Master of Science Structural Chemistry and Spectroscopy

Academic degree	Module number	Module form
Master of Science	**13-122-0111**	**Choice-Obligatory**

Module Name	**Mass Spectrometry**
Recommended for:	1st / 3rd semester
Responsible	Junior research group leader "Physical chemistry of reactive intermediates".
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "Mass Spectrometry " (2 SWS) = 30 h attendance time and 60 h self-study = 90 h • Practical course with seminar part "Mass Spectrometry " (1 SWS) = 15 h attendance time and 45 h self-study = 60 h
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy
Aims	Students will be familiar with the major ionization techniques (EI, SI, MALDI) and mass analyzers (quadrupole, ion traps, time of flight, high-resolution analyzers) and will be able to interpret mass spectra. The most important fragmentation rules are known. Fundamentals for the analysis of mass spectra of small organic molecules, inorganic molecular ions and larger biomolecules are provided.
Content	An introduction to mass spectrometry and its application in the field of molecular analysis is given. The main ionization methods of modern analytics (EI, ESI, MALDI) are presented. The operation of common mass analyzers (TOF, quadrupole, ion traps, FTICR and Orbitrap) will be explained. The different ways to initiate fragmentation reactions (e.g., post-source decay (PSD) in MALDI-MS and ESI tandem MS are discussed. Using organic and inorganic compounds as examples, fragmentation reactions both in EI - MS and by CID of quasimolecule ions are explained and mass spectra are evaluated. Fundamentals of peptide sequencing by mass spectrometry will be developed. An introduction to mass spectrometry-based gas phase spectroscopy of molecular ions will be given.
Participation requirements	none
Literature	Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Dr. Jonas Warneke, jonas.warneke@uni-leipzig.de

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1 Pre-requisite for the examination: practical performance (1 experiment, 1 protocol)	
	Lecture "Mass Spectrometry" (2SWS)
	Practical Course with seminar part "Mass Spectrometry" (1SWS)

Master of Science Structural Chemistry and Spectroscopy

Academic degree	Module number	Module form
Master of Science	**13-122-0121**	**Obligatory (SCS)**

Module Name	**NMR on Biosystems**
Recommended for:	2nd semester
Responsible	Professors for Molecular spectroscopy
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "NMR at Biosystems" (2 SWS) = 30 h attendance time and 30 h self-study = 60 h • Seminar "NMR on Biosystems" (1 SWS) = 15 h attendance time and 30 h self-study = 45 h • practical course "NMR on Biosystems" (1 SWS) = 15 h attendance time and 30 h self-study = 45 h
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy
Aims	Students gain knowledge of the most important NMR methods for structure elucidation, as well as NMR methods on biosystems, and are able to apply them.
Content	Basics of 2D NMR spectroscopy, description of J-resolved techniques, different forms of COSY, NOESY, and TOCSY, CH- correlations such as HETCOR, HMQC, HSQC, and HMBC, CC-correlations such as INADEQATE and ADEQUATE [WS], application of the above techniques to proteins, DNA and RNA fragments.
Participation requirements	none
Literature	1. Jeremy K. Sanders, Brian K. Hunter: Modern NMR Spectroscopy, a guide for Chemists, Oxford University Press 1993 2. Stefan Berger, Siegmar Braun: 200 and More NMR Experiments, Wiley-VCH, 2004 3. http://www.uni-leipzig.de/~nmr/ANALYTIK/Studium
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Jörg Matysik (joerg.matysik@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1 *Examination prerequisites: performance in the practical course*	
	Lecture "NMR on Biosystems" (2SWS)
	Seminar "NMR on Biosystems" (1SWS)
	practical course "NMR on Biosystems" (1SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0122**	**Choice-Obligatory**

Module Name	**Research Practical Course Molecular Spectroscopy**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Analytical Chemistry/Molecular Spectroscopy
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Molecular Spectroscopy" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy
Aims	Students know selected NMR methods and can apply them in a research-oriented manner.
Content	Research practical course on selected topics in molecular spectroscopy.
Participation requirements	Knowledge of the basics of magnetic resonance, the most important NMR methods and their application.
Literature	Stefan Berger, Siegmar Braun: 200 and More NMR Experiments, Wiley-VCH, 2004 Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Jörg Matysik (joerg.matysik@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Molecular Spectroscopy" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-122-0122**	**Choice-Obligatory**

Module Name	**Selected Topics of NMR Spectroscopy**
Recommended for:	2nd semester
Responsible	Professors for Molecular Spectroscopy
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "Selected Topics of NMR Spectroscopy" (2 SWS) = 30 h attendance time and 50 h self-study = 80 h • Practical course "Selected Topics of NMR Spectroscopy" (1 SWS) = 15 h attendance time and 30 h self-study = 45 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemistry and Biotechnology • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The students obtain a deep understanding of special NMR methods.
Content	The module contains specialized lectures with the following contents: Product Operator Formalism 2D NMR Spectroscopy NMR Spin-Systems Dynamic NMR Weakly-oriented molecules Solid State NMR of selected NMR cores Hyperpolarization NMR with pulsed field gradients
Participation requirements	none
Literature	1. M. Levitt: Spin Dynamics”, Wiley-VCH 2. H. Günther "NMR-Spetroscopy", Wiley-VCH, 3rd ed. 2013 Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Jörg Matysik, joerg.matysik@uni-leipzig.de

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1 *Pre-requisite for the examination: practical course completion*	
	Lecture "Selected Topics of NMR Spectroscopy" (2SWS)
	Practical course "Selected Topics of NMR Spectroscopy" (1SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0123**	**Choice-Obligatory**

Module Name	**Research Practical Course in Concentration Analysis**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Concentration Analysis
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Concentration Analysis" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Chemistry and Spectroscopy
Aims	The students know analytical methods and can apply them. They are able to analyze, process and independently present selected topics of concentration analysis under different objectives.
Content	Research practical course on selected topics in concentration analysis.
Participation requirements	none,.
Literature	R. Kellner (Hrsg) Analytical Chemistry Wiley 2004, ISBN 3-527-30590-4 Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Detlev Belder (belder@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Concentration Analysis" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0126**	**Choice-Obligatory**

Module Name	**Research Practical Course in Trace Analysis**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Analytical Chemistry in Biological Systems
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Trace Analysis " (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The students know trace analytical methods and techniques. They are able to apply these in a research-oriented manner.
Content	Participation in a current research project of the working group: sampling and sample preparation; digestion and extraction of samples; methods of elemental trace analysis with spectroscopic or mass spectrometric techniques, element speciation by coupling with chromatographic separation techniques; organic trace analysis with gas chromatography-mass spectrometry and related techniques, liquid chromatography-mass spectrometry; Qualitative and quantitative analysis; application of these and other techniques to samples of water, soil and air and to biological materials.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Thorsten Reemtsma (thorsten.reemtsma@ufz.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Trace Analysis" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0125**	**Choice-Obligatory**

Module Name	**Methods and Procedures for Trace Analysis**
Recommended for:	1st / 3rd semester
Responsible	Professors for Analytical Chemistry in Biological Systems
Duration	1 semester
Offered in	each winter semester
Teaching formats	• Lecture "Methods and Procedures for Trace Analysis" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h • Exercise "Methods and Procedures for Trace Analysis" (1 SWS) = 15 h attendance time and 20 h self-study = 35 h • Seminar "Methods and Procedures for Trace Analysis" (1 SWS) = 15 h attendance time and 25 h self-study = 40 h
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie • M.Sc. Chemistry and Biotechnology
Aims	Students know trace analysis methods for a quantitative proof of organic and inorganic trace materials in water, soil, air and biological materials. They can apply the methods and interpret their results.
Content	The module contains lecture and seminar about selected topics of organic trace analysis and the element trace analysis including speciation analysis, from water, soil, air and biological materials; Including sampling techniques, sample treatment (enhancement, extraction, solution etc.) and sample cleaning procedures. Applications of the following methods will be treated: Gas chromatography, liquid chromatography, coupling with mass spectrometry; Atom spectroscopy, Element mass spectrometry; Coupling with Chromatography, Photometry, electrochemical methods. In addition, a hands-on training in selected instrumental trace analysis techniques (analysis of water and/or sediments) enables to obtain experience.
Participation requirements	none
Literature	1. Marr,Cresser, Ottendorfer, Umweltanalytik - eine allgemeine Einführung, Thieme Verlag, Stuttgart, 1988. 2. Perez-Bendito, Rubio, Rubio, Environmental Analytical Chemistry, Elesevier, Amsterdam, 1999. 3. Otto, Analytische Chemie, Wiley-VCH, Weinheim, 3. Aufl., 2006. Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.

Teaching staff and contact email Prof. Dr. Thorsten Reemtsma, thorsten.reemtsma@ufz.de

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
	Lecture "Methods and Procedures for Trace Analysis" (2SWS)
	Exercise "Methods and Procedures for Trace Analysis" (1SWS)
	Exercises "Methods and Procedures for Trace Analysis" (1SWS)

Master of Science Structural Chemistry and Spectroscopy

Academic degree	Module number	Module form
Master of Science	**13-122-0221**	**Obligatory (SCS)**

Module Name	**Structural Analysis in Inorganic Chemistry**
Recommended for:	2nd semester
Responsible	Professors for Inorganic Chemistry
Duration	1 semester
Offered in	each summer semester
Teaching formats	Lecture "Inorganic Structural Analysis" (4 SWS) = 60 h classes and 90 h self-study = 150 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemistry and Biotechnology
Aims	The students are familiar with modern structural analytical methods for the characterization of inorganic compounds.
Content	X-ray structure analysis: basics of crystallography, X-ray diffraction at a crystal, symmetry theory (point groups and spatial symmetry), structure factors, Fourier synthesis, experimental methods, structure solution and refinement, phase problem; results and interpretation of single crystal X-ray structure analysis; databases and program systems. IR spectroscopy: basics, spectra prediction, selected examples. NMR spectroscopy: basics, heteronuclei (e.g., ^{19}F, ^{31}P, ^{207}Pb, ^{119}Sn), selected examples. Magnetochemistry: molecular magnetism, magnetic susceptibility, magnetic properties of coordination compounds, "spin-only" magnetism, magnetic exchange interactions, single molecule magnets.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Harald Krautscheid, krautscheid@rz.uni-leipzig.de

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
	Lecture "Inorganic Structural Analysis" (4SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0215**	**Choice-Obligatory**

Module Name	**Research Practical Course in Inorganic Chemistry**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Inorganic Chemistry: Solid State Chemistry/ Materials Science
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Inorganic Chemistry" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie • M.Sc. Advanced Spectroscopy in Chemistry
Aims	By participating in a current research project, students are able to work independently in a scientific manner. They can apply suitable synthesis methods and are familiar with X-ray (single crystals, powder samples), spectroscopic (IR, NMR, MS) and thermochemical (TG, DTA, DSC) methods for the investigation of inorganic compounds.
Content	Students participate in a current research project in the group, such as the synthesis and characterization of metal-organic frameworks (MOFs) or the preparation and investigation of precursor compounds for the generation of solid-state compounds.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Harald Krautscheid (krautscheid@rz.uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Inorganic Chemistry" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0216**	**Choice-Obligatory**

Module Name	**Research Practical Course Organometallic Chemistry**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Organometallic Chemistry/ Photochemistry
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Organometallic Chemistry" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie • M.Sc. Advanced Spectroscopy in Chemistry
Aims	Students will be able to develop synthesis concepts for inorganic and organometallic molecular compounds for use in catalysis or medicinal chemistry and characterize them using modern spectroscopic methods.
Content	Participation in a current research project of the group in one of the following areas: a) Development of mono- and polynuclear transition metal complexes for homogeneous (asymmetric) catalysis. b) Homo- and heterometallic metal macrocycles as multifunctional ligands for use in catalysis and sensing. c) Development of phosphine ligands (chiral, macrocyclic, sterically demanding, P-H functionalized, water soluble) for homogeneous catalysis. d) Inorganic/organometallic compounds as selective antitumor agents. e) Biologically active boron compounds (especially carbaborane derivatives) for medical applications (boron neutron capture therapy, enzyme inhibitors) f) Phosphorus-rich ligands and complexes as precursors for binary metal phosphides MPx. Most reactions are carried out under inert gas conditions; characterization is performed and spectroscopic methods (esp., NMR, IR, MS, also GC-MS) and X-ray crystal structure analysis.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Evamarie Hey-Hawkins (hey@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Organometallic Chemistry" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0217**	**Choice-Obligatory**

Module Name	**Research Practical Course in Inorganic Chemistry - Functional Materials**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Inorganic Chemistry - Functional Materials
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Functional Materials" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie • M.Sc. Advanced Spectroscopy in Chemistry
Aims	Students acquire an in-depth understanding of inorganic solids as functional materials and master a broad repertoire of methods for their preparation and characterization.
Content	Participation in a current research project of the working group on one of the following classes of functional materials: - High-performance materials (intermetallic phases, ceramics) - Hydrogen storage materials (metal hydrides, porous materials) - Magnetic materials (intermetallic phases, borides, carbides, oxides, nitrides) - Luminescent materials (e.g. halides, hydrides, oxides, oxinates) - photocatalysts (e.g. nitrides, nitride oxides, oxides, hydroxides) - ionic conductors (e.g. Li^+, Na^+, Ag^+, Mg^{2+}, N^{3-}, O^{2-}, F^-).
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Holger Kohlmann (holger.kohlmann@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Functional Materials" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0218**	**Choice-Obligatory**

Module Name	**Research Practical Course Supramolecular Coordination Chemistry**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Coordination Chemistry
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Supramolecular Coordination Chemistry" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie • M.Sc. Advanced Spectroscopy in Chemistry
Aims	Students master the synthesis and characterization of supramolecular compounds and know their properties and significance.
Content	Participation in a current research project of the group; synthesis and characterization of macrocyclic ligands and their complexes, organic transformations in molecular cavities, receptor design, artificial enzymes, encapsulation of biochemically relevant compounds (hormones, proteins, viruses), morphosynthesis, stabilization of reactive intermediates, organization by self-association, supramolecular catalysis, self-replication, green chemistry, nanocapsules, molecular magnetism.
Participation requirements	none
Literature	J. W. Steed, J. L. Atwood, Supramolecular Chemistry, Wiley-VCH, 2000, Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Berthold Kersting (b.kersting@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Supramolecular Coordination Chemistry" (10SWS)

Master of Science Structural Chemistry and Spectroscopy

Academic degree	Module number	Module form
Master of Science	**13-121-0313**	**Choice-Obligatory**

Module Name	**Research Practical Course in Advanced Synthetic Organic Chemistry**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Organic Chemistry/ Heterocyclic Chemistry
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Advanced Synthetic Organic Chemistry" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemie
Aims	The student masters modern organic chemical synthesis and analysis techniques, can use them to synthesize complex fine chemicals, and can characterize the products by modern spectroscopic methods.
Content	In this course, the student will first investigate the research background by conducting a literature review. Compounds will then be synthesized using for example, chiral auxiliaries, catalysts, and enzymes. Furthermore, multistep syntheses of biologically active compounds will be performed and working under inert gas atmosphere with organometallic compounds will be learned. The experiments are evaluated, recorded and the products are fully characterized by NMR, IR, mass spectroscopy. This is accompanied by an introduction to patent database research.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Christoph Schneider (schneider@chemie.uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Advanced Synthetic Organic Chemistry" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0315**	**Choice-Obligatory**

Module Name	**Research Practical Course Catalytic Methods in Organic Chemistry**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Organic Chemistry/ Synthesis and Catalysis
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Catalytic Methods in Organic Chemistry" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemie
Aims	Students learn modern organic synthesis methods and use the (heterocyclic) products as catalysts or reactants in (homogeneous) catalytic applications. They are able to control reaction progressions and characterize products using modern analytical techniques and spectroscopic methods. Student will develop a broad, critical understanding in current applications in various systems and fields.
Content	Within the scope of the practical course, the student should first explore the respect research background by researching (current) literature. Preparations and catalysts are prepared using different synthesis methods, also in multi-step reactions. Advanced techniques, such as working under inert gas atmosphere, photochemical reactions, working in micro scale are learned and deepened. In catalytic reactions, influences of the reaction conditions on the reaction result are investigated and use for optimization. All experiments are recorded and evaluated using various analytica techniques. All products are fully characterized spectroscopically (IR, UV, NMR spectroscopy, mass spectrometry). In parallel, an introduction to special methods o literature research (e.g. databases) and to the use of suitable software for data evaluation is given.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Kirsten Zeitler (kzeitler@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Catalytic Methods in Organic Chemistry" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0316**	**Choice-Obligatory**

Module Name	**Research Practical Course Organic Chemistry / Chemical Biology**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Organic Chemistry/ Chemical Biology
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Organic Chemistry/ Chemical Biology" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemie
Aims	Students will be able to apply organic chemical and biochemical methods for the synthesis and biochemical characterization of low molecular weight substances.
Content	Students will first plan a synthesis route of the target compounds based on a comprehensive literature review. Carrying out the synthesis of the compounds constitutes the core of the practical course. The activities of the synthesized compounds against the proteins or protein domains of interest are to be investigated by the students themselves in biochemical assays.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Thorsten Berg (tberg@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Organic Chemistry/ Chemical Biology" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0321**	**Obligatory (SCS)**

Module Name	**Chemistry of Natural Products**
Recommended for:	1st semester
Responsible	Professors for Organic Chemistry
Duration	1 semester
Offered in	each winter semester
Teaching formats	• Lecture "Natural Products Chemistry" (3 SWS) = 45 h attendance time and 45 h self-study = 90 h • Seminar "Natural Products Chemistry" (1 SWS) = 15 h attendance time and 45 h self-study = 60 h
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie
Aims	Students will know the chemical and biochemical aspects of important natural products. These include amino acids (also non-proteinogenic amino acids), carbohydrates and lipids.
Content	Modern methods for synthesis of chiral non-proteinogenic amino acids; carbohydrates; bioactive lipids; terpenes, steroids, alkaloids, antibiotics.
Participation requirements	none
Literature	Collins, Ferrier: Monosaccharides, K.B.G. Torsell: Natural Product Chemistry, further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Tanja Gulder (tanja.gulder@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
	Lecture "Natural Products Chemistry" (3SWS)
	Seminar "Natural Products Chemistry" (1SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-122-0321**	**Choice-Obligatory**

Module Name	**Highlights in Natural Products Synthesis**
Recommended for:	2nd semester
Responsible	Professors for Organic Chemistry
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "Highlights in Natural Products Synthesis" (3 SWS) = 45 h attendance time and 45 h self-study = 90 h • Seminar "Highlights in Natural Products Synthesis" (1 SWS) = 15 h attendance time and 45 h self-study = 60 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemistry and Biotechnology • M.Sc. Chemie
Aims	The aims of this unit are: learning from famous total syntheses of natural products the students shall be able to apply retrosynthesis considerations for syntheses of complex organic molecules. After completing this unit the student should be able to: cope with theoretical dissection of molecules into retrons; understand advanced organic synthetic methods
Content	Natural products are an inspiring source for organic chemistry. Their unique structure as well as biological activity make them ideal targets for synthetic studies. In this course a broad range of different natural products with significant biological activities will be discussed with respect to their structure, biological activity and synthesis (prostaglandins, alkaloids, macrolides, steroids, terpenes). A major focus will be on the retrosynthesis of the target molecule, that is identification of suitable bond disconnections to form smaller compounds which are more easily assembled. The students will learn how to plan a complex total synthesis of a given structure.
Participation requirements	none
Literature	K. C. Nicolaou, Classics in Total Synthesis 1 und 2, Wiley-VCH; Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Christoph Schneider (schneider@chemie.uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: oral exam 30 min., with weighting factor: 1	
	Lecture "Highlights in Natural Products Synthesis" (3SWS)
	Seminar "Highlights in Natural Products Synthesis" (1SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0326**	**Choice-Obligatory**

Module Name — **Research Practical Course in Biomimetic Catalysis**

Recommended for: 1st / 2nd / 3rd semester

Responsible Professors for Organic Chemistry

Duration 1 semester

Offered in each semester

Teaching formats • Practical course "Biomimetic Catalysis" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h

Workload 10 ESTC = 300 working hours

Within programs
- M.Sc. Structural Chemistry and Spectroscopy
- M.Sc. Chemie
- M.Sc. Advanced Spectroscopy in Chemistry

Aims The students learn modern organic chemical and biochemical working techniques in order to apply them to the development and investigation of new nature based synthesis methods. In addition, modern analytical techniques and spectroscopic methods are introduced to follow reaction processes in detail and to characterize products.

Content Selective halogenations, recombinant protein expression, enzyme-catalyzed organic chemical transformations, photochemistry, electrochemistry, enantioselective catalysis, (solid-phase) peptide synthesis, metal-peptide catalysis.

Participation requirements none

Literature Literature references will be given during the classes.

Assignment of credit points Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.

Teaching staff and contact email Prof. Dr. Tanja Gulder (tanja.gulder@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Biomimetic Catalysis" (10SWS)

Master of Science Structural Chemistry and Spectroscopy

Academic degree	Module number	Module form
Master of Science	**13-122-0413**	**Choice-Obligatory**

Module Name	**Surface Analysis of Solids**
Recommended for:	1st / 3rd semester
Responsible	Professors for Physical Chemistry of Surfaces
Duration	1 semester
Offered in	alternating every 2 years in the winter semester
Teaching formats	• Lecture "Surface Analysis of Solids" (3 SWS) = 45 h attendance time and 105 h self-study = 150 h
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemistry and Biotechnology
Aims	The aims of this unit are: Basic knowledge of the methods of surface spectroscopy. After completing this unit the student should be able to cope with: Solid state surface structures, gas solid state interaction, growth of thin layers and be able to compare the more important techniques of surface analytics.
Content	Structure of solid state surfaces and interfaces, gas adsorption, physical basics, instruments und examples of application of analytical methods for surface investigations: electronspectroscopy: photoelectron (XPS, UPS) and Auger electron spectroscopies (AES), electron energy loss spectroscopy (EELS), quantitative lateral distribution and depth profile analysis of the chemical states, analytical results of adsorption, catalysis, corrosion, adhesion, film growth and segregation. Electron diffraction (LEED,XPD). Secondary ion Mass Spectrometry (SIMS, SNMS). scanning microscopies: STM, AFM, scanning electrochemical microscopy (SECM). Applications: Adsorption, desorption, catalysis, corrosion, adhesion, film growth and segregation.
Participation requirements	none
Literature	1. H. Bubert and H. Jenett, Surface and Thin Film Analysis, Wiley-VCH, 3-527- 30458-4; 2. H. Lüth, Surface and Interfaces of Solids, Springer, 3-540-42331-1
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Reinhard Denecke (denecke@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: written exam 90 min., with weighting factor: 1	
	Lecture "Surface Analysis of Solids" (3SWS)

Master of Science ASC

Academic degree	Module number	Module form
Master of Science	**13-122-0415**	**Mandatory ASC**

Module Name	**Synchrotron Radiation and its Applications**
Recommended for:	2nd semester
Responsible	Professors for Physical Chemistry of Surfaces
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture " Synchrotron Radiation and its Applications" (2 SWS) = 30 h attendance time and 45 h self-study = 75h • Seminar " Synchrotron Radiation and its Applications" (1 SWS) = 15 h attendance time and 60 h self-study = 75 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Advanced Spectroscopy in Chemistry
Aims	Students will know and understand the fundamentals of the generation of synchrotron radiation and advanced analytical methods using synchrotron synchrotron radiation. They can critically evaluate the applicability of different specific spectroscopy methods for the investigation of specific structural problems and apply these techniques as appropriate.
Content	General introduction to synchrotron radiation sources: Physical fundamentals; experimental requirements; magnetic devices, optical Instruments and vacuum pump systems. Synchrotron beam tube designs and detection methods. Interaction between matter and light (absorption, emission, scattering). - Hull level spectroscopy with synchrotron radiation. X-ray absorption spectroscopy: Physical phenomena: photoelectric effect, cause of fine structure, interference, EXAFS oscillations, EXAFS spectrum, EXAFS equation Data analysis: normalization, background processing, Fourrier transform, fit of the EXAFS equation, multiple scattering, pre-edge structure Operando and in situ measurements with XAS X-ray photoelectron spectroscopy: Introduction to XPS: photoelectric effect, instrumentation, binding energies, Spin-orbit coupling, XPS spectra, qualitative analysis, quantitative XPS (XPS equation). , XPS fit, XPS with syncrothron radiation sources : advantages (spectral resolution, time resolution, polarization) and disadvantages (charge effect), X-ray emission and resonant inelastic X-ray scattering: Generation of the hull hole, decay of the hull hole, determination of the X-ray emission lines, XES and RIXS process, relation to other spectroscopies (XAS,XES, EELS), instrumentation (hard RIXS, high-energy Resolution Fluorescence Detected (HERFD) XAS, Site selective XAS). - Further spectroscopy methods with synchrotron radiation Infrared spectroscopy (high resolution, large spectral range), X-ray diffraction (high resolution, use of hard X-rays, protein crystallography ...), Tomography and imaging techniques, small angle X-ray scattering (Small Angle X-Ray Scattering)
Participation requirements	none

Literature	Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.

Performance assessment and prerequisites for examination

Module examination: portfolio (4 weeks), with weighting factor: 1	
	Lecture " Synchrotron Radiation and its Applications " (3SWS)
	Seminar " Synchrotron Radiation and its Applications " (1SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0417**	**Choice-Obligatory**

Module Name	**Research Practical Course in Reaction Kinetics and Structure Elucidation**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Technical Chemistry of Polymers
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Reaction Kinetics and Structure Elucidation" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie • M.Sc. Advcanced Spectroscopy in Chemistry
Aims	The students are able to investigate and elucidate elementary reactions of reactive transients in solutions at room temperature by means of stationary and time-resolved spectroscopy. They are able to work on selected topics of short-time spectroscopy in a research-oriented, independent manner and to present on the various effects.
Content	Research practical course on selected topics of short-term spectroscopy using pulse radiolysis or laser photolysis and optical detection of absorption and, if necessary, emission in solutions.
Participation requirements	none
Literature	1. A. Henglein, W. Schnabel, J. Wenedenburg: "Einführung in die Strahlenchemie", Akademieverlag, Berlin, 1969; 2. N. J. Turro: "Modern Molecular Photochemistry", Wiley, 1991; Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Bernd Abel (bernd.abel@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Reaction Kinetics and Structure Elucidation" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0418**	**Choice-Obligatory**

Module Name	**Research Practical Course in Thin Film Growth, Phenomena and Analysis of Solid Interfaces**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Physical Chemistry of Surfaces
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Thin Film Growth, Phenomena and Analysis of Solid Interfaces" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie • M.Sc. Advanced Spectroscopy in Chemistry
Aims	Students will be able to independently identify principles of thin film growth and interfacial structure, as well as investigate them using surface analysis techniques and evaluate them in a research-oriented manner.
Content	Research practical course to study selected metal, oxide, and sulfide layer systems generated by various techniques and to be analyzed by X-ray fluorescence and electron spectroscopy, tunneling microscopy, and electron diffraction techniques.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Reinhard Denecke (denecke@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Thin Film Growth, Phenomena and Analysis of Solid Interfaces" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0419**	**Choice-Obligatory**

Module Name	**Research Practical Course on the Characterization of Gas Phase Clusters and Liquid Interfaces**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Physical Chemistry/ Condensed Inhomogeneous Matter
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Characterization of Gas Phase Clusters and Liquid Interfaces" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The students know modern spectroscopic methods of physical chemistry for the investigation of gas phase clusters or fluid interfaces and can apply their knowledge in research-oriented projects.
Content	Participation in a current research project as part of a research internship on selected topics in modern spectroscopy, such as linear and non-linear optical methods, particle spectroscopy, photochemical and photophysical probing of size-selected molecular aggregates in the gas phase or fluid interfaces.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Knut Asmis (knut.asmis@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Characterization of Gas Phase Clusters and Liquid Interfaces" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0420**	**Choice-Obligatory**

Module Name	**Physical Chemistry of Clusters**
Recommended for:	1st / 3rd semester
Responsible	Professors of the Institute for Physical Chemistry
Duration	1 semester
Offered in	each winter semester
Teaching formats	• Lecture "Physical Chemistry of Clusters" (2 SWS) = 30 h attendance time and 70 h self-study = 100 h • Seminar "Physical Chemistry of Clusters" (1 SWS) = 15 h attendance time and 35 h self-study = 50 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemie
Aims	The students know the concepts and methods to study and describe nanoscaled matter in the range between single atoms and bulk solids.
Content	Classification and production of clusters, size-dependent properties of clusters, non-scalable regime, rare gas-, molecular, metal, semiconductor, ionic and microsolvatised clusters, experimental characterization of cluster properties in the gas phase and at surfaces: Mass spectrometry, laser spectroscopy and scanning microscopy, clusters in the atmosphere, catalytic properties of deprotonated clusters, cluster beam synthesis of nanostructured materials
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Knut Asmis (knut.asmis@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination	
Written exam 90 min., with weighting factor: 2	Lecture "Physical Chemistry of Clusters" (2SWS)
Presentation* 15 min., with weighting factor: 1	Seminar "Physical Chemistry of Clusters" (1SWS)

*These examination performances must be passed.

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0422**	**Choice-Obligatory**

Module Name	**Function Control at Complex Surfaces**
Recommended for:	1st / 3rd semester
Responsible	Professors of the Institute for Physical and Theoretical Chemistry
Duration	1 semester
Offered in	each winter semester
Teaching formats	• Lecture "Functional control of complex surfaces" (2 SWS) = 30 h attendance time and 60 h self-study = 90 h • Seminar "Functional control of complex surfaces" (1 SWS) = 15 h attendance time and 45 h self-study = 60 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy ▪ M.Sc. Chemie • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The student will learn about applied and current issues and solutions for the development of functionalized polymers and hybrid materials, the use of radiation- and photochemical technologies.
Content	Changing topics from current research fields for the preparation and modification of functional surfaces and functional nano- and microstructured systems. This includes the preparation of nanocomposites and linked porous polymer systems. The beam and photon-modified materials obtain extraordinary mechanic, thermal, biocompatible or barrier or membrane properties with specific functionalities.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Bernd Abel (bernd.abel@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
	Lecture "Function Control at Complex Surfaces" (2SWS)
	Seminar "Function Control at Complex Surfaces" (1SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0423**	**Choice-Obligatory**

Module Name	**Surface Spectroscopy - Methods and Applications**
Recommended for:	2nd semester
Responsible	Professors for Physical Chemistry of Surfaces
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "Surface Spectroscopy - Methods and Applications" (3 SWS) = 45 h attendance time and 105 h self-study = 150 h
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie • M.Sc. Mineralogie und Materialwissenschaft • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The students know rules and laws in context with the solid surface structure, the gas-sold interaction and the thin film growth. They know important techniques of the surface analysis and can compare and evaluate them
Content	Introduction to structure of solid surfaces and interfaces. Physical basis, instrumentation and application examples of surface analysis methods: electron spectroscopy: Photo (XPS, UPS) and Auger electron spectroscopy (AES), energy loss spectroscopy (EELS), Quantitative lateral distributions and depths profile analysis of the chemical state; Electron diffraction (LEED,XPD); Secondary ion mass spectrometry (SIMS, SNMS). Applications: Adsorption, Desorption, Catalysis, Thin film growth and Segregation.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Reinhard Denecke, denecke@uni-leipzig.de

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
	Lecture "Surface Spectroscopy - Methods and Applications" (3SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0424**	**Choice-Obligatory**

Module Name	**Research Practical Course on the Chemistry of Molecular Fragment Ions and Ion Soft-landing**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Junior research group leader "Physical chemistry of reactive intermediates"
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course " Chemistry of Molecular Fragment Ions and Ion Soft-landing " (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The students know methods for the generation of highly reactive molecular gas phase ions, as well as the possibilities of using them by preparative mass spectrometry for chemical reactions in surface layers. to be used.
Content	Participation in a current research project within the framework of a research internship on selected topics such as the elucidation of fragmentation reactions, the structural elucidation of these fragments and their Deposition on suitable substrate surfaces.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Dr. Jonas Warneke (jonas.warneke@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Characterization of Gas Phase Clusters and Liquid Interfaces" (10SWS)

Master of Science Structural Chemistry and Spectroscopy

Academic degree	Module number	Module form
Master of Science	**13-122-0511**	**Choice-Obligatory**

Module Name	**Nanostructured Catalytic Systems**
Recommended for:	1st / 3rd semester
Responsible	Professors for Technical Chemistry (Heterogeneous catalysis)
Duration	1 semester
Offered in	each winter semester
Teaching formats	• Lecture "Nanostructured Catalytic Systems" (2 SWS) = 30 h attendance time and 60 h self-study = 90 h • Exercise "Nanostructured Catalytic Systems" (2 SWS) = 30 h attendance time and 30 h self-study = 60 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemistry and Biotechnology
Aims	Students gain in-depth knowledge of the influence of nanostructure on the properties of catalysts.
Content	Catalyst systems (monoliths, debris, microsystems), classification, synthesis, characterization, application, importance, reaction engineering modeling.
Participation requirements	none
Literature	Cybulski, Moulijn, Stuctured Catalysts and Reactors, Marcel Dekker, ISBN 0-8247- 9921-6 Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	tba

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
	Lecture "Nanostructured Catalytic Systems" (2SWS)
	Exercise "Nanostructured Catalytic Systems" (2SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-122-0512**	**Choice-Obligatory**

Module Name	**Sustainable Systems in Chemistry**
Recommended for:	1st / 3rd semester
Responsible	Professors for Technical Chemistry (Heterogeneous Catalysis)
Duration	1 semester
Offered in	each winter semester
Teaching formats	• Lecture "Sustainable Systems in Chemistry" (3 SWS) = 40 h attendance time and 55 h self-study = 95 h • Seminar "Sustainable Systems in Chemistry" (1 SWS) = 15 h attendance time and 30 h self-study = 45 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemistry and Biotechnology
Aims	Students gain in-depth knowledge of sustainable systems in chemical applications and can independently apply this knowledge to complex case studies.
Content	Tools and methods for assessing the sustainability of chemical processes and products, chemical industry as a pioneer for the development of sustainable chemistry (political framework, social responsibility, practical examples), catalysis as a key technology for sustainable development, fundamentals of process intensification, energetic and material use of biomass and biogas (renewable raw materials and biorefineries), material use of CO_2 as a C1 building block (status and perspectives), coupling with the energy industry and renewable energies (electrolysers, power-to-X technologies, energy storage and conversion, hydrogen economy).
Participation requirements	none
Literature	Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	tba

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
	Lecture "Sustainable Systems in Chemistry" (3SWS)
	Seminar "Sustainable Systems in Chemistry" (1SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0514**	**Choice-Obligatory**

Module Name	**Research Practical Course in Heterogeneous Catalysis**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Technical Chemistry (Heterogeneous Catalysis)
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Heterogeneous Catalysis" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The students learn the basics of heterogeneous catalysis through scientific work in a current research project. They are able to produce the catalysts, characterize them with suitable analytical methods and subsequently investigate them in an application-oriented manner.
Content	Preparation, characterization and testing of solid catalysts. Preparation methods: Impregnation, precipitation, etc., Characterization: spectroscopy, gas adsorption, temperature programmed methods, Testing: environmental catalysis, energy conversion.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	tba

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Heterogeneous Catalysis" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0515**	**Choice-Obligatory**

Module Name	**Research Practical Course Chemical Reaction Engineering**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Technical Chemistry (Chemical Reaction Engineering)
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Chemical Reaction Engineering" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	By working on a current research project in a working group in technical chemistry, students learn how to work scientifically in the field of chemical reaction engineering.
Content	Preparation, characterization and application of monolithic materials; optimization of pore systems with respect to reaction engineering objectives.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Dirk Enke (dirk.enke@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Chemical Reaction Engineering" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-122-0521**	**Choice-Obligatory**

Module Name	**Modern Concepts in Catalysis**
Recommended for:	2nd semester
Responsible	Professors for Technical Chemistry (Heterogenous Chemistry)
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "Heterogeneous Catalysis" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h • Seminar "Modern Concepts in Catalysis" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemistry and Biotechnology
Aims	Students have in-depth knowledge of the concepts of catalysis.
Content	Kinetics of catalytic reactions, catalyst characterization, solid catalysts, bifunctional catalysts, catalytic reaction mechanisms, shape-selective catalysis, catalyst deactivation, industrial catalytic processes.
Participation requirements	none
Literature	Chorkendorff, Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Wiley, ISBN 3-527-30574-2 Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	tba

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
	Lecture "Heterogeneous Catalysis" (2SWS)
	Seminar "Modern Concepts in Catalysis " (2SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0621**	**Choice-Obligatory**

Module Name	**Modern Methods in Theoretical Chemistry**
Recommended for:	2nd semester
Responsible	Professors for Theoretical Chemistry
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "Modern Methods in Theoretical Chemistry" (3 SWS) = 60 h attendance time (discussion session) and 90 h self-study = 150 h (preparatory study of the provided lecture videos); - Practical course “Modern Methods in Theoretical Chemistry” (1 SWS) = 15 h attendance time and 30 h self-study.
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie
Aims	Students are familiar with the relevant techniques (see content) and can assess their applicability to different systems and problems. Students are able to independently perform computer simulations on cluster and periodic systems and critically assess their validity. Students have gained initial basic knowledge beyond the Born-Oppenheimer approximation and the restriction to time-independent phenomena.
Content	Methods for taking electron correlation into account (post-Hartree-Fock methods, density functional theory), methods for calculating very large systems, supercell approaches for calculating periodic structures, methods for treating dynamic processes.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Ralf Tonner-Zech, ralf.tonner@uni-leipzig.de

Performance assessment and prerequisites for examination

Module examination: Oral exam 30 min., with weighting factor: 1	
	Lecture "Modern Methods in Theoretical Chemistry" (4SWS) Practical course “Modern Methods in Theoretical Chemistry (1 SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0631**	**Choice-Obligatory**

Module Name	**Research Practical Course Theoretical Chemistry**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Theoretical Chemistry
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Theoretical Chemistry" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The students gain first insights into the processing of problems in a current research project through independent scientific work. They are able to apply the basic, but especially the modern methods and calculations of theoretical chemistry.
Content	Semiempirical methods: HMO, EHT, AM1. Quantum chemical ab-initio methods: Hartree-Fock method, post-Hartree-Fock method. Density functional methods. Molecular dynamics Periodic systems: supercell DFT method. Introduction to UNIX operating systems.
Participation requirements	Knowledge of modern methods of theoretical chemistry
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Ralf Tonner-Zech (ralf.tonner@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Theoretical Chemistry" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0632**	**Choice-Obligatory**

Module Name	**Research Practical Course Artificial Intelligence in Theoretical Chemistry**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professorship for Theoretical chemistry of material design
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course " Artificial Intelligence in Theoretical Chemistry " (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The aim of the research practical course is to provide students with a first insights into the application of machine learning methods for (theoretical) chemistry. Students are able to transfer current problems in (theoretical) chemistry into machine learning problems and will apply supervised, unsupervised and reinforcement learning methods.
Content	Generating training datasets using theoretical chemistry methods (DFT, excited state methods, semiempirical methods,...) Regression problems: learning relationships between structure and properties of molecules and materials (kernel ridge and Gaussian process regression, deep neural networks) Classification problems: obtaining new knowledge using data analysis (dimension reduction methods, clustering,...). Molecular and material design using generative models
Participation requirements	Basic knowledge of theoretical chemistry
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Julia Westermayr (julia.westermayr@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Theoretical Chemistry" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0641**	**Choice-Obligatory**

Module Name	**Computational Spectroscopy**
Recommended for:	1st / 3rd semester
Responsible	Professors for Theoretical Chemistry of Complex Systems
Duration	1 semester
Offered in	each winter semester
Teaching formats	• Lecture "Computational Spectroscopy" (2 SWS) = 30 h attendance time and 30 h self-study = 60 h • Practical course "Computational Spectroscopy" (3 SWS) = 45 h attendance time and 45 h self-study = 90 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemistry and Biotechnology • M.Sc. Chemie
Aims	Basics of density functional theory, optimization of geometry, ionization potential and electron affinity, polarizability, vibrational spectroscopy (IR and Raman), NMR, EPR and UV/Vis spectroscopy.
Content	The students learn to calculate spectra using modern methods of computational chemistry and to determine structure and properties of molecules by comparison with calculated parameters.
Participation requirements	none
Literature	Christopher J. Cramer, Essentials of Computational Chemistry, Joswig/Geleßus/Heine, Computational Chemistry Workbook. Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	PD Dr. Agnieszka Kuc (a.kuc@hzdr.de)

Performance assessment and prerequisites for examination

Module examination: Performance in practical exercises (presentation), with weighting factor: 1	
	Lecture "Computational Spectroscopy" (2SWS)
	Practical course “Computational Spectroscopy" (3SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-0642**	**Choice-Obligatory**

Module Name	**Computational Chemistry of Solids**
Recommended for:	2nd semester
Responsible	Professors for Theoretical Chemistry of Complex Systems
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "Computational Chemistry of Solids" (2 SWS) = 30 h attendance time and 30 h self-study = 60 h • Practical course "Computational Chemistry of Solids" (3 SWS) = 45 h attendance time and 45 h self-study = 90 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemistry and Biotechnology • M.Sc. Chemie
Aims	The students learn methods suitable for the theoretical quantum description of solids. They learn the basics of the electronic and vibrational structure of solids and gain insight into current research fields of materials chemistry through examples.
Content	Crystal lattice, reciprocal lattice, Sommerfeld model, band structure, electronic density of states, magnetism, phonons, nanostructures, two-dimensional crystals, topological insulators.
Participation requirements	none
Literature	Hofmann, Philip: Solid State Physics, Wiley-VCH Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	PD Dr. Agnieszka Kuc (a.kuc@hzdr.de)

Performance assessment and prerequisites for examination

Module examination: Performance in practical course, with weighting factor: 1	
	Lecture "Computational Chemistry of Solids" (2SWS)
	Practical course "Computational Chemistry of Solids" (3SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**11-121-1112**	**Choice-Obligatory**

Module Name	**Bioorganic Chemistry**
Recommended for:	1st / 3rd semester
Responsible	Professors for Biochemistry/ Bioorganic Chemistry
Duration	1 semester
Offered in Teaching	each winter semester
formats	• Lecture "Bioorganic Chemistry" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h • Seminar "Bioorganic Chemistry" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemistry and Biotechnology • M.Sc. Chemie
Aims	Students know and understand bioorganic synthesis and analytical methods.
Content	Synthesis methods and strategies of peptides, carbohydrates and nucleic acids, chemical modification, introduction of fluorescent dyes, radioligands and biotin, and their applications, molecular probes for biological questions and their selective introduction. A distinct focus on the application of these molecues in therapy will be provided.
Participation requirements	Participation in the module "Fundamentals of Biochemistry" (11-111-1152-N) or equivalent knowledge.
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Annette Beck-Sickinger, abeck-sickinger@uni-leipzig.de

Performance assessment and prerequisites for examination

Module examination: Oral exam 30 min., with weighting factor: 1 *Pre-requisite: presentation, 30 min.*	
	Lecture "Bioorganic Chemistry" (2SWS)
	Seminar “Bioorganic Chemistry" (2SWS)

Master of Science

Academic degree	Module number	Module form
Master of Science	**13-121-1114**	**Choice-Obligatory**

Module Name **Research Practical Course Bioanalytics**

Recommended for: 1st / 2nd / 3rd semester

Responsible Professors for Bioanalytics

Duration 1 semester

Offered in each semester

Teaching formats • Practical course "Bioanalytics" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h

Workload 10 ESTC = 300 working hours

Within programs
- M.Sc. Chemie
- Prerequisite for master thesis in the field of bioanalytics

Aims Students are able to assess the applicability of bioanalytical methods for scientific problems largely independently and employ them correspondingly.

Content Based on the lectures and seminars in the field of protein chemistry, peptide chemistry and protein analysis, the theoretical knowledge acquired in other modules is to be applied to a scientific problem. The current state of knowledge in the subject area is to be determined by literature research in order to work on the assigned topic based on this. All methods and equipment available in the laboratory can be used for this purpose, for example: chromatographic and electrophoretic separation methods, ESI and MALDI mass spectrometry, in-gel digestion, cell culture techniques, immunochemical methods, UV/VIS and fluorescence spectroscopy, fluorescence polarization, solid phase peptide synthesis, cell culture techniques. Advanced thesis topics will be assigned individually based on student interests.

Participation requirements Participation in module 13-121-1119

Literature Literature references will be given during the classes.

Assignment of credit points Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.

Teaching staff and contact email Prof. Dr. Ralf Hoffmann (bioanaly@rz.uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Bioanalytics" (10SWS)

Master of Science

Academic degree	Module number	Module form
Master of Science	**13-121-1115**	**Choice-Obligatory**

Module Name	**Practical Course Recombinant Protein Expression**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Structural Analysis of Biopolymers
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Recombinant Protein Expression" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Chemistry and Biotechnology
Aims	The students know methods for the production of proteins in recombinant expression systems. They are able to perform selected methods in practice and explain the theoretical background.
Content	Based on the fundamental knowledge in molecular biology and protein biochemistry (partly Bachelor Chemistry) the following methods for protein expression and isolation will be applied practically. A typical assignment is the development of a construct for overexpression of a protein in E. coli or P. pastoris and the detection of protein expression and activity or the preparation and analysis of mutants of a protein. You will be able to practically perform the following methods and explain the theoretical background: primer design, PCR, DNA isolation and analysis, mutagenesis, cloning, microbiological techniques, protein expression, purification of proteins: chromatography, concentration, dialysis, precipitation and protein analysis: SDS-PAGE, blotting and immunological methods, mass spectrometry, enzyme assays, UV/Vis.
Participation requirements	none
Literature	1. A. Pingoud u. C. Urbanke: Arbeitsmethoden der Biochemie, de Gruyter 2. C. Mülhardt: Der Experimentator: Molekularbiologie /Genomics, Spektrum Verlag Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Norbert Sträter (strater@bbz.uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Recombinant Protein Expression" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**11-121-1116**	**Choice-Obligatory**

Module Name	**Research Practical Course Bioorganic Chemistry**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Biochemistry/ Bioorganic Chemistry
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Bioorganic Chemistry" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ECTS = 300 working hours
Within programs	• M.Sc. Chemie
Aims	Students know the basic working techniques in bioorganics and can apply them in a research-oriented manner.
Content	Application of synthesis methods and strategies to modify peptides, learning solid phase synthesis strategies, polymer handling, analysis of biopolymers, functional investigations.
Participation requirements	Participation in the module "Bioorganic Chemistry" (11-121-1112)
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Annette Beck-Sickinger (abeck-sickinger@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Bioorganic Chemistry" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-1119**	**Choice-Obligatory**

Module Name	**Separation techniques and advanced "-omics"-techniques**
Recommended for:	2nd semester
Responsible	Professors for Bioanalytics
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "Separation techniques and advanced "-omics"-techniques" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h • Seminar "Separation techniques and advanced "-omics"-techniques" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemistry and Biotechnology • M.Sc. Chemie
Aims	The students know modern analytical high-throughput methods to identify and quantify complex sample mixtures as part of "hypothesis-free" and "hypothesis-driven" research routes and are able to report profoundly.
Content	The identification and quantification of multiple substances in complex sample mixtures, like body fluids, demands the combination of multiple separation techniques with mass-spectrometric methods. The module treats regularly used separation technqiues with high resolution including multi-dimensional chromatographic and electrophoretic separations. The possibilities and requirements of these techniques in combination with fast high-resolution mass spectrometers are extensively demonstrated and discussed with examples from Proteomics, Lipidomics, Peptidomics and Metabolomics.
Participation requirements	Knowledge of mass spectrometric analysis methods
Literature	J.D. Watson & O.D. Sparkman: Mass spectrometry, Wiley Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Ralf Hoffmann

Performance assessment and prerequisites for examination

Module examination:	
Written exam 90 min., with weighting factor: 2	Lecture "Separation techniques and advanced "-omics"-techniques" (2SWS)

Presentation 30 min., with weighting factor: 1	Seminar "Separation techniques and advanced "-omics"-techniques" (2SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-1120**	**Choice-Obligatory**

Module Name	**Protein Crystallography**
Recommended for:	1st / 3rd semester
Responsible	Professors for Structural Analysis of Biopolymers
Duration	1 semester
Offered in	each winter semester
Teaching formats	• Lecture "Protein Crystallography" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h • Practical course "Protein Crystallography" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemie • M.Sc. Chemistry and Biotechnology
Aims	After completing this module, the student should be able to cope with: Problems of crystallization, symmetry and space groups, X-ray instrumentation, application of X-ray methods to biomolecules
Content	With the method X-ray crystallography, the structure or organic molecules, inorganic solid-state compounds as well as biological macromolecules can be determined to atomic resolution. The lecture course treats the basics of these methods with special emphasis on bio-crystallography. Single topics are: crystallization, crystals, symmetry and space groups, X-ray sources and detectors, data collection, scattering of X-rays and neutrons, phase problem, phasing and phase refinement, structure determination of small compounds using Patterson function and direct methods, structure determination of bio-molecules by molecular replacement, heavy atom replacement and anomalous dispersion, model building and structure visualization, structure refinement, validation and interpretation, comparison with NMR data.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Norbert Sträter (strater@bbz.uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1 *Pre-requisite for the examination: practical course completion*	
	Lecture "Protein Crystallography" (2SWS)
	Practical course "Protein Crystallography" (2SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**11-122-1121**	**Choice-Obligatory**

Module Name	**Receptor Biochemistry**
Recommended for:	2nd semester
Responsible	Professors for Bioorganic Chemistry and Biochemistry
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture "Receptor Biochemistry" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h • Seminar "Receptor Biochemistry" (2 SWS) = 30 h attendance time and 45 h self-study = 75 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemie
Aims	The students are familiar with the basics of signal transduction in eukaryotic cells. They are able to develop biochemical assays and apply them to current problems of signal transduction, the testing of drugs. Current literature on this topic should be discussed adequately.
Content	Principle mechanisms of signal transduction in cells, knowledge of the major classes of receptors, as well as their ligands and signal transduction mechanisms. In particular, steroid receptors, G Protein-coupled receptors, tyrosine kinase-coupled receptors, and ligand- and voltage-gated ion channels will be discussed, the possibility of regulation, development, and testing of drugs, as well as basics of assay performance for membrane proteins. Other topics include knowledge of the function and mechanisms of transport proteins.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Annette Beck-Sickinger (abeck-sickinger@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: oral exam 30 min., with weighting factor: 1	
	Lecture "Receptor Biochemistry" (2SWS)
	Seminar "Receptor Biochemistry" (2SWS)

Master of Science

Academic degree	Module number	Module form
Master of Science	**13-121-1311**	**Choice-Obligatory**

Module Name	**Research Practical Course Crystallography in Materials Science**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Crystallography in Materials Science
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Crystallography in Materials Science" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Mineralogie und Materialwissenschaften
Aims	By working scientifically on a current research project in the research group, students develop a broad and critical understanding in the field and gain insight into working independently on research projects.
Content	Participation in a current research project of the group in one of the following areas: a) structure determination of disordered materials; b) synthesis and characterization of metastable tellurides; c) development of new chalcogenide-based thermoelectrics; d) development of methods for real structure analysis; e) silicate and silicate analog network structures. Syntheses are carried out by various solid-state chemical routes, often under inert gas conditions; characterization is carried out by X-ray, synchrotron beam or neutron diffraction on single crystals and powder samples, as well as by transmission electron microscopy and, if necessary, spectroscopic methods and thermal analysis.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Oliver Oeckler (oliver.oeckler@uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Crystallography in Materials Science" (10SWS)

Master of Science ASC-SCS

Academic degree	Module number	Module form
Master of Science	**13-121-1415**	**Choice-Obligatory**

Module Name	**Research Practical Course in Environmental Chemistry**
Recommended for:	1st / 3rd semester
Responsible	Professors for Technical Chemistry (Heterogeneous Catalysis)
Duration	1 semester
Offered in	each winter semester
Teaching formats	• Practical course "Environmental Chemistry" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The students learn to work independently and scientifically by participating in a current research project. They gain knowledge of selected methods for the determination and removal of pollutants and can apply these methods in a research-oriented manner.
Content	Research practicum on the use of analytical methods to determine pollutants in the various compartments; passive collection, O/W partition coefficients, structure-activity relationships, X-ray fluorescence analysis, gamma spectroscopy. Application of basic operations to remove pollutants from the respective compartments; catalytic reduction, catalytic post-combustion, liquid-liquid extraction, membrane extraction, reverse osmosis, ultrasonic treatment.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	tba

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Environmental Chemistry" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-1416**	**Choice-Obligatory**

Module Name	**Recent Trends in Chemistry**
Recommended for:	1st-2nd/2nd–3rd semesters
Responsible	Dean of studies
Duration	2 semesters
Offered in	each semester
Teaching formats	• Colloquium "Recent Trends in Chemistry" (3 SWS) = 45 h attendance time and 105 h self-study = 150 h
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	The students shall be able to understand, discuss and present science topics from current research fields in chemistry
Content	This module course is consisting of independent lectures by different (international) scholars in English. Contents will be communicated each semester.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	(studekan@chemie.uni-leipzig.de) (current dean of studies)

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
	Colloquium "Recent Trends in Chemistry" (3SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**13-121-1422**	**Choice-Obligatory**

Module Name	**Research Practical Course in Atmospheric Chemistry**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Professors for Atmospheric Chemistry
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Atmospheric Chemistry" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Chemie • M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry
Aims	Students know physico-chemical and analytical methods for atmospheric chemical field measurements, as well as laboratory investigations, and are able to apply them in a research-oriented manner.
Content	Research practical course on selected topics in atmospheric chemistry.
Participation requirements	none
Literature	R. Zellner (Hrg.): Global Aspects of Atmospheric Chemistry, Topics in Physical Chemistry; Springer, Berlin 1999 Further literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Hartmut Herrmann (hartmut.herrmann@tropos.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Atmospheric Chemistry" (10SWS)

Master of Science ASC - SCS

Academic degree	Module number	Module form
Master of Science	**09-121-1501**	**Choice-Obligatory**

Module Name	**Research Practical Course in Modern Drug Discovery**
Recommended for:	1st / 2nd / 3rd semester
Responsible	Institute for Drug Development/Pharmaceutical Chemistry
Duration	1 semester
Offered in	each semester
Teaching formats	• Practical course "Modern Methods of Drug Development" (10 SWS) = 150 h attendance time and 150 h self-study = 300 h
Workload	10 ESTC = 300 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Advanced Spectroscopy in Chemistry • M.Sc. Chemie
Aims	The student masters computer-aided design of active substances (small molecules, antibodies or immunogens) and can apply organic chemical synthesis methods or molecular biological methods to produce the active substances. They can characterize the active ingredients by modern analytical methods (e.g. GC-MS, HPLC, ESI, NMR), as well as assess the biological activity and evaluate the structure-activity relationship using appropriate measurement methods.
Content	In the context of this internship, the student will be introduced to the research focus of modern drug development. The research background will first be gained by literature search. The target molecules are designed on the computer. After preparation of the molecules by appropriate synthesis methods (medicinal chemistry or molecular biology), the potential active ingredients are characterized. Finally, the biological activity is tested. The experiments are documented, the results obtained are critically evaluated and finally presented in a presentation.
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Jens Meiler (jens.meiler@medizin.uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: performance in the practical course, with weighting factor: 1	
	Practical course "Modern Drug Discovery" (10SWS)

Master of Science Structural Chemistry and Spectroscopy

Academic degree	Module number	Module form
Master of Science	**12-122-1511**	**Choice-Obligatory**

Module Name	**Basics of Interaction of Electromagnetic Radiation with Matter (Spectroscopy)**
Recommended for:	2nd semester
Responsible	Professors for Chemical Physics
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture " Basics of Interaction of Electromagnetic Radiation with Matter " (4 SWS) = 60 h attendance time and 90 h self-study = 150 h
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemistry and Biotechnology
Aims	Students will master the general principles and essential spectroscopic methods and their application.
Content	- Introduction and history - Absorption and emission of radiation - Structure and symmetry - Nuclear magnetic resonance - Electron paramagnetic resonance - IR, Raman and UV/VIS spectroscopy - X-ray and photoelectron spectroscopy - Moessbauer spectroscopy
Participation requirements	none
Literature	Literature references will be given during the classes.
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	PD Dr. Marko Bertmer (bertmer@physik.uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: oral exam 30 min., with weighting factor: 1	
	Lecture "Basics of Interaction of Electromagnetic Radiation with Matter" (4SWS)

Master of Science Structural Chemistry and Spectroscopy

Academic degree	Module number	Module form
Master of Science	**13-121-0622**	**Choice Obligatory**

Module Name	**Machine Learning: fundamentals and applications in chemistry**
Recommended for:	2nd semester
Responsible	Professors for Theoretical Chemistry of Material Design
Duration	1 semester
Offered in	each summer semester
Teaching formats	Lecture " Machine Learning: fundamentals and applications in chemistry" (2 SWS) = 30 h classes and 60 h self-study = 90 h Seminar " Machine Learning: fundamentals and applications in chemistry" (1 SWS) = 30 h classes and 60 h self-study = 90 h
Workload	5 ECTS = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemistry
Aims	Students gain an insight into the field of artificial intelligence and its application in chemistry. Based on the theoretical background of modern machine learning methods, the students apply the learned methods in an exercise part. Students are introduced to the Python programming language in order to be able to use artificial intelligence. Students work through the exercises in self-study. In the seminar students deal with applications of the methods.
Content	Introduction to artificial intelligence: supervised learning, unsupervised learning, and reinforcement learning. - Representation of chemical systems to artificially intelligent methods: How can we translate chemical systems so that artificially intelligent methods can learn from them? - Regression: from linear regression to ridge regression to deep neural networks and their application in chemistry - Big Data analysis: dimensionality reduction, clustering and classification - Molecular and material design with generative models - Self-Driven Laboratories: State of the art and potential of AI in chemistry
Participation requirements	Basic understanding of theoretical chemistry
Literature	Pavlo Dral: „Quantum Chemistry in the Age of Machine Learning“ Christopher M. Bishop: „Pattern Recognition and Machine Learning“ Ian Goodfellow, Yoshua Bengio and Aaron Courville: „Deep Learning“ Literature references will be given during the classes.
Assignment of	Credit points are awarded upon successful completion of the module.

credit points	Further details are specified in the examination regulations.
Teaching staff and contact email	Prof. Dr. Julia Westermayr, julia.westermayr@uni-leipzig.de

Performance assessment and prerequisites for examination

Module examination: Written exam 90 min., with weighting factor: 1	
Written exam (60 min.)*, weighting 2	Lecture " Machine Learning: fundamentals and applications in chemistry" (2 SWS)
Presentation (20 min.), weighting 1	Seminar " Machine Learning: fundamentals and applications in chemistry" (1 SWS)

Master of Science Structural Chemistry and Spectroscopy

Academic degree	Module number	Module form
Master of Science	**13-122-1503**	**Choice Obligatory**

Module Name	**Computer-aided drug discovery**
Recommended for:	2nd semester
Responsible	Professors for Pharmaceutical chemistry
Duration	1 semester
Offered in	each summer semester
Teaching formats	• Lecture " Computer-aided drug discovery" (2 SWS) = 30 h attendance time and 60 h self-study = 90 h • Seminar " Computer-aided drug discovery" (1 SWS) = 15 h attendance time and 45 h self-study = 60 h
Workload	5 ESTC = 150 working hours
Within programs	• M.Sc. Structural Chemistry and Spectroscopy • M.Sc. Chemie
Aims	After active participation in the module, students will be able to - define and explain basic terms from the lecture - describe and analyze selected methods and algorithms of virtual drug screening and drug design - explain algorithmic approaches and apply them to problems independently - to solve problems practically in the form of a software-based procedure.
Content	Types of virtual drug libraries (fragment-based, reaction-based, etc.). Coding of chemical molecules and reactions. Molecular descriptors and their use for modeling structure-activity relationships (QSAR). Algorithms of ligand and receptor-based virtual screening (machine learning methods, ligand docking, and others). Importance and application of pharmacophore models in virtual screening. Modeling of receptor-ligand interactions (scoring functions, molecular dynamics, and others). The lecture content will be reinforced by the seminar in which current research in computational drug discovery will be discussed.
Participation requirements	none
Literature	Literature references will be given during the classes
Assignment of credit points	Credit points are awarded upon successful completion of the module. Further details are specified in the examination regulations.
Teaching staff and contact email	Dr. Georg Künze (georg.kuenze@medizin.uni-leipzig.de)

Performance assessment and prerequisites for examination

Module examination: Oral examination 30 min., with weighting: 1 Pre-requisite: 1 presentation (20 min.) in seminar	
	Lecture " Computer-aided drug discovery" (2SWS)
	Seminar " Computer-aided drug discovery" (1SWS)