care infrastructures
- Transformative science and transdisciplinary collaboration, critical reflection, and integrative assessment

This course employs an inverted classroom (flipped classroom) approach: Classroom meetings focus on deepening understanding through structured reflection, discussion, and practical group exercises. These activities provide opportunities for students to articulate and apply their knowledge, collaborate with peers, and clarify questions under the guidance of the course instructor.

Prior to each session, students are expected to engage in independent preparation by studying assigned readings and completing guiding questions which will be posed on Moodle (Note: No preparation is required before the first session).

Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• assigned readings and guiding questions which will be posed on Moodle
Module Examination	Continuous Assessment (MCA)

Assessment Mode for Module Examination

Student performance in this course will be evaluated based on a combination of continuous engagement, collaborative work, and summative assessment, as follows:

- **Pre-Session Assignments, 1-2 hours each (50%)** – Students are required to submit responses to 10 out of 12 sets of guided questions on Moodle prior to each session. These assignments assess preparation, comprehension of the readings, and the ability to engage with key concepts.
- **Active participation** in practical group exercises during in-person sessions **(30%)** - These exercises focus on collaborative knowledge application, reflection, and problem-solving
- **Final E-Assessment, 60 min (20%)** – A *summative e-assessment* evaluates students' overall understanding, analytical skills, and capacity to integrate knowledge across the module.

Grades will reflect both individual preparation and contribution to group learning activities, ensuring alignment with the module's learning outcomes.

Evaluation of Module Examination

Performance Verification – graded

Limited Number of Participants

60

Remarks

none

Module Components

- Lectures 2 hours per week per semester
- Group Work/Seminars/Projects 2 hours per week per semester, including presentations

Components to be offered in the Current Semester

510604 Lecture
Sustainability Transformation: Systems, Actors, and Pathways - 2 Hours per Term
510605 Seminar
Sustainability Transformation: Systems, Actors, and Pathways - 2 Hours per Term

Module 41205 Sociology

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	41205	Compulsory elective

Modul Title	Sociology
	Soziologie
Department	Faculty 5 - Business, Law and Social Sciences
Responsible Staff Member	Prof. Dr. phil. Jaeger-Erben, Melanie
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	General overview on sociological approaches, theories and research topics. Insights into different epistemological perspectives and paradigms. Appropriation of a sociological perspective.
Contents	The module provides basic knowledge of sociological approaches, theories and research topics. The focus is on trying out and acquiring sociological perspectives and approaches in the analysis of society and social change. Various paradigms of past and present sociology are taught and current issues such as the Anthropocene debate or feminist sociology are addressed. Topics include: - Core topics in sociology: social order and social change. - Sociological paradigms: from the linguistic turn to New Materialism - Sociological perspectives on human-environment relations and social relations with nature - Current issues in sociology: socio-ecological transformation, global inequalities and intersectionality, post-pandemic renewal Students will be given various assignments throughout the semester, such as reviews of texts or documentaries, Ted Talks, debate walks, and mappings, which will be presented and discussed in class.
Recommended Prerequisites	None
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature

The lecture will partially refer to the following books:

- Giddens, A., & Sutton, P. W. (2021). *Sociology*. John Wiley & Sons.
- Dürbeck, G., & Hüpkes, P. (Eds.). (2020). *The Anthropocenic Turn: The Interplay Between Disciplinary and Interdisciplinary Responses to a New Age*. Routledge.
- Harper, C. L., & Snowden, M. (2017). *Environment and society: Human perspectives on environmental issues*. Routledge.
- Abbott, P., Tyler, M., & Wallace, C. (2006). *An introduction to sociology: Feminist perspectives*. Routledge.

Further literature will be announced during the lectures.

Module Examination

Continuous Assessment (MCA)

Assessment Mode for Module Examination

- Pecha Kucha Presentation, 7:40 min (30%)
- Protocol, 1-2 pages (20%)
- Review, 1-2 pages (20%)
- Reflection, 2-3 pages (30%)

Evaluation of Module Examination

Performance Verification – graded

Limited Number of Participants

none

Remarks

none

Module Components

- 248106 Lecture Sociology
- 248107 Exercise Sociology

Components to be offered in the Current Semester

510503 Lecture
Sociology - 2 Hours per Term
510504 Seminar
Sociology - Seminar - 2 Hours per Term

Module 41217 General and Applied Ecology

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	41217	Compulsory elective

Modul Title	General and Applied Ecology
	Allgemeine und Angewandte Ökologie
Department	Faculty 2 - Environment and Natural Sciences
Responsible Staff Member	Dr. Djoudi, El Aziz
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The Module General and Applied Ecology provides an overview of the basic and applied aspects of ecology. The lectures provide a comprehensive overview of modern concepts of ecology including ecophysiology, population and community ecology. Ecological research further requires a fundamental understanding of sampling techniques and designs. Students will learn about • basic concepts of ecology • analyses of simple and more complex ecological data • the diversity of ecosystems and organisms • contemporary challenges in ecology • basic concepts of study design • sampling techniques
Contents	• What is ecology? • Organisms in the environment • Ecophysiology • Population ecology • Community ecology • Understanding biodiversity • Analysing ecological data • Describing spatial distributions • Macroecology • Study design & hypothesis testing • Sampling organisms
Recommended Prerequisites	Bachelor Module 41102 Ecology, 12954 Biostatistics, 41106 Biology
Mandatory Prerequisites	none

Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The class is organized as lectures complemented by discussions and individual contributions. All slides and schedules are available in Moodle. Self-organized work, in particular independent acquisition of relevant ecological information, is required. Textbooks Begon, M., Townsend, C.R. & Harper, J.L. 2006. Ecology: from individuals to ecosystems. Blackwell Publ. Townsend, C.R., Begon, M. & Harper, J.L. 2008. Essentials of ecology. Blackwell Publ. Southwood, T. R. 1994. Ecological methods. Chapman & Hall MacGarigal, K., Cushman, S. & Stafford, S. 2000 Multivariate statistics for wildlife and ecology research. Springer Zuur, A.F., Ieno, E.N. & Smith, G.M. 2007 Analysing ecological data. Springer Scheiner, S.M. 2001 Design and analysis of ecological experiments. Oxford Univ. Press Quinn, G.P. & Keough, M.J. 2002 Experimental design and data analysis for biologists. Cambridge Univ. Press EBooks Jorgensen - Encyclopedia of Ecology Levin - Encyclopedia of Biodiversity Levin – The Princeton Guide to Ecology Pla - Quantifying Functional Biodiversity Adams – Species Richness
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	Written exam at the end of the lecture period (120 min.)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	Complementary module WHS
Module Components	• 240745 Lecture/Seminar Fundamentals of Ecology • 240746 Lecture/Seminar Ecological Methods and Models
Components to be offered in the Current Semester	240745 Lecture/Seminar Fundamentals of Ecology - 2 Hours per Term 240746 Lecture/Seminar Ecological Methods and Models - 2 Hours per Term 240748 Examination Exam General and Applied Ecology

Module 43201 Corporate Environmental Protection

assign to: Environment, Economy, Human, Law

Study programme Chemistry: Materials, Engineering and Sustainability

Degree	Module Number	Module Form
Master of Science	43201	Compulsory elective

Modul Title	Corporate Environmental Protection Umweltschutz im Unternehmen
Department	Faculty 5 - Business, Law and Social Sciences
Responsible Staff Member	Prof. Dr. rer. pol. habil. Lee, Roh Pin
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	After attending the module, students will have a basic understanding of environmental and sustainability management. Especially, they: • Understand the relevance of environmental protection and sustainability for corporations; • Contextualize the historical development of sustainability and the implications for corporations; • Understand critical terms and concepts in sustainability within the corporate context; • Have developed an understanding of how to build up a sustainability management in a corporation; • Understand the use of tools and management systems for environmental and sustainability management; • Understand the most important legal frameworks influencing environmental and sustainability management in corporations
Contents	• Concepts of sustainability as guidelines for corporations • The history of sustainability and implications for corporations • Laws and regulations for environmental protection and sustainability and their implications for corporations • Integrated sustainability management in corporations • Evaluation and measuring tools (e.g., life cycle assessment), indicators for ecological performance, and environmental accounting • Management tools and standardisation of management tools: EMAS, DIN ISO 14000

	• Sustainability and environmental protection communications, reports, labels, terms
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Self organised studies - 120 hours Project Seminars - 2 hours per week per semester
Teaching Materials and Literature	The lecture is based on presentations, which can be used for lecture notes. Additional reading may be referenced during the lectures.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Written examination, 60 min. (50 %) • Group examination, 30 min. (50 %)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Lectures 2 hours per week per semester • Seminars/Projects 2 hours per week per semester, including presentations
Components to be offered in the Current Semester	No assignment

Modul 43504 Biologische Verfahren der Biomasse- und Abfallbehandlung

zugeordnet zu: Environment, Economy, Human, Law

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	43504	Wahlpflicht

Modultitel	Biologische Verfahren der Biomasse- und Abfallbehandlung Biological Methods for Biomass and Waste Treatment
Einrichtung	Fakultät 2 - Umwelt und Naturwissenschaften
Verantwortlich	Prof. Dr. habil. Abendroth, Christian
Lehr- und Prüfungssprache	Deutsch
Dauer	1 Semester
Angebotsturnus	jedes Wintersemester
Leistungspunkte	6
Lernziele	<p data-start="0" data-end="990">Die Studierenden werden mit ökologisch und ökonomisch tragfähigen Alternativen zur konventionellen Abfallbehandlung vertraut gemacht, wobei integrierte und systemische Lösungen im Mittelpunkt stehen. Ein besonderer Schwerpunkt liegt auf anaeroben Mikrobiomen und deren zentraler Rolle in biologischen Umwandlungsprozessen wie Vergärung, Kompostierung sowie weiteren innovativen Verfahren der Reststoffverwertung. Aufbauend auf mikrobiologischen und biochemischen Grundlagen werden Funktionsprinzipien, Prozessdynamiken und Wirkungsgrade analysiert und auf reale Anwendungen übertragen. Neben etablierten Technologien werden auch aktuelle Forschungsansätze, internationale Entwicklungen sowie neuartige Verfahrenskombinationen – einschließlich Beiträge aus der eigenen Forschung – behandelt. Ziel ist es, ein vertieftes Verständnis für die stoffliche und energetische Nutzung von Reststoffen im Kontext einer nachhaltigen Kreislaufwirtschaft zu entwickeln und die Fähigkeit zu fördern, eigenständig systemorientierte Lösungsansätze zu entwerfen. <p data-start="0" data-end="990">Ein interaktives Lehrformat bildet den didaktischen Kern: Während der Veranstaltungen bearbeiten die Studierenden kontinuierlich Aufgabenstellungen, deren Ergebnisse in die Leistungsbewertung einfließen. Dadurch wird ein aktiver Lernprozess unterstützt, der analytisches Denken, Anwendungskompetenz und wissenschaftliche Diskussion fördert. <p data-start="0" data-end="990">
Inhalte	<p data-start="75" data-end="466">Der Kurs bietet einen fundierten und zugleich praxisnahen Einstieg in die biologische Nutzung von Reststoffen im Kontext einer nachhaltigen Kreislaufwirtschaft.

Ausgehend von den Grundlagen der Biologie und Photosynthese wird zunächst das Spannungsfeld „Teller vs. Tank“ beleuchtet, um Nutzungskonflikte zwischen Nahrungsmittelproduktion und bioenergetischer Verwertung kritisch einzuordnen. Im weiteren Verlauf werden zentrale Verfahren der biologischen Reststoffbehandlung behandelt, darunter Kompostierung, Biogasproduktion und Dunkelfermentation. Diese Prozesse werden nicht nur technologisch, sondern insbesondere aus Sicht anaerober Mikrobiome verstanden, die als treibende Kraft hinter Stoffumwandlungen im Fokus stehen. Eine Einführung in Mikrobiome sowie deren Analyse – von taxonomischen Profilen bis hin zu funktionellen Ansätzen wie der Proteomik – ermöglicht ein vertieftes Verständnis mikrobieller Gemeinschaften und ihrer Leistungsfähigkeit. Darauf aufbauend werden zentrale Stoffwechselprozesse wie Gärung und Methanogenese detailliert betrachtet und in den Kontext technischer Anwendungen eingeordnet. Ergänzend werden innovative und weniger etablierte Ansätze wie der Einsatz von Insekten, Biolaugung, Sanierungskonzepte sowie neue Materialien und Systeme (z. B. SLMs) vorgestellt. Der Kurs verbindet aktuelle Forschung mit anwendungsorientiertem Wissen und eröffnet einen interdisziplinären Blick auf biologische Transformationsprozesse – mit dem Ziel, nachhaltige und kreative Lösungsansätze für die Ressourcennutzung von morgen zu entwickeln.

Empfohlene Voraussetzungen	keine
Zwingende Voraussetzungen	keine
Lehrformen und Arbeitsumfang	Vorlesung - 4 SWS Selbststudium - 120 Stunden
Unterrichtsmaterialien und Literaturhinweise	- Kranert M. Einführung in die Kreislaufwirtschaft, Springer Vieweg Wiesbaden, 2017, https://doi.org/10.1007/978-3-8348-2257-4 - Bischofsberger, Dichtl, Rosenwinkel, Seyfried, Böhnke. Anaerobtechnik. Springer-Verlag Berlin Heidelberg 2005, ISBN: 3-540-06850-3 - Weitere Literatur wird im Rahmen der Lehre bekannt gegeben
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	Die Leistungsüberprüfung in diesem Modul erfolgt kontinuierlich und dialogorientiert in mündlicher Form. Die Studierenden sollen ihr Verständnis der Kursinhalte unter Beweis stellen, indem sie fachspezifische Fragen beantworten und Fragen an ihre Kommilitonen formulieren. Die Leistungsüberprüfung findet regelmäßig während des gesamten Semesters statt und zielt darauf ab, fachspezifisches Wissen, Verständnis sowie die Fähigkeit zur Teilnahme an wissenschaftlichen Diskussionen zu bewerten. Mündliche Leistungsüberprüfung grundsätzlich nach jeder zweiten Lehrveranstaltung Etwas 15–20 Minuten pro Prüfungseinheit 1–2 Fragen

pro Studierenden etwa alle zwei Wochen<li data-start="536" data-end="1040">ca. 10 bewertete Fragen pro Studierenden im Verlauf des Semesters<li data-start="536" data-end="1040">1 Punkt für jede erfolgreich beantwortete Frage<li data-start="536" data-end="1040">Bewertung der Antworten auf Grundlage der fachlichen Richtigkeit und des nachgewiesenen Verständnisses<li data-start="536" data-end="1040">Bewertung der von den Studierenden formulierten Fragen auf Grundlage ihrer wissenschaftlichen Relevanz, Klarheit und Angemessenheit<p> Alle bewerteten Fragen/ Aufgaben werden gleich gewichtet. Das Gesamtergebnis der Prüfungsleistung ergibt sich aus dem Anteil der erreichten Punkte an der insgesamt erreichbaren Punktzahl (100 %). Vergleichbare Anzahl und vergleichbares Niveau der Prüfungsmöglichkeiten für alle Studierenden

Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	15
Bemerkungen	keine
Veranstaltungen zum Modul	• 238117 Vorlesung/Seminar Biologische Verfahren der Biomasse und Abfallbehandlung
Veranstaltungen im aktuellen Semester	238117 Vorlesung/Seminar Biologische Verfahren der Biomasse und Abfallbehandlung - 4 SWS

Modul 12818 Basis-Deutsch für den Uni-Alltag

zugeordnet zu: Language Competence

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	12818	Wahlpflicht

Modultitel	Basis-Deutsch für den Uni-Alltag Basic German for Student Life
Einrichtung	ZES - Zentrale Einrichtung Sprachen
Verantwortlich	Diebel, Simone
Lehr- und Prüfungssprache	Deutsch
Dauer	2 Semester
Angebotsturnus	jedes Semester
Leistungspunkte	6
Lernziele	Bei Erreichen der Niveaustufe GER A1 sind die Teilnehmenden befähigt, vertraute, alltägliche Ausdrücke und ganz einfache Sätze zu verstehen und zu verwenden, die auf die Befriedigung konkreter Kommunikationsbedürfnisse zielen. Die Teilnehmenden können sich und andere vorstellen sowie anderen Fragen zu ihrer Person stellen und auf Fragen dieser Art Antwort geben. Sie können sich auf einfache Art verständigen, wenn die Gesprächspartner*innen langsam und deutlich sprechen und bereit sind zu helfen (Vergleich Kann-Beschreibungen des GER A1). Bei Erreichen der Niveaustufe GER A2 sind die Teilnehmenden imstande, häufig gebrauchte Sätze bzw. Ausdrücke aus Bereichen von unmittelbarer Bedeutung (z.B. Informationen zu Personen, Studium und Beruf, Freizeit und Familie) zu verstehen und anzuwenden. Sie können sich in einfachen, routinemäßigen Situationen verständigen, einfache und direkte Fragen zu vertrauten und geläufigen Dingen stellen und beantworten, kürzere Sachverhalte wiedergeben und mit einfachen Mitteln, Dinge und Zusammenhänge beschreiben (Vergleich Kann-Beschreibungen des GER A2). Schließlich reflektieren die Teilnehmenden im Kontext der vermittelten Inhalte und ihrer eigenen Kultur die Kultur im deutschsprachigen Raum und werden nach Abschluss des Moduls Grundzüge und Gepflogenheiten der Lebensformen im deutschsprachigen Raum verstehen.
Inhalte	Handlungsorientierte Aufgaben zum globalen, selektiven und detaillierten Hör- und Leseverstehen, zur Produktion themen- und situationsbezogener schriftlicher Texte, zum themen- und situationsbezogenen mündlichen Ausdruck sowie Übungen zum

	Verständnis und zur Festigung sprachlicher Strukturen (Wortschatz und Grammatik). Weiterhin werden Lernstrategien und -techniken für das Selbststudium vermittelt und erprobt. Thematische und grammatische Schwerpunkte lt. Empfehlungen des Gemeinsamen Europäischen Referenzrahmens (GER) für die Niveaustufen Deutsch als Fremdsprache A1 und Deutsch als Fremdsprache A2.
Empfohlene Voraussetzungen	Keine Vorkenntnisse für Deutsch als Fremdsprache A1.1 erforderlich Dringend empfohlen: • Niveau GER A1.1 für die Sprachlehrveranstaltung Deutsch als Fremdsprache A1.2 • Niveau GER A1 für die Sprachlehrveranstaltung Deutsch als Fremdsprache A2.1 • Niveau GER A2.1 für die Sprachlehrveranstaltung Deutsch als Fremdsprache A2.2 Die vorhandenen Deutschkenntnisse können zu Semesterbeginn mit einem Eingangstest überprüft oder mittels Zertifikat nachgewiesen werden.
Zwingende Voraussetzungen	keine
Lehrformen und Arbeitsumfang	Übung - 8 SWS Selbststudium - 60 Stunden
Unterrichtsmaterialien und Literaturhinweise	• kurstragendes Lehr- und Übungsmaterial • Zusatzmaterialien
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	Pro Sprachlehrveranstaltung 3 themenbezogene Abgabearbeiten oder Tests à 45 – 60 Minuten (je 1/6 Gewichtung für Modulnote)
Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	keine
Bemerkungen	• Das Modul richtet sich an Studierende der internationalen englischsprachigen Studiengänge ohne oder mit geringen Deutschvorkenntnissen. Es ist nicht geeignet für Studierende mit höherem Sprachniveau. • Studierende ohne Deutschvorkenntnisse können im Rahmen des Moduls den erfolgreichen Abschluss der Sprachlehrveranstaltungen Deutsch als Fremdsprache A1.1 und A1.2 abrechnen. • Studierende mit geringen Deutschvorkenntnissen der Niveaustufe GER A1 können im Rahmen des Moduls den erfolgreichen Abschluss der Sprachlehrveranstaltungen Deutsch als Fremdsprache A1.2 und A2.1 oder A2.1 und A2.2 abrechnen. • Eine zusätzliche und vorherige ANMELDUNG der Studierenden bei der Zentralen Einrichtung Sprachen (via moodle Projekte Plattform) ist erforderlich!

- Es können nicht mehr als 25 Teilnehmende in jeder Sprachkursgruppe eingeschrieben werden. Aufgrund der hohen Nachfrage behalten wir uns vor, Studierende bei (regelmäßigem) Nicht-Erscheinen vom Kurs abzumelden und nachzubeseetzen.
- Die Lehrveranstaltungen können in Präsenz oder online durchgeführt werden.

Veranstaltungen zum Modul

Für Interessent*innen ohne Deutschvorkenntnisse:

- Übung: Deutsch als Fremdsprache Start A1.1 - Intensivkurs **oder**
- Übung: Deutsch als Fremdsprache Start A1.1 (semesterbegleitend im Wintersemester oder Sommersemester)

und

- Übung: Deutsch als Fremdsprache Start A1.2 - Intensivkurs **oder**
- Übung: Deutsch als Fremdsprache Start A1.2 (semesterbegleitend im Wintersemester oder Sommersemester)

Für Interessent*innen mit Deutschvorkenntnissen auf der Niveaustufe GER A1.1:

- Übung: Deutsch als Fremdsprache Start A1.2 - Intensivkurs **oder**
- Übung: Deutsch als Fremdsprache Start A1.2 (semesterbegleitend im Wintersemester oder Sommersemester)

und

- Übung: Deutsch als Fremdsprache Start A2.1 - Intensivkurs **oder**
- Übung: Deutsch als Fremdsprache Start A2.1 (semesterbegleitend im Wintersemester oder Sommersemester)

Für Interessent*innen mit Deutschvorkenntnissen auf der Niveaustufe GER A1:

- Übung: Deutsch als Fremdsprache Start A2.1 - Intensivkurs **oder**
- Übung: Deutsch als Fremdsprache Start A2.1 (semesterbegleitend im Wintersemester oder Sommersemester)

und

- Übung: Deutsch als Fremdsprache Start A2.2 - Intensivkurs **oder**
- Übung: Deutsch als Fremdsprache Start A2.2 (semesterbegleitend im Wintersemester oder Sommersemester)

Veranstaltungen im aktuellen Semester

- 019101 Übung**
Deutsch als Fremdsprache Start A1.1 - 4 SWS
- 019103 Übung**
Deutsch als Fremdsprache A1.2 - 4 SWS
- 019104 Übung**
Deutsch als Fremdsprache A2.1 - 4 SWS
- 019105 Übung**
Deutsch als Fremdsprache A2.2 - 4 SWS
- 019130 Intensivkurs**
Deutsch als Fremdsprache Start A1.1 Intensivkurs - 4 SWS
- 019131 Intensivkurs**
Deutsch als Fremdsprache A1.2 Intensivkurs - 4 SWS
- 019132 Intensivkurs**
Deutsch als Fremdsprache A2.1 Intensivkurs - 4 SWS
- 019133 Intensivkurs**
Deutsch als Fremdsprache A2.2 Intensivkurs - 4 SWS

Modul 13363 Deutsch als Fremdsprache Start A1

zugeordnet zu: Language Competence

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	13363	Wahlpflicht

Modultitel	Deutsch als Fremdsprache Start A1 German as a Foreign Language Starter A1
Einrichtung	ZES - Zentrale Einrichtung Sprachen
Verantwortlich	Diebel, Simone
Lehr- und Prüfungssprache	Deutsch
Dauer	2 Semester
Angebotsturnus	jedes Semester
Leistungspunkte	6
Lernziele	In diesem Modul werden die Teilnehmenden befähigt, vertraute, alltägliche Ausdrücke und ganz einfache Sätze zu verstehen und zu verwenden, die auf die Befriedigung konkreter Kommunikationsbedürfnisse zielen. Nach Abschluss des Basismoduls können die Teilnehmenden sich und Andere vorstellen sowie Anderen Fragen zu ihrer Person stellen und auf Fragen dieser Art Antwort geben. Sie können sich auf einfache Art verständigen, wenn die Gesprächspartner*innen langsam und deutlich sprechen und bereit sind zu helfen (vgl. Kann-Beschreibungen des GER A1). Schließlich reflektieren die Teilnehmenden im Kontext der vermittelten Inhalte und ihrer eigenen Kultur die Kultur im deutschsprachigen Raum und werden nach Abschluss des Moduls Grundzüge und Gepflogenheiten der Lebensformen im deutschsprachigen Raum verstehen.
Inhalte	Handlungsorientierte Aufgaben zum globalen, selektiven und detaillierten Hör- und Leseverstehen, zur Produktion themen- und situationsbezogener schriftlicher Texte, zum themen- und situationsbezogenen mündlichen Ausdruck sowie Übungen zum Verständnis und zur Festigung sprachlicher Strukturen (Wortschatz und Grammatik). Weiterhin werden Lernstrategien und -techniken für das Selbststudium vermittelt und erprobt. Thematische und grammatische Schwerpunkte lt. Empfehlungen des Gemeinsamen Europäischen Referenzrahmens (GER) für die Niveaustufe Deutsch als Fremdsprache A1.
Empfohlene Voraussetzungen	keine

Zwingende Voraussetzungen	keine
Lehrformen und Arbeitsumfang	Übung - 8 SWS Selbststudium - 60 Stunden
Unterrichtsmaterialien und Literaturhinweise	• kurstragendes Lehr- und Übungsmaterial • Zusatzmaterialien
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	Pro Semester je 3 themenbezogene Abgabearbeiten oder Tests à 45 - 60 Minuten (je 1/6 Gewichtung für Modulnote)
Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	keine
Bemerkungen	• Das Modul richtet sich an Studierende der internationalen Studiengänge ohne Deutschvorkenntnisse. Es ist nicht geeignet für Studierende mit höherem Sprachniveau. • Eine zusätzliche ANMELDUNG der Studierenden in der Zentralen Einrichtung Sprachen ist erforderlich (https://www.b-tu.de/sprachen)! • Es können nicht mehr als 25 Teilnehmende in jeder Sprachkursgruppe eingeschrieben werden. Aufgrund der hohen Nachfrage behalten wir uns vor, Studierende bei (regelmäßigem) Nicht-Erscheinen vom Kurs abzumelden und nachzubeseetzen. • Die Lehrveranstaltungen können in Präsenz oder online durchgeführt werden.
Veranstaltungen zum Modul	• Übung: Deutsch als Fremdsprache Start A1.1 - Intensivkurs oder • Übung: Deutsch als Fremdsprache Start A1.1 (semesterbegleitend im Wintersemester oder Sommersemester) und • Übung: Deutsch als Fremdsprache Start A1.2 - Intensivkurs oder • Übung: Deutsch als Fremdsprache Start A1.2 (semesterbegleitend im Wintersemester oder Sommersemester)
Veranstaltungen im aktuellen Semester	019101 Übung Deutsch als Fremdsprache Start A1.1 - 4 SWS 019103 Übung Deutsch als Fremdsprache A1.2 - 4 SWS 019130 Intensivkurs Deutsch als Fremdsprache Start A1.1 Intensivkurs - 4 SWS 019131 Intensivkurs Deutsch als Fremdsprache A1.2 Intensivkurs - 4 SWS

Modul 13364 Deutsch als Fremdsprache A2

zugeordnet zu: Language Competence

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	13364	Wahlpflicht

Modultitel	Deutsch als Fremdsprache A2
	German as a Foreign Language A2
Einrichtung	ZES - Zentrale Einrichtung Sprachen
Verantwortlich	Diebel, Simone
Lehr- und Prüfungssprache	Deutsch
Dauer	2 Semester
Angebotsturnus	jedes Semester
Leistungspunkte	6
Lernziele	Nach Abschluss des Moduls sind die Teilnehmenden imstande, häufig gebrauchte Sätze bzw. Ausdrücke aus Bereichen von unmittelbarer Bedeutung (z.B. Informationen zu Personen, Studium und Beruf, Freizeit und Familie) zu verstehen und anzuwenden. Sie können sich in einfachen, routinemäßigen Situationen verständigen, einfache und direkte Fragen zu vertrauten und geläufigen Dingen stellen und beantworten, kürzere Sachverhalte wiedergeben und mit einfachen Mitteln, Dinge und Zusammenhänge beschreiben (vgl. Kann-Beschreibungen des GER A2). Schließlich reflektieren die Teilnehmenden im Kontext der vermittelten Inhalte und ihrer eigenen Kultur die Kultur im deutschsprachigen Raum und werden nach Abschluss des Moduls Grundzüge und Gepflogenheiten der Lebensformen im deutschsprachigen Raum verstehen.
Inhalte	Handlungsorientierte Aufgaben zum globalen, selektiven und detaillierten Hör- und Leseverstehen, zur Produktion themen- und situationsbezogener schriftlicher Texte, zum themen- und situationsbezogenen mündlichen Ausdruck sowie Übungen zum Verständnis und zur Festigung sprachlicher Strukturen (Wortschatz und Grammatik). Weiterhin werden Lernstrategien und -techniken für das Selbststudium vermittelt und erprobt. Thematische und grammatische Schwerpunkte lt. Empfehlungen des Gemeinsamen Europäischen Referenzrahmens (GER) für die Niveaustufe Deutsch als Fremdsprache A2
Empfohlene Voraussetzungen	Dringend empfohlen:

- Modul 13363 Deutsch als Fremdsprache Start A1
bzw. Deutschkenntnisse auf dem Niveau GER A1

Die vorhandenen Deutschkenntnisse können zu Semesterbeginn mit einem Eingangstest überprüft werden. Vorkenntnisse auf dem Niveau GER A1 können auch mit einem Zertifikat nachgewiesen werden.

Zwingende Voraussetzungen	keine
Lehrformen und Arbeitsumfang	Übung - 8 SWS Selbststudium - 60 Stunden
Unterrichtsmaterialien und Literaturhinweise	• kurstragendes Lehr- und Übungsmaterial • Zusatzmaterialien
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	Pro Semester je 3 themenbezogene Abgabearbeiten oder Tests à 45 - 60 Minuten (je 1/6 Gewichtung für Modulnote)
Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	keine
Bemerkungen	• Das Modul richtet sich an internationale Studierende aller englischsprachigen Studiengänge oder Gaststudierende mit Vorkenntnissen der Zielsprache auf Niveau GER A1. Es ist nicht geeignet für Studierende mit niedrigerem oder höherem Sprachniveau. • Eine zusätzliche ANMELDUNG der Studierenden in der Zentralen Einrichtung Sprachen ist erforderlich (https://www.b-tu.de/sprachen)! • Es können nicht mehr als 25 Teilnehmende in jeder Sprachkursgruppe eingeschrieben werden. Aufgrund der hohen Nachfrage behalten wir uns vor, Studierende bei (regelmäßigem) Nicht-Erscheinen vom Kurs abzumelden und nachzubersetzen. • Die Lehrveranstaltungen können in Präsenz oder online durchgeführt werden.
Veranstaltungen zum Modul	• Übung: Deutsch als Fremdsprache A2.1 - Intensivkurs oder • Übung: Deutsch als Fremdsprache A2.1 (semesterbegleitend) und • Übung: Deutsch als Fremdsprache A2.2 - Intensivkurs oder • Übung: Deutsch als Fremdsprache A2.2 (semesterbegleitend)
Veranstaltungen im aktuellen Semester	019104 Übung Deutsch als Fremdsprache A2.1 - 4 SWS 019105 Übung Deutsch als Fremdsprache A2.2 - 4 SWS 019132 Intensivkurs Deutsch als Fremdsprache A2.1 Intensivkurs - 4 SWS 019133 Intensivkurs Deutsch als Fremdsprache A2.2 Intensivkurs - 4 SWS

Modul 13367 Deutsch als Fremdsprache C1.1

zugeordnet zu: Language Competence

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	13367	Wahlpflicht

Modultitel	Deutsch als Fremdsprache C1.1 German as a Foreign Language C1.1
Einrichtung	ZES - Zentrale Einrichtung Sprachen
Verantwortlich	Frühauf, Regina
Lehr- und Prüfungssprache	Deutsch
Dauer	1 Semester
Angebotsturnus	jedes Wintersemester
Leistungspunkte	5
Lernziele	In diesem Kurs werden die Teilnehmenden befähigt, anspruchsvolle populärwissenschaftliche Texte zu verstehen und dabei auch implizite Bedeutungen zu erkennen. Der selbstständig erfasste wesentliche Inhalt kann mit eigenen Worten wiedergegeben werden. Die Teilnehmenden können sich spontan und fließend ausdrücken, ohne lange nach Worten suchen zu müssen. Sie können die deutsche Sprache im gesellschaftlichen und beruflichen Leben oder im Studium wirksam und flexibel gebrauchen. Sie können sich klar, strukturiert und ausführlich zu komplexen Sachverhalten äußern und dabei verschiedene Mittel zur Textverknüpfung angemessen verwenden. (Vgl. Kann-Beschreibungen GER C1) Schließlich reflektieren die Teilnehmenden - im Kontext der vermittelten Inhalte und ihrer eigenen Kultur - die Kultur im deutschsprachigen Raum und werden nach Abschluss des Moduls Grundzüge und Gepflogenheiten der Lebensformen im deutschsprachigen Raum verstehen.
Inhalte	Handlungsorientierte Aufgaben zum globalen, selektierenden und detaillierten Hör- und Leseverstehen, zur Produktion themen- und situationsbezogener schriftlicher Texte, zum themen- und situationsbezogenen mündlichen Ausdruck sowie Übungen zum Verständnis und zur Festigung sprachlicher Strukturen (Wortschatz und Grammatik) kommen zum Einsatz. Weiterhin werden Lernstrategien und -techniken für das Selbststudium vermittelt und erprobt. Thematische und grammatische Schwerpunkte lt. Empfehlungen des Gemeinsamen Europäischen Referenzrahmens (GER)
Empfohlene Voraussetzungen	Dringend empfohlen:

	Modul Deutsch als Fremdsprache B2.2 oder Deutschkenntnisse auf dem Niveau GER B2 Die vorhandenen Deutschkenntnisse werden zu Beginn des Semesters mit einem Eingangstest überprüft oder mittels Zertifikat nachgewiesen.
Zwingende Voraussetzungen	keine
Lehrformen und Arbeitsumfang	Übung - 4 SWS Selbststudium - 90 Stunden
Unterrichtsmaterialien und Literaturhinweise	• kurstragendes Lehr- und Übungsmaterial • Zusatzmaterialien
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	3 themenbezogene Abgabeaufgaben bzw. Tests à 45 - 60 Minuten (je 1/3 der Gewichtung für Modulnote)
Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	keine
Bemerkungen	• Das Modul richtet sich an internationale Studierende bzw. Gaststudierende mit Vorkenntnissen der deutschen Sprache auf der Niveaustufe GER B2. Es ist nicht geeignet für Studierende mit einem niedrigeren Sprachniveau. • Eine zusätzliche ANMELDUNG der Studierenden in der Zentralen Einrichtung Sprachen ist erforderlich (www.b-tu.de/sprachen)! • Es können nicht mehr als 25 Teilnehmende in jeder Sprachkursgruppe eingeschrieben werden. • Präsenzlehrveranstaltungen können im Ausnahmefall durch Online-Live-Sessions ersetzt werden.
Veranstaltungen zum Modul	Übung Deutsch als Fremdsprache C1.1
Veranstaltungen im aktuellen Semester	019163 Übung Deutsch als Fremdsprache C1.1 für den Beruf - 4 SWS

Modul 14073 Deutsch als Fremdsprache B1.1 für Uni, Job & Alltag

zugeordnet zu: Language Competence

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	14073	Wahlpflicht

Modultitel	Deutsch als Fremdsprache B1.1 für Uni, Job & Alltag German as a Foreign Language B 1.1 German for University, Work & Everyday Life
Einrichtung	ZES - Zentrale Einrichtung Sprachen
Verantwortlich	Diebel, Simone
Lehr- und Prüfungssprache	Deutsch
Dauer	1 Semester
Angebotsturnus	sporadisch nach Ankündigung
Leistungspunkte	6
Lernziele	In diesem Modul werden die Teilnehmenden befähigt, die Hauptpunkte einer kommunikativen Situation zu verstehen, wenn klare Standardsprache verwendet wird und wenn es um vertraute Dinge aus Arbeit, Studium, Alltag usw. geht. Sie können sich einfach und zusammenhängend über vertraute Themen und persönliche Interessengebiete äußern. Sie können über Erfahrungen und Ereignisse berichten, Ziele beschreiben und zu Plänen und Ansichten kurze Begründungen oder Erklärungen geben (vgl. Kann-Beschreibungen des GER Niveaustufe B1). Schließlich reflektieren die Teilnehmenden im Kontext der vermittelten Inhalte und ihrer eigenen Erfahrungen die Arbeitskultur im deutschsprachigen Raum. Nach Abschluss des Moduls können die Teilnehmenden u.a. Informationen aus Stellenanzeigen entnehmen und mit eigenem Profil abgleichen, mit Firmen in Kontakt treten, ein Bewerbungsgespräch führen, einem Arbeitsvertrag grundlegende Informationen bzgl. der sich daraus ergebenden Rechte und Pflichten entnehmen, relevante Informationen aus der Schilderung von Arbeitsabläufen entnehmen und Abläufe selbst beschreiben, in hochschulrelevanten und informellen Kontexten adäquat und zielgerichtet in Kommunikation treten und Argumente sammeln, gewichten, abwägen und in schriftlicher Form abbilden, um die Meinung zu einer vorgegebenen Fragestellung schriftlich zu begründen.
Inhalte	Handlungsorientierte Aufgaben zum globalen, selektierenden und detaillierten Hör- und Leseverstehen, zur Produktion themen

und situationsbezogener schriftlicher Texte, zum themen- und situationsbezogenen mündlichen Ausdruck sowie **Übungen** zum Verständnis, zur Erweiterung und zur Festigung sprachlicher Strukturen (Wortschatz und Grammatik). Weiterhin werden Lernstrategien und -techniken für das Selbststudium vermittelt und erprobt.

Thematische und grammatische Schwerpunkte lt.

Empfehlungen des Gemeinsamen Europäischen Referenzrahmens (GER) für die Niveaustufe B 1.1

Themen sind u.a. Jobsuche, Bewerbung, Wohnen, Arbeitsvertrag, Freundschaft sowie Studium in Deutschland.

Empfohlene Voraussetzungen

Dringend empfohlen:

- Modul 13364 Deutsch als Fremdsprache A2 bzw. Deutschkenntnisse auf dem Niveau GER A2

Die vorhandenen Deutschkenntnisse können zu Semesterbeginn mit einem Eingangstest überprüft oder mittels Zertifikat nachgewiesen werden.

Zwingende Voraussetzungen

keine

Lehrformen und Arbeitsumfang

Übung - 4 SWS
Selbststudium - 120 Stunden

Unterrichtsmaterialien und Literaturhinweise

- kurstragendes Lehr- und Übungsmaterial
- Zusatzmaterialien

Modulprüfung

Continuous Assessment (MCA)

Prüfungsleistung/en für Modulprüfung

3 themenbezogene Abgabenaufgaben bzw. Tests, max. 60 min pro Test (je 1/3 der Gewichtung für Modulnote)

Bewertung der Modulprüfung

Prüfungsleistung - benotet

Teilnehmerbeschränkung

keine

Bemerkungen

- Das Modul richtet sich an internationale Studierende in englischsprachigen Studiengängen bzw. Gaststudierende mit Vorkenntnissen der deutschen Sprache auf der Niveaustufe GER A2. Es ist **nicht geeignet** für Studierende mit einem niedrigeren oder höheren Sprachniveau.
- Eine **zusätzliche ANMELDUNG** der Studierenden in der Zentralen Einrichtung Sprachen ist **erforderlich** (www.b-tu.de/sprachen)!
- Es können nicht mehr als 25 Teilnehmende in jeder Sprachkursgruppe eingeschrieben werden. Aufgrund der hohen

Nachfrage behalten wir uns vor, Studierende bei (regelmäßigem) Nicht-Erscheinen vom Kurs abzumelden und nachzubeseetzen.

- Die Lehrveranstaltungen können in Präsenz oder online durchgeführt werden.
- Es können Blockveranstaltungen stattfinden.

Veranstaltungen zum Modul

- Übung: Deutsch als Fremdsprache B1.1 für Uni, Job und Alltag (Intensivkurs) **oder**
- Übung: Deutsch als Fremdsprache B1.1 für Uni, Job und Alltag (4 SWS Unterricht und 120 Stunden Selbststudium) im Sommer- und Wintersemester

Veranstaltungen im aktuellen Semester

019106 Übung
Deutsch als Fremdsprache B1.1 für Uni, Job und Alltag - 4 SWS

Modul 14187 Deutsch als Fremdsprache B1.2 für Uni, Job & Alltag

zugeordnet zu: Language Competence

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	14187	Wahlpflicht

Modultitel	Deutsch als Fremdsprache B1.2 für Uni, Job & Alltag German as a Foreign Language B 1.2 German for University, Work & Everyday life
Einrichtung	ZES - Zentrale Einrichtung Sprachen
Verantwortlich	Diebel, Simone
Lehr- und Prüfungssprache	Deutsch
Dauer	1 Semester
Angebotsturnus	sporadisch nach Ankündigung
Leistungspunkte	6
Lernziele	In diesem Modul werden die Teilnehmenden befähigt, die Hauptpunkte einer kommunikativen Situation zu verstehen, wenn klare Standardsprache verwendet wird und wenn es um vertraute Dinge aus Arbeit, Studium, Alltag usw. geht. Sie können sich einfach und zusammenhängend über vertraute Themen und persönliche Interessengebiete äußern. Sie können über Erfahrungen und Ereignisse berichten, Ziele beschreiben und zu Plänen und Ansichten kurze Begründungen oder Erklärungen geben (vgl. Kann-Beschreibungen des GER Niveaustufe B1). Schließlich reflektieren die Teilnehmenden im Kontext der vermittelten Inhalte und ihrer eigenen Erfahrungen die Arbeitskultur im deutschsprachigen Raum. Nach Abschluss des Moduls können die Teilnehmenden u.a. eigene Aufgaben und relevante Arbeitsabläufe für andere nachvollziehbar beschreiben und Verständnis sichern, über erledigte Aufgaben berichten, in Vorträgen wichtige Informationen identifizieren und zusammenfassen, angemessen auf Anfragen und Beschwerden von Kunden reagieren, Grafiken beschreiben, eine formelle E-Mail schreiben, im Rahmen einer Präsentation ein Konzept vorstellen und um ein Arbeitszeugnis bitten.
Inhalte	Handlungsorientierte Aufgaben zum globalen, selektierenden und detaillierten Hör- und Leseverstehen, zur Produktion themen- und situationsbezogener schriftlicher Texte, zum themen- und situationsbezogenen mündlichen Ausdruck sowie Übungen zum Verständnis und zur Festigung sprachlicher Strukturen (Wortschatz und

Grammatik). Weiterhin werden Lernstrategien und -techniken für das Selbststudium vermittelt und erprobt.

Thematische und grammatische Schwerpunkte lt. Empfehlungen des Gemeinsamen Europäischen Referenzrahmens (GER) für die Niveaustufe B 1.2

Themen sind u.a. Arbeiten im Team, Studienalltag, Kund*innenberatung, Arbeiternehmer*innenrechte und Arbeitsverhältnisse beenden.

Empfohlene Voraussetzungen	Dringend empfohlen: Modul 13365 Deutsch als Fremdsprache B1.1 bzw. gute Deutschkenntnisse in der Allgemeinsprache auf dem Niveau GER B1.1 Die vorhandenen Deutschkenntnisse können zu Semesterbeginn mit einem Einstufungstest überprüft oder mittels B1.1 Zertifikat nachgewiesen werden.
Zwingende Voraussetzungen	keine
Lehrformen und Arbeitsumfang	Übung - 4 SWS Selbststudium - 120 Stunden
Unterrichtsmaterialien und Literaturhinweise	• kurstragendes Lehr- und Lernmaterial • Zusatzmaterialien
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	3 themenbezogene Abgabenaufgaben oder Tests à 45 - 60 Minuten (je 1/3 der Gewichtung für Modulnote)
Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	keine
Bemerkungen	• Das Modul richtet sich vor allem an Studierende aller Studiengänge bzw. an Gaststudierende mit Vorkenntnissen der deutschen Sprache auf der Niveaustufe GER B1.1. Es ist nicht geeignet für Studierende mit einem niedrigeren oder höheren Sprachniveau. • Eine zusätzliche ANMELDUNG der Studierenden in der Zentralen Einrichtung Sprachen ist erforderlich (https://www.b-tu.de/sprachen). • Es können nicht mehr als 25 Teilnehmende in jeder Sprachkursgruppe eingeschrieben werden. Aufgrund der hohen Nachfrage behalten wir uns vor, Studierende bei (regelmäßigem) Nicht-Erscheinen vom Kurs abzumelden und nachzubeseetzen. • Die Lehrveranstaltung kann in Präsenz oder online durchgeführt werden. • Es können Blockveranstaltungen stattfinden.
Veranstaltungen zum Modul	Übung: Deutsch als Fremdsprache B1.2 für Uni, Job und Alltag (4 SWS und 120 Stunden Selbststudium)

Veranstaltungen im aktuellen Semester 019107 Übung

Deutsch als Fremdsprache B1.2 für Uni, Job und Alltag - 4 SWS

Modul 14363 Deutsch als Fremdsprache B2.1 für den Beruf

zugeordnet zu: Language Competence

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	14363	Wahlpflicht

Modultitel	Deutsch als Fremdsprache B2.1 für den Beruf German as a Foreign Language B2.1 for Professional Purposes
Einrichtung	ZES - Zentrale Einrichtung Sprachen
Verantwortlich	Diebel, Simone Dr. Hashold, Joanna
Lehr- und Prüfungssprache	Deutsch
Dauer	1 Semester
Angebotsturnus	sporadisch nach Ankündigung
Leistungspunkte	6
Lernziele	In diesem Modul werden die Teilnehmenden befähigt, im beruflichen Kontext (z.B. während eines Praktikums, im Beruf oder bei einer freiberuflichen Tätigkeit) mit begrenzter Präzision in deutscher Sprache zu handeln. Die Studierenden können nach Abschluss des Moduls Nachrichten entgegennehmen, Anfragen formulieren, Probleme erklären, in einem Gespräch/ einer Konsultation konkrete Informationen geben, einen Artikel, einen Vortrag, eine Diskussion zusammenfassen und ihre Meinung dazu äußern, Interviews oder Dokumentarfilme zusammenfassen und weitere Detailfragen beantworten. Sie können ein vorbereitetes Interview durchführen, Informationen überprüfen und bestätigen, auch wenn sie gelegentlich um Wiederholung bitten müssen, wenn andere Personen schnell und ausführlich antworten. Die Studierenden können Abläufe beschreiben und Anweisungen geben. Sie können Informationen über vertraute Routineangelegenheiten und weniger routinemäßige Angelegenheiten in ihrem Fachgebiet mit einiger Sicherheit austauschen (vgl. GER-Niveaubeschreibungen).
Inhalte	Die Studierenden erwerben allgemeinsprachige Fertigkeiten in einem handlungsorientierten hochschul- und berufsspezifischen Lernkontext. Mit diesen Fertigkeiten ist die Aneignung eines akademischen und vor allem berufsorientierten Wortschatzes verbunden sowie relevante Aspekte der Grammatik und entsprechende sprachliche Strukturen. Sprachliche Kompetenzen im Sinne des GER stehen dabei im Vordergrund. In der Gruppenarbeit spielt der Erwerb einer Mediationskompetenz (erklären, mitteln, aushandeln) eine zentrale Rolle.

	Darüber hinaus werden Strategien des autonomen Lernens vermittelt, um den Lernprozess effektiv zu gestalten und damit die eigene Lernfähigkeit zu stärken, sowie unterschiedliche Kommunikationsstrategien ausprobiert. Trainiert werden ebenfalls soziale Kompetenzen wie z.B. Teamarbeit.
Empfohlene Voraussetzungen	Deutschkenntnisse auf dem Niveau GER B1 Die vorhandenen Deutschkenntnisse werden zu Beginn des Semesters mit einem Eingangstest überprüft oder mittels Zertifikats nachgewiesen.
Zwingende Voraussetzungen	keine
Lehrformen und Arbeitsumfang	Übung - 4 SWS Selbststudium - 120 Stunden
Unterrichtsmaterialien und Literaturhinweise	• kurstragendes Lehr- und Übungsmaterial • Zusatzmaterialien
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	3 themenbezogene Tests à 30 - 60 Minuten (jeweils 1/3 der Gewichtung für Modulnote)
Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	0
Bemerkungen	• Das Modul richtet sich an internationale Studierende bzw. Gaststudierende mit Vorkenntnissen der deutschen Sprache auf der Niveaustufe GER B1. Es ist nicht geeignet für Studierende mit einem niedrigeren Sprachniveau. • Eine zusätzliche ANMELDUNG der Studierenden in der Zentralen Einrichtung Sprachen ist erforderlich (www.b-tu.de/sprachen)! • Es können nicht mehr als 25 Teilnehmende in jeder Sprachkursgruppe eingeschrieben werden. • Es können Blockveranstaltungen stattfinden. • Die Lehrveranstaltung kann in Präsenz oder online durchgeführt werden.
Veranstaltungen zum Modul	Übung Deutsch als Fremdsprache für den Beruf B2.1 (4 SWS)
Veranstaltungen im aktuellen Semester	019161 Übung Deutsch als Fremdsprache B2.1 für den Beruf - 4 SWS

Modul 14497 Deutsch als Fremdsprache B2.2 für den Beruf

zugeordnet zu: Language Competence

Studiengang Chemistry: Materials, Engineering and Sustainability

Akademischer Grad	Modulnummer	Modulform
Master of Science	14497	Wahlpflicht

Modultitel	Deutsch als Fremdsprache B2.2 für den Beruf German as a Foreign Language B2.2 for Professional Purposes
Einrichtung	ZES - Zentrale Einrichtung Sprachen
Verantwortlich	Diebel, Simone Dr. Hashold, Joanna
Lehr- und Prüfungssprache	Deutsch
Dauer	1 Semester
Angebotsturnus	sporadisch nach Ankündigung
Leistungspunkte	6
Lernziele	In diesem Modul werden die Teilnehmenden befähigt, im beruflichen Kontext (z.B. während eines Praktikums, im Beruf oder bei einer freiberuflichen Tätigkeit) in deutscher Sprache zu handeln. Die Studierenden können nach Abschluss des Moduls die Hauptinhalte komplexer Texte zu konkreten und abstrakten Themen verstehen. Sie können sich zu Fachdiskussionen in ihrem Spezialgebiet äußern. Sie können sich so spontan und fließend verständigen, dass ein normales Gespräch mit Nutzer*innen der Zielsprache als Erstsprache ohne größere Anstrengung auf beiden Seiten gut möglich ist. Sie können sich zu einem breiten Themenspektrum klar und detailliert ausdrücken, einen Standpunkt zu einer aktuellen Frage erläutern und die Vor- und Nachteile verschiedener Möglichkeiten angeben. Die Studierenden können Abläufe und Prozesse beschreiben und präzise Anweisungen geben (vgl. GER-Niveaubeschreibungen).
Inhalte	Die Studierenden erwerben allgemeinsprachige Fertigkeiten in einem handlungsorientierten hochschul- und berufsspezifischen Lernkontext. Mit diesen Fertigkeiten ist die Aneignung eines akademischen und vor allem berufsorientierten Wortschatzes verbunden sowie relevante Aspekte der Grammatik und entsprechende sprachliche Strukturen. Sprachliche Kompetenzen im Sinne des GER stehen dabei im Vordergrund. In der Gruppenarbeit spielt der Erwerb einer Mediationskompetenz (erklären, mitteln, aushandeln) eine zentrale Rolle. Darüber hinaus werden Strategien des autonomen Lernens vermittelt, um den Lernprozess effektiv zu gestalten und damit die eigene Lernfähigkeit zu stärken, sowie unterschiedliche

	Kommunikationsstrategien ausprobiert. Trainiert werden ebenfalls soziale Kompetenzen wie z.B. Teamarbeit.
Empfohlene Voraussetzungen	Deutschkenntnisse auf dem Niveau GER B1+ Die vorhandenen Deutschkenntnisse werden zu Beginn des Semesters mit einem Eingangstest überprüft oder mittels Zertifikat nachgewiesen.
Zwingende Voraussetzungen	keine
Lehrformen und Arbeitsumfang	Übung - 4 SWS Selbststudium - 120 Stunden
Unterrichtsmaterialien und Literaturhinweise	kurstragendes Lehr- und Übungsmaterial Zusatzmaterialien
Modulprüfung	Continuous Assessment (MCA)
Prüfungsleistung/en für Modulprüfung	3 themenbezogene Tests à 30-60 Minuten bzw. Abgabenaufgaben (jeweils 1/3 der Gesamtnote)
Bewertung der Modulprüfung	Prüfungsleistung - benotet
Teilnehmerbeschränkung	keine
Bemerkungen	Das Modul richtet sich an internationale Studierende bzw. Gaststudierende mit Vorkenntnissen der deutschen Sprache auf der Niveaustufe GER B1+. Es ist nicht geeignet für Studierende mit einem niedrigeren Sprachniveau. Eine zusätzliche Anmeldung der Studierenden in der Zentralen Einrichtung Sprachen ist erforderlich (www.b-tu.de/sprachen)! Es können nicht mehr als 25 Teilnehmende in jeder Sprachkursgruppe eingeschrieben werden. Die Lehrveranstaltung kann in Präsenz oder online durchgeführt werden.
Veranstaltungen zum Modul	Übung Deutsch als Fremdsprache für den Beruf B2.2 (4 SWS)
Veranstaltungen im aktuellen Semester	019162 Übung Deutsch als Fremdsprache B2.2 für den Beruf - 4 SWS

Erläuterungen

Das Modulhandbuch bildet als Teil der Prüfungsordnung die Rechtsgrundlage für ein ordnungsgemäßes Studium. Darüber hinaus soll es jedoch auch Orientierung bei der Gestaltung des Studiums geben.

Dieses Modulhandbuch wurde am 18. September 2026 automatisch für den Master (universitär)-Studiengang Chemistry: Materials, Engineering and Sustainability (universitäres Profil), PO-Version 2025, aus dem Prüfungsverwaltungssystem auf Basis der Prüfungsordnung generiert. Es enthält alle zugeordneten Module einschließlich der ausführlichen Modulbeschreibungen mit Stand vom 18. September 2026. Neben der Zusammensetzung aller Veranstaltungen zu einem Modul wird zusätzlich das Veranstaltungsangebot für das jeweils aktuelle Semester gemäß dem Verzeichnis der BTU ausgegeben.

The module catalogue is part of the examination regulation and as such establishes the legal basis for studies according to the rules. Furthermore, it should also give orientation for the organisation of the studies.

This module catalogue was generated automatically by the examination administration system on the base of the examination regulation on the 18 September 2026, for the Master (universitär) of Chemistry: Materials, Engineering and Sustainability (research-oriented profile). The examination version is the 2025, Catalogue contains all allocated modules including the detailed module descriptions from 18 September 2026. Apart from the composition of all components of a module, the list of lectures, seminars and events for the current semester according to the catalogue of lectures of the BTU is displayed.